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## On the time scale behavior of equity-commodity links: Implications for portfolio management<sup>☆</sup>

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### ABSTRACT

We investigate the time-scale relationships between US equity and commodity markets. The empirical evidence from the risk-return profitability analysis based on the wavelet coherence measure shows that equity and commodity markets exhibit time-varying co-movement patterns and behave differently across investment horizons. Moreover, we find evidence of time-frequency causality between the two investigated markets. Our results can have important implications for optimal asset allocation and portfolio diversification.

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## 1. Introduction

The last two decades have witnessed a number of significant changes in international financial markets. In particular, high volatility and contagion risk, arising from increased financial integration and interdependence amongst stock markets, has created lower diversification benefits for global investors and higher systemic risk (e.g., [Forbes and Rigobon, 2002](#); [Markwat et al., 2009](#); [Aloui et al., 2011](#)). This has led some investors and portfolio managers to seek diversification benefits in other asset classes. As commodity assets are not dependent on the same macroeconomic factors and also exhibit low correlation against equities, they seem to offer attractive risk-adjusted returns as reported in [Gorton and Rouwenhorst \(2006\)](#), [Daskalaki and Skiadopoulos \(2011\)](#), and [Roll \(2013\)](#) among others. The growing financialization of commodity markets further facilitates the allocation of commodities in large multi-asset portfolios to accomplish investment or hedging demands ([Dwyer et al., 2011](#); [Hong and Yogo, 2012](#)).

A plethora of past and recent studies reveals commodity price dynamics and their interactions with the macroeconomy and equity markets ([Fama and French, 1987](#); [Elder and Jin, 2007](#); [Byrne et al., 2013](#); [Vacha and Barunik, 2012](#); [Narayan et al., 2013](#)). Indicatively, [Fama and French \(1987\)](#) find evidence of a time-varying risk premium as well as enhanced forecastability for many commodity futures over the period 1967–1984. [Elder and Jin \(2007\)](#), studying the volatility of the agricultural

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commodity futures market find evidence of long memory with finite unconditional variance. [Byrne et al. \(2013\)](#) explores the determinants of commodity price fluctuations for developing and developed countries, and reports a statistically significant degree of co-movement that is attributable to common factors. Demand and supply shocks as well as information transmission across different commodity markets can also affect their co-movement with equity markets as described in [Chkili et al. \(2014\)](#), [West and Wong \(2014\)](#), and [Arezki et al. \(2014\)](#).

The links between commodity and equity markets have been also analyzed in recent studies. [Aloui et al. \(2013\)](#) examine the relationship between crude oil and exchange rates and [Pukthuanthong and Roll \(2011\)](#) between currencies and gold. [Gorton and Rouwenhorst \(2006\)](#) find a negative correlation between an equally weighted index of monthly returns of commodity futures and US equity returns over the period July 1959–December 2004. Moreover, [Chong and Miffre \(2010\)](#) examine the conditional correlations between 25 commodity futures and 13 stock and fixed-income indices, and report a decrease in their linkages over time. Because of this decrease, the authors suggest that commodity futures have become more valuable in strategic asset allocation. In addition, they find that the correlation of 11 out of 25 commodities vis-à-vis S&P500 is lower during bearish periods than an average. However, commodity–equity asymmetric correlation and/or its decreasing trend are not always supported by empirical evidence. For instance, [Delatte and Lopez \(2013\)](#) use a copula approach to investigate the conditional dependence structure between commodity and equity markets and find that the dependence structure is time-varying, frequent and symmetric. [Büyüksahin and Harris \(2011\)](#) using an extensive dataset of trader positions in U.S. energy futures markets, show that dynamic conditional correlations between returns on investable energy and stock market indices increase with greater speculative activity. Similarly, the results of [Silvennoinen and Thorp \(2013\)](#) and [Hong and Yogo \(2010\)](#) using a smooth transition bivariate GARCH model, find an increasing co-movement between commodities and financial markets, which can be explained by their high sensitivity to common predictors, such as the short rate and the yield spread. Finally, in a related study, [Chan et al. \(2011\)](#) find the existence of two distinct regimes in the relationship between returns of three different asset classes, namely US stock and bonds, oil and gold, and real estate. They report that the high-volatility regime (crisis period) is characterized by large negative returns, spillovers and contagion between stocks, oil and real estate.

In this work, we investigate the equity-commodity links in the US markets. As opposed to previous studies that mainly dealt with this issue based on linear causality modeling, we use a wavelet approach to detect time-varying links between commodity and equity returns under a time–frequency framework. The investigation of the time-scale behavior is motivated not only by the temporal joint dynamics of commodity and equity returns over time, but also across different investment horizons. In practice, market participants may have diverse trading objectives ([Aguilar-Conraria and Soares, 2014](#)). Short-term investors or traders are more interested in short-run market fluctuations (i.e., several days or weeks), whilst long-term investors focus on long-run oscillations (i.e., months or quarters). It is also possible that commodity and equity prices are characterized by a multi-scale structure caused by the effects of institutional changes, business cycle phases, major economic or financial crises, yet more importantly by investor heterogeneity in terms of risk preferences and informational asymmetry. Several recent studies including, among others, [Vacha and Barunik \(2012\)](#), [Aloui et al. \(2013\)](#), [Bekiros and Marcellino \(2013\)](#) and [Graham et al. \(2013\)](#) have demonstrated the existence of time scale behavior of commodity, foreign exchange and stock markets.

Our study contributes to the literature in three major aspects. First, we assess how commodity and equity returns in the United States co-move both over time and across different investment horizons, through the use of the continuous wavelet coherence measure. Second, we verify the emerged co-movement by detecting the causality effects between commodity and equity returns via the frequency domain causality test developed by [Breitung and Candelon \(2006\)](#). Finally, we show the importance of time scale analysis for portfolio management by estimating and comparing the frequency Generalized Sharp Ratio (GSR) of equity-commodity portfolios. Our research is thus broadly linked to the literature focusing on the time-frequency dynamics of commodity prices and closely related to the contributions of [Delatte and Lopez \(2013\)](#) and [Graham et al. \(2013\)](#) on the equity-commodity return linkages. However, we go beyond these studies by investigating the time-scale behavior and causality of the links and discussing their impact on optimal asset allocation and portfolio diversification.

Our empirical results for energy, metal and agriculture commodities in the United States as well as for the S&P 500 index over the period 1990–2013, show evidence of significant inter-relationships. These markets experienced an increase in their co-movement after the onset of the recent global financial crisis. Furthermore, the frequency domain causality testing indicates diverse directional interdependencies in accordance with the results of the wavelet coherence analysis. Both bidirectional and unidirectional causalities exist at different frequency bands. These results further uncover that the performance of diversified portfolios including both equity and commodity assets differs importantly across diverse investment horizons.

The remainder of the article is organized as follows. Section 2 presents the novel spectral methodology utilized to explore the links between commodity and equity markets. Section 3 describes the data, while Section 4 reports and discusses the results. Section 5 concludes.

## 2. Methodology

Wavelets analysis is utilized to investigate the relationships between equity and commodity futures markets in the United States. This method allows for the estimation of spectral characteristics and scale-related measuring components of the time series over and across time horizons. The interest in economic applications of wavelets occurred in the mid-90s

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