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Wavelet-based evidence of the impact of oil prices on stock returns

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ABSTRACT

We examine the relationship between oil and stock markets in Europe and the USA at the aggregate and sectoral levels using wavelet multi-resolution analysis. Wavelet decomposition of the original time series is useful in characterizing the oil–stock price relationship at different time scales, in revealing contagion and interdependence between oil and stock prices (as in the recent global financial crisis) and in analysing oil lead and lag effects on stock prices through wavelet cross-correlation. Empirical evidence for the period June 2000 to July 2011 indicates that oil price changes had no effect on stock market returns in the pre-crisis period at either the aggregate or sectoral level (with the exception of oil and gas company stock). At both levels, however, with the onset of the financial crisis we found evidence of contagion and positive interdependence between these markets. Additionally, we found no evidence of lead and lag effects in the pre-crisis period, and so reject the underreaction hypothesis. Since the onset of the financial crisis, oil price leads stock prices and vice versa for higher frequencies, whereas for lower frequencies oil and stock prices lead each other in a complex way.

1. Introduction

Crude oil is arguably an influential commodity with extraordinary ramifications for the real economy and financial markets. Although the negative impact of oil price shocks on the macroeconomy is well documented (see, e.g., Hamilton, 1983, 2003; Hamiltom & Herrera, 2004; Hooker, 2002; Kilian, 2008; Mork, 1994), there is less consensus among economists about the response of stock markets to oil price movements. Whilst some empirical research into the oil–stock market relationship provides evidence of a negative impact of an oil shock on stock returns (Ciner, 2001; Kaul & Jones, 1996; Kilian & Park, 2009; Kling, 1985; Sadorsky, 1999, among others), another strand of the literature reports evidence of either a positive and significant link (see, e.g., Arouri & Rault, 2012; El-Sharif, Brown, Nixon, & Russel, 2005; Narayan & Narayan, 2010), an insignificant link (see, e.g., Apergis & Miller, 2009; Henriques & Sadorsky, 2008) or a conditional and nonlinear link (see, e.g., Park & Ratti, 2008; Reboredo, 2010).

One limitation of the existing empirical research into the oil and stock price nexus is that it has been restricted to one or at most two time scales (the short and the long run). Theoretically, the stock market response to an oil price shock is complex since an increase in oil prices impacts both a firm's future cash flows (positively or negatively depending on its oil dependence) and cash flow discount factors (related to the effect of oil prices on the macroeconomy, in particular on inflation, interest rates and monetary policy). These two impacts on stock values have potentially different time horizons, so the effect of an oil price shock on stock returns may be observed at different time scales. Likewise, investors in oil and stock markets are heterogeneous with

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respect to their investment horizons, so the transmission of an oil shock through market transactions may vary according to time scale.

In this article, we study oil and stock market interdependence at different time scales using wavelet multi-resolution analysis. Wavelets are an approach to filtering which involves decomposing a time series into different frequency components, with each resolution matched to its time scale. Lower time scales capture higher frequency time series components which occur over very short periods of time, whilst higher time scales capture lower frequency components occurring over very long periods of time. The original series is transformed through special functions (base) called wavelets rendered from successive approximation series (similar to Fourier series), which are represented by sine and cosine. The wavelet functions have the property of concentrating energy in time to provide an analysis of temporality, nonstationarity and volatility changes over time (Burrus, Gopinath, & Guo, 1998; Rua & Nunes, 2009). In the economic and financial literature, several studies use the wavelet approach to study the dynamic properties of different financial and economic phenomena, such as the relationship between the money supply and output (Ramsey & Lampart, 1998a), expenditure and income (Ramsey & Lampart, 1998b) and stock returns and inflation (Kim & In, 2005), business cycles (Gallegati, 2012; Yogo, 2008) and capital asset pricing at different time frequency scales (Fernandez, 2005; Gençay, Selçuk, & Whitcher, 2005). Wavelets have also been used to model oil price cycles (Naccache, 2011), to forecast crude oil prices (Jammazi & Aloui, 2012; Yousefi, Weinreich, & Reinarz, 2005), to study co-movement of energy commodities (Vacha & Barunik, 2012) and of oil and exchange rates (Reboredo & Rivera-Castro, 2013) and to decompose Europe Brent and West Texas Intermