Cointegration and nonlinear causality amongst gold, oil, and the Indian stock market: Evidence from implied volatility indices

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ARTICLE INFO

ABSTRACT

The emerging economy of India counts gold and oil amongst its top imports, suggesting that the prices of these resources affect the domestic inflation and stock market. Expectations on future volatility in these prices might lead to changes in the expected (implied) volatility of the Indian stock market. Unlike prior studies, we use implied volatility indices to examine the cointegration and nonlinear causality amongst international gold, crude oil, and the Indian stock market. Results indicate the presence of cointegration relationships and a nonlinear and positive impact of the implied volatilities of gold and oil on the implied volatility of the Indian stock market. Interestingly, there is evidence of an inverse bi-directional causality between the implied volatilities of gold and oil prices.

1. Introduction

There is no doubt that crude oil and gold are two leading imported commodities of India, as India is one of the two leading consumers of crude oil and gold; the other one is China. In 2013, India consumed more than 3660 million barrels of crude oil per day (IndexMundi, 2016), and the Energy Information Administration (EIA) indicates that India's demand for oil is expected to expand to 10 million barrels per day by 2040. In parallel, the World Gold Council (2016) shows that India consumed 864.3 metric tons of gold in 2015 and officially holds 557.8 metric tons of gold, representing more than 6% of its total reserves. Several studies suggest that India is a key driver of the world commodity markets, in particular oil and gold, due to its consistent and high economic growth.

Crude oil and gold are strategic resources that are largely used in various national economic activities and in national security. Large fluctuations in oil and gold markets lead to increased price volatility, which affects price stabilization policies and imposes more challenges on market participants (producers, consumers, and investors), who often try to predict the future prices of gold and oil. Increased price volatility also plays an important role in determining the price of options and the value at risk.

As commodities have emerged as an investment asset class, economic actors are especially interested in the interactions across oil, gold, and the stock markets, given the unprecedented booms and busts in energy and metals prices. Several portfolio managers now include oil and gold in equity portfolios to enhance their risk-adjusted return (Jain and Biswal, 2016). Furthermore, based on strong evidence on the hedge and safe haven properties of gold, and to a lesser extent of oil, investors often hedge the downside risk of their equity portfolio using these two commodities (Chkili, 2016; Ciner et al., 2013). The fact that investors switch between commodities and stock markets to optimize their risk-adjusted returns further motivates us to conduct this study (Jain and Biswal, 2016).

In addition to return linkages, many studies have looked at the volatility linkages across oil, gold, and stock prices. Along with the studies related to the 2007-08 global financial crisis (GFC) and the financialization of commodity markets (Aboura and Chevallier, 2015), other studies also argue that several macroeconomic variables that include gold and oil prices and their volatilities, can affect stock market indices (Jain and Biswal, 2016). While most prior studies have relied on historical volatilities proxied by absolute returns, squared returns, or models based on GARCH frameworks, this study instead uses the newly published implied volatility indices in studying the relationships across gold, oil, and the Indian stock market over the period from June 2009 to May 2016. Implied volatility indices have been shown to have

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more informational content in predicting future volatility than other volatility measures.

The existing literature provides evidence on the superiority of the implied volatility measure over other aforementioned measures. Published by the Chicago Board Options Exchange (CBOE), implied volatility indices are derived from option prices. Given that most option traders are well-informed institutional traders, we argue that the implied volatility is a better measure in forecasting future volatility than historical volatility. In this sense, implied volatility indices not only reflect historical volatility information, but also investors' expectation on future market conditions (Liu et al., 2013). Accordingly, they represent a forward-looking measure of market uncertainty.

Through the use of implied volatility indices, and given the valuable properties of the implied volatility indices, this study provides a novel extension to the work of authors such as Jain and Biswal (2016) who have used gold, crude oil, and Indian stock price series to model volatility. Haugom et al. (2014) provide evidence that daily and weekly volatility forecasting can significantly improve if information from the implied volatility index for crude oil is included in the forecasting model. This paper also extends the current literature, which has mostly relied on linear models to examine the volatility relationships between commodities and stock markets (Lin et al., 2014; Sadorsky, 2014). It also extends the work of Maghyereh et al. (2016), which has only examined the relationships between the implied volatilities of oil and stock indices.

Motivated by the works of Jain and Ghosh (2013) and Jain and Biswal (2016), we use several econometric tests that include the ARDL Bounds testing approach to co-integration as well as the non-linear asymmetric causality test of Kyrtsou and Labys (2006). The importance of our econometric approach lies in its focus on the nonlinearities between the implied volatilities of commodities and stock indices (Beckmann et al., 2015).

