1. Introduction

On account of oil’s frequent tradability, voluminous trades, high liquidity and synchronization of its movement, gold has held its righteous positions in not only national but in international economies as well. Oil is the commodity with the highest volume of trade and with higher price volatility and gold, on the other hand, is the most traded precious metal with the lowest price volatility. A comprehensive analysis of oil and gold prices suggests that prices of both are strongly related. Oil and gold hold a positive price correlation of 80% in the last 50 years.1 There are a large number of studies suggesting that oil price changes give rise to price variations in gold. To illustrate, according to Sari et al. (2010) gold price changes are related to the oil price changes and oil price changes explain the 1.7% of the price change in gold. Hence, an empirical study is of enormous importance in examining this relationship and this study aims to examine the causality-in-quantiles running from oil to gold.

There are several channels accounting for the relation between oil and gold prices. Many oil-exporting countries, for instance, perform oil transaction in return for gold. Due to its nature of safe investment, oil revenues are invested in gold. Besides, the costs in gold mining are very much related to energy and oil issues. This being the case, a rise in energy and oil prices inevitably has an impact on the costs in gold mining. Another channel effective in explaining the relation between oil and gold prices is inflation. As a support to explain this connection, Narayan et al. (2010) argues that the relation between oil and gold prices can be best explained through inflation. Other things being equal, a rise in oil prices at the international scale will affect the prices in global terms and will have a negative effect on the oil importing countries, yielding a negative relation between oil and inflation. Nowadays, gold is regarded as an instrument investors buy to balance their portfolio during times with high inflation (Ghosh, 2011). Since gold is a safe means of investment (safe heaven) the price of gold goes up in high inflation periods, hence, as oil prices rise so does inflation and price of gold.

The literature on oil and gold price relationship and their interaction with a specific emphasis on macroeconomic and financial issues is scant. Each economic crisis led to some studies into the issue, especially gold seen as a safe haven. One of the leading studies is that of Melvin and Sultan (1990) and Kim and Dilts (2011), in which they found out a high correlation between oil and gold in terms of export channel. Nevertheless, the literature hosts other studies with no evidence of the relationship between the rises in prices of oil and gold (e.g., Soytas et al., 2009; Liao and Chen, 2008; Sari et al., 2007; Hammoudeh and Yuan, 2008; Narayan et al., 2010; Simakova, 2011; Le and Chang, 2011 and Lee et al., 2012). Sari et al. (2007) examined the dynamic links among commodities such as the oil, gold, silver and copper and financial variables, exchange rate and the interest rate.
Their result showed that gold and exchange rate have predictive power for the oil, but oil does not have significant explanatory power these commodities. Soytas et al. (2009) studied the dynamic relationships among the oil, commodities (gold and silver), and financial variables (dollar exchange rate and bond rate) in Turkey. They examined both the short- and long-run dynamic interactions and concluded that oil prices do not have significant explanatory power for the gold.

Thus, the empirical evidence on the relationship between the oil and gold markets can be best described as mixed, if not confusing. The studies on oil-gold relationship center more on whether oil has predictive power for gold and given the mixed evidence further studies are needed. The mixed evidence on the relationship between the oil and gold gets even more complicated due the use of different sample periods, methods and countries under consideration. What is more important is that no comprehensive and insightful study exists to date to examine the relationship between oil and gold prices. A study that takes into account of nonlinearities, structural breaks, outliers and effects of extreme markets conditions in the analysis of the oil and gold market relationship will resolve some of the ambiguities relating to the empirical studies.

Against this backdrop, the objective of the current study is to use the recently proposed nonparametric causality-in-quantiles test by of Balcilar et al. (2016a, 2016b) to analyze the predictability of mean and variance of gold price by oil price. The weekly data for the spot and 1- to 12-month futures prices of oil and gold market have been employed. The sample period ends at 8/10/16 and the beginning of the sample varies from 4/6/83 to 1/8/86 due to the varying operation start-up times in the futures markets.

