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Gold, oil, and stocks: Dynamic correlations☆

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ABSTRACT

We employ a wavelet approach and conduct a time-frequency analysis of dynamic correlations between pairs of key traded assets (gold, oil, and stocks) covering the period from 1987 to 2012. The analysis is performed on both intra-day and daily data. We show that heterogeneity in correlations across a number of investment horizons between pairs of assets is a dominant feature during times of economic downturn and financial turbulence for all three pairs of the assets under research. Heterogeneity prevails in correlations between gold and stocks. After the 2008 crisis, correlations among all three assets increase and become homogenous: the timing differs for the three pairs but coincides with the structural breaks that are identified in specific correlation dynamics. A strong implication emerges: during the period under research, and from a different-investment-horizons perspective, all three assets could be used in a well-diversified portfolio only during relatively short periods.

1. Introduction

Given the extent of the global financial market, co-movements in asset prices receive considerable attention due to their relevance to market integration, portfolio diversification, cross–hedging, and cross-speculation.[1] However, a majority of the empirical analyses that investigate dynamic co-movements employ a time-domain approach that is limited to dynamic links while the frequency analysis of investment horizons is omitted (Ramsey, 2002). Yet, dynamic correlations among assets have been documented to have specific characteristics for particular investment horizons (Conlon, Cotter, & Gençay, 2015), which may be instructive both for policy-makers (financial stability measures) and market participants (predictions of price changes). To better understand the co-

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[1] The literature on co-movements is vast and a full review is beyond the scope of our study. There was a wave of publications on co-movements in top-tier journals in the mid-1990s. More recent contributions include Forbes and Rigobon (2002), Greenwood (2008), Bekaert et al. (2009), Green and Hwang (2009), and Bekaert et al. (2010) with a focus on co-movement factors. Later in this section we introduce studies that are more directly related to our analysis.

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movements in asset prices a combined time and frequency analysis is needed. In this paper we take a comprehensive approach to enrich the literature. We perform a time-frequency wavelet analysis of three important assets that have unique economic and financial characteristics: gold, oil, and stocks. For comparison, we also employ standard techniques as well as include a cointegration analysis. By covering a long time span (1987–2012) at both intra-day and daily frequencies and using an array of investment horizons, we deliver a comprehensive study of the dynamic correlations among different classes of major assets.[2] To the best of our knowledge our paper is the first to address the issue of the heterogeneity in correlations among several highly financialized assets over various investment horizons and it brings new insights into their dynamics.

A knowledge of the correlations among assets at different investment horizons is significant for several reasons that are underpinned by the fact that homogenous correlations between assets across investment horizons preclude effective risk diversification in time. First, the importance of various investment horizons for portfolio selection was already recognized by Samuelson (1989). In this respect, Marshall (1994) showed that investors' preference for risk is inversely related to time and different investment horizons have direct implications for portfolio selection.[3] Second, there exist a variety of investors with markedly different investment horizons and transmissions of shocks through market transactions may vary according to time scale (Reboredo & Rivera-Castro, 2014a). Long-term investors base their strategy on fundamental analysis and trade at monthly or yearly horizons. Weekly or daily investors operate on much shorter horizons and base their strategies more on technical analysis. The shortest investment horizons are the domain of speculative traders that operate on an intra-day basis. In such an environment, market activity is necessarily far from homogeneous. Still, the dynamics of the market would be subject to interactions across all trading classes at different investment horizons (Gençay, Gradojevic, Selçuk, & Whitcher, 2010). Third, heterogeneity of market behavior coupled with interactions among assets might result in dynamic correlations among assets that would exhibit less-than-obvious patterns.