Our sample period is from June 2009 to May 2016. This allows us to provide a recent view on the volatility relationships across gold, oil, and stock prices, while most of the prior literature has only accounted for the periods before and around the GFC. Compared to prior studies, this study therefore provides insights from the post-GFC period, which represents a quite interesting period for gold, crude oil, and equity markets in India. In fact, during this period, the price of an ounce of gold had peaked to around $1900 in September 2011 and then declined by about one-third. Crude oil, which had peaked to around $145 earlier in July 2008, has suffered an extreme rise and decline in prices. As for the Indian stock market, it has experienced a major steady upward movement in which the Nifty index advanced more than 3000 points or nearly 70% between June 2009 and May 2016.

The rest of the paper is structured as follows. Section 2 reviews the related literature. Section 3 describes the data and econometric models. Section 4 provides and discusses the results. Finally, Section 5 concludes.

2. Review of related literature

A large body of literature exists, describing the relationships between crude oil, gold, and stock markets in developed economies (see Ciner et al. (2013), among others), but only a small proportion of literature focuses on these relationships in developing and emerging economies (Baur and McDermott, 2010; Gurgun and Unalmis, 2014; Mensi et al., 2014). Given the focus of our study, special attention is given to literature on the oil-stock and gold-stock relationships in an emerging economy like India.

Baur and McDermott (2010) use data from 1979 to 2009 within a regression analysis augmented with dummy variables that represent extreme market conditions. They argue that gold cannot act as an effective hedge against extreme movements in the BRIC stock markets that include India. Using the same methodology but a different data set that spans from 1992 to 2013, Gurgun and Unalmis (2014) highlight

the hedge and safe haven properties of gold for Indian stock markets in their role as part of some emerging and developing countries. Using a multivariate GARCH model, Kumar (2014) examines the mean and variance linkages between gold prices and Indian sectoral indices, and shows unidirectional significant return spillover from gold to stock, and no evidence of a volatility spillover running from gold prices. The author also highlights the hedging effectiveness of adding gold to a portfolio of Indian stocks.

Mensi et al. (2014) use a quantile regression approach to examine the dependence structure between the BRICS stock markets and several influential global factors from September 1997 to September 2013. They show that the BRICS stock markets exhibit dependence on oil and gold prices, as well as on changes in the uncertainty of the US stock market as measured by the CBOE VIX index. Using a cointegration test, vector error correction model, Granger causality test, impulse response functions, and variance decompositions, Sahu et al. (2014) indicate the existence of a long-term relationship between oil and the Indian stock markets from January 2001 to March 2013. They also confirm that no short-run causality exists between the examined variables, and reveal that a positive shock in oil price has a small but persistent positive impact on Indian stocks in the short run.

Beckmann et al. (2015) use a smooth transition regression to assess the hedge and safe haven roles of gold from 1970 to March 2012 on a monthly frequency, and find that gold exhibits a strong safe haven function in India. The authors also highlight the importance of nonlinearity in modelling the gold-stock relationship. Chkili (2016) uses an asymmetric DCC model for weekly data on gold and BRICS stock markets. The author provides evidence that gold can act as a safe haven in times of market stress and thereby can reduce the risk of a portfolio composed of BRICS stocks.

An interesting study, Shalini and Prasanna (2016), uses a Markov regime shift model and shows that Indian metal and energy futures indices have a significant relationship with the Indian stock market returns. Furthermore, the energy futures index has an inverse relationship with Indian stock during the tranquil period and a positive relationship in the crisis period. As for the metal futures index, it has an inverse relationship with stock returns in both tranquil and crisis periods. This implies that gold has a negative relationship with the Indian stock market. Ghosh and Kanjilal (2016) use nonlinear threshold cointegration tests to examine nonlinear cointegration between international crude oil and Indian stock market indices from January 2, 2003 to July 29, 2011. Their overall results reveal the presence of a long-run relationship between the examined variables. Jain and Biswal (2016) use a DCC-GARCH model and a nonlinear causality test to examine the relationship between prices of gold, crude oil, and Indian stocks. They uncover strong relationships across the examined variables, suggesting the importance of using gold and oil prices to restrain stock market volatility.

The importance of the GFC of 2007–2008 in intensifying the relationships between oil, gold, and stock markets has also been the subject of several studies (see Zhang and Wei (2010), among others).

The role of the increased financialization phenomenon in the commodity markets has also been reported in prior literature. Cartwright and Riabko (2015) indicate that, in addition to the laws of supply and demand, diversification strategies and risk appetite of index investors and fund managers also affect commodity prices. Similar results are reported by Adams and Glück (2015), who suggest that the flow of index investments into commodity futures has distorted commodity prices and changed their dependence structure. Furthermore, Aboura and Chevallier (2015) indicate that the financialization phenomenon has increased interactions between financial and commodity markets, especially after the GFC period. Brunetti and Reiffen (2014) show that commodity index positions have contributed to the increase in the volatility of commodity markets.

The above review of literature shows close interactions between the prices of gold, oil, and the Indian stock markets. However, prior studies