Our first contribution to the literature on oil and gold price is that, rather than focusing on specific episodes of market periods, we use a nonparametric quantile testing approach which is rich enough to consider all market conditions jointly (low volatility, high volatility, crises, crashes, or bubbles). Thus, we can examine the predictive content of the oil market for the gold market under different market conditions. This will allow us to see under what conditions oil does predict the gold or does not. Our second contribution to the literature is the consideration of the both spot and futures markets. To our knowledge Narayan et al. (2010) is the only study considering futures markets. However, our study considers dynamic nonparametric quantile Granger causality and, therefore, significantly differs from Narayan et al. (2010) which only considers contemporaneous relationship via a static regression. Our third contribution to the literature is the examination of causality not only in mean but also causality in variance (volatility). Previous literature only studied the predictive power of the oil for gold in mean. Oil market may have predictive power for the second moment (variance) even if it does not have predictive power for the first moment (mean). The predictive power of oil market for gold market volatility can even be more important for investors and portfolio manager in developing hedging strategies. Our last contribution to the literature on oil and gold price causal nexus is that we use a novel nonparametric causality-in-quantiles test recently proposed by Balcilar et al. (2016a, 2016b) to study whether oil price causes gold price returns and volatility. Their test integrates the test for nonlinear causality of k-th order developed by Nishiyama et al. (2011) with the quantile-causality test advanced by Jeong et al. (2012) and, hence, can be considered to be a generalization of the former. The causality-in-quantiles approach mainly has three novel aspects: first, this approach identifies the dependence structure of the time series under consideration using a nonparametric estimation and therefore misspecification errors are at minimum level or none. Next, it is viable to test both causality-in-mean and causality-in-variance; this being the case, it allows for higher-order dependency investigation, considered an essential point since there might be no causality in the conditional-mean for some periods, but higher-order dependency might be exists in the same periods. Finally, to date, this paper is the first one to examine the predictability and volatility of gold returns with the nonparametric causality-in-quantiles method, to the best knowledge of the authors. Our results show that oil prices have a weak predictive power for gold markets, as suggested by the results of the nonparametric causality tests. Still, we obtain strong evidence for causality-in-variance tests as we strongly reject the null hypothesis that oil prices does not Granger cause gold price volatility for spot and the futures markets at all maturities.

The paper is organized as the following: Section-2 accommodates the literature review, Section-3 introduces the method and Section-4 presents the data and the results and lastly Section-5 presents the conclusion.

2. Literature review

There are some studies (e.g., Zhang and Wei, 2010) holding that oil and gold prices have high correlation, which is attributed to the phenomenon that high oil prices could have negative effect for economies and which in turn has an adverse effect that lowers the share prices (Kilian, 2009). Also, according to Melvin and Sultan (1990), export revenue channel may be used to explain the relationship between oil and gold prices. In an attempt to distribute the risks involved and to sustain the value of commodities and in order to possess more gold in their portfolio, major oil exporting countries invest the revenues obtained from oil in gold, paving the way for a rise in price of gold by increasing the demand. Finally, as stated by Narayan et al. (2010), Hooker (2002), Hunt (2006) and Beckmann and Czudaj (2013), inflation channel fits well in explaining the relation between oil and gold markets. On the other hand, there are studies, e.g., Bampinas and Panagiotidis (2015), claiming that oil and gold prices go hand in hand due to the correlation stemming from the volatility in US dollars and in international politics.

From the empirical perspectives, there are studies using time series data for a given country (Abhyankar et al., 2013; Mollick and Assefa, 2013; Reboredo, 2013; Wang and Chueh, 2013; Tiwari and Sahadudheen, 2015; and Ghosh and Kanjilal, 2016) and studies with cross-national data (Cuadra and Perez de Gracia, 2003, 2005; Cologni and Manera, 2008; Asteriou and Bashmakoiva, 2013; Degiannakis et al., 2014; and Cuadra and de Gracia, 2014). Considering the energy sectors, studies with the theme of oil and stock markets are on the increase (e.g., Basher and Sadorsky, 2006; Park and Ratti, 2008; Kilian and Park, 2009; and Broadstock and Filia, 2014). As suggested by Kilian and Park (2009), the reaction of real stock returns depends on the demand-driven increases or supply shock in the crude oil market.

A position of a country in the global crude oil market is very much related to the impacts of oil price uncertainty, as shown by Wang et al. (2013). They reveal that, compared to oil-importing countries, the relation between demand uncertainties on stock market is negative, much stronger and more persistent in oil exporting countries. Furthermore, there are studies incorporating short-term interest rates in their models to determine the effect of oil price shock on stock markets (e.g., Cong et al., 2008 and Park and Ratti, 2008).

Exchange rate is another variable used in examining the stock market revenues (Mishra, 2004). However, the results obtained from studies using exchange rates could yield misleading results because they do not integrate oil prices as an important variable, a significant one in the relation between exchange rate and stock market (Abdelaziz et al., 2008).

What is more, the number of studies on the relations between gold prices and macroeconomic variables is fewer when compared with oil prices (Patel, 2013; Reboredo and Rivera-Castro, 2014; Arouiri et al., 2015; Beckmann et al., 2015; and Pierdzioch et al., 2015). The theoretical framework puts forward that the volatility in the exchange rate of dollar have an impact on gold prices, for gold price is quoted in US dollars. The price of gold is likely to go up in the event of dollar depreciation and the value of gold is sustained in this manner. For this reason, gold is seen as a safe asset against currency fluctuations,
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