We aim to analyze those patterns simultaneously in the time and frequency domains by employing wavelet analysis. Gençay, Selçuk, and Whitcher (2001) and Ramsey (2002) provide ample exposition on the use and versatility of wavelet techniques in economics and finance. During the past decade the methodology gained currency and relevant applications of wavelets include analyses of stocks (Fernandez, 2006, 2008; In & Kim, 2006; Rua & Nunes, 2009), commodities (Graham, Kiviaho, & Nikkinen, 2013; Reboredo & Rivera-Castro, 2014a; Vacha & Barunik, 2012), exchange rates (Karuppiah & Los, 2005; Nekhili, Altay-Salih, & Gençay, 2002; Nikkinen, Pynnönen, Ranta, & Vähämaa, 2011), and other financial and economic variables or their interactions (Aguiar-Conraria & Soares, 2011; Aguiar-Conraria, Martins, & Soares, 2012; Faÿ, Moulines, Roueff, & Taqqu, 2009; Gallegati, Gallegati, Ramsey, & Semmler, 2011 Kim & In, 2005, 2007; Reboredo & Rivera-Castro, 2014b; Rua, 2010).

By using wavelets we are able to test the hypothesis on the existence of homogeneity in dynamic correlations across various investment horizons among assets, an issue that so far has been largely overlooked in the literature. In this way we are able to explore the following related questions: To what extent do the assets co-move at different investment horizons? Do correlations among the assets at various investment horizons vary a lot or a little, and are they subject to dramatic changes? Do they share a long-term equilibrium relationship?

For our empirical analysis we chose three assets: gold, oil, and stocks (proxied by the S&P 500). This selection is based on the following reasons: (i) gold and oil represent the most actively traded commodities in the world and the S&P 500 is one of the most actively traded and comprehensive stock indices[4]; (ii) all three assets exhibit marked differences in leverage, which makes them highly interesting from a financial perspective; (iii) there is a motivation for the existence of links among the three assets but empirical evidence is limited to a time-domain approach. Below we review some key facts that further underpin the above reasoning along with some of the literature covering co-movements among the assets under research.

In terms of individual assets, first, gold is traditionally perceived as a store of wealth, especially with respect to periods of political and economic insecurity (Aggarwal & Lucey, 2007). However, gold is a commodity as well as a monetary asset. In this respect Batten, Ciner, and Lucey (2010) find monetary variables to explain gold volatility. The behavior of gold prices is covered by Lucey, Larkin, and O'Connor (2013). Second, the key importance of oil comes from an industrial perspective and its importance for our society can be documented by the almost 90 million barrels of daily global consumption.[5] As oil is a vital input of production, its price is driven by distinct demand and supply shocks. Lombardi and Van Robays (2011) find that a short run destabilization in the oil price may be caused by financial investors. However, they argue that while financial activity boosted volatility in the oil market over the recent 2007–2008 crisis, shocks to oil demand and supply remain the main drivers of oil price swings. Over the years, oil also became heavily financialized, as documented in Büyükşahin and Robe (2013). Third, from an economic perspective, stocks reflect the economic and financial development of firms, and market perceptions of a company's standing. They also represent investment opportunities, as well as a link to perceptions of aggregate economic development. Further, stock prices provide helpful information on financial stability and can serve as an indicator of crisis (Gadanecz & Jayaram, 2009). Hence, a wide market index can be used to convey messages on the status and stability of the economy.

From the above account, one may sense that the channels through which the links and co-movements among the assets under research may propagate are not limited only to differences among investors and their investment horizons.[6] For example, the

[2] The literature on asset co-movements is fragmented in terms of the assets used, time spans, data frequencies, and the techniques employed. Further, correlation analyses usually investigate behavior within a specific class of assets and often disregard the existence of structural shifts.

[3] A parallel can be drawn from the classical term structure theory of interest rates where different maturities are, in a sense, investment horizons as well.

[4] According to the CME Group Leading Products Resource, S&P 500 futures are traded with the highest average volume among equity indices, gold among metals, and oil among energy commodities (http://www.cmegroup.com/education/featured-reports/cme-group-leading-products.html).

[5] The corresponding consumption figures in millions of barrels daily are 29 for Asia, 18.5 for the U.S.A., and 14.4 for Europe (2012 World Oil Consumption in millions of barrels per day, U.S. Energy Information Administration, assessed on March 1, 2014, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=5&pid=5&aid=2).

[6] Investment horizons are associated with various types of investors, trading tools, and strategies that correspond to different trading frequencies (Gençay et al., 2010).