Contents lists available at ScienceDirect

## Physica A

journal homepage: www.elsevier.com/locate/physa

## Oil-gold time varying nexus: A time-frequency analysis

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#### НІСНLІСНТЅ

- Time varying nexus of oil-gold pairwise are studied.
- DCC-GARCH model is implemented to analyze the time varying dynamic conditional correlations.
- A novel approach are proposed: The Wavelet-based time varying hedge ratio.
- A reverse nexus for oil-gold pairwise in the mid-run and long-run horizons.

#### ARTICLE INFO

Article history: Received 3 February 2017 Received in revised form 14 February 2018 Available online 4 March 2018

Keywords: DCC-MGARCH Wavelet analysis Global financial crisis Hedging Oil Gold

#### ABSTRACT

This paper analyzes the time varying nexus for oil–gold pairwise by employing the dynamic conditional correlation generalized multivariate autoregressive conditional heteroscedasticity DCC-MGARCH model of Engle (2002) as well as the time-scale approach based on multi-resolution analysis. For this goal, we focus on three subsamples, **before**, **during** and **after** the 2008–2009 global financial crisis. Key findings are as follows. (i) Wavelet analysis is a splendid complement to analyze the nexus between oil and gold markets. (ii) Low nexus for oil–gold pairwise after the recent global financial crisis. (iii) Gold and oil moved in reverse direction in the mid-run and long-run horizons during the crisis. (iv) Thanks to wavelets for helping financial managers and investors to manage their investment risks and making decision strategies.

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#### 1. Introduction

In the last decade, there were sharp changes in oil and gold market prices. For instance, the West Texas Intermediate (WTI) oil spot price moved down from \$145.310 per barrel in July 2008 to \$26.190 per barrel in February 2016 for the first time in its history (source: Energy Information Administration). Gold price rose from \$610.800 per ounce in January 2007 to \$1889.400 per ounce in August 2011. In addition to that, as shown in Fig. 1 we noticed that gold price increased dramatically during the global financial crisis and the European debt crisis due to a series of crises and world turmoils, such as, the US sub-prime crisis in 2007, the global financial crisis in 2008–2009, the Euro-zone sovereign debt crisis in 2010–2012, political turmoils in Libya (Exporting oil country) in 2011, the crisis in Syria and Yemen during the last six years, and more recently, the war in Iraq, among others. Changes in crude oil price affected almost world economies, including gold market. Gold is a precious metal which is treated as commodity and a monetary asset. It is shown that gold serves as a safe haven in periods of market crises (See [1–5, among others]).







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Fig. 1. Time series plots of oil (dollars per barrel) and gold (dollars per ounce). For interpretation of the references to color in this figure, the reader is referred to the web version of this article.

The noteworthy increase of gold spot price during the recent crisis mentioned above has motivated other researchers to explore the linkage between oil market and gold market and to examine straightforward the viability of gold as a safe haven from losses in other financial markets including oil market. During the last decade, especially during the 2008–2009 global financial crisis and the 2010–2012 Euro-zone sovereign debt crisis, the oil and gold markets have shown serious drops in market volatility which have been a starting point for concern to policymakers, financial market participants, portfolio managers, global investors and central banks. However, there existed a variety of investors who participated into markets with various investment horizons, for instance, the long-run investors (central banks) traded at monthly and yearly horizons and based their investment strategies on fundamental analysis, the mid-run investors (biweekly or monthly investors) base their investment strategies on speculation and operate on daily and weekly horizons.

In order to analyze the co-movements between oil market and gold market in a time-frequency base and to explore the behavior of various types of investors we adopt wavelet analysis. Wavelet theory was born in the mid-1980s with Grossmann and Morlet [6]. This approach is extensively used in physics, chemistry, hydrology, signal processing, etc., and more recently in economics and finance. For a review of literature on the wavelet applications to economics and finance, the reader is referred to [7–16, among others].

Given the importance of gold and oil assets, which represent the most actively traded commodities in the world and given the relationship between markets, including oil market and gold market, we propose that instability in prices in one market (say oil market) are likely to affect other markets (say gold market),

we investigate the dynamic correlation between oil and gold markets according to various investment horizons. The reasons for choosing the oil and gold markets are as follows.

- First, gold is considered as a safe haven from market turbulence. (see [17] and [3]). In addition, gold is easily divisible because it can be converted into bars and coins (gold bullion), and it is well-considered as the highly durable asset among all physical assets.
- Second, oil is one of the most important global commodities since it is a vital input of production and its price is driven by the shocks on market supply and market demand. It is also considered as a safe haven against extreme declines in the US bond markets (see [3]).

Under this circumstance, it is important to examine the linkage between oil market and gold market. However, we aim to study the dynamic correlations between oil and gold markets with respect to various investment horizons, which might be informative for policymakers and financial participants. To understand the dynamic linkages between the two markets according to the behavior of various types of investors bearing various investment horizons, we combine a time-scale wavelet analysis with the famous dynamic correlation approach of Engle [18].

There is a large literature studying the linkages between financial markets in a time domain approach only. Consequently, this approach suffers from lack of information about long-run behavior. This crucial loss of information might be well important for policymakers, market participants and investors in the whole. By applying wavelets (Time–frequency domain), we are able to analyze the dynamics between markets simultaneously in the short-run and long-run horizons and we are able to identify hedging strategy decisions and portfolio diversification opportunities for various set of investors bearing various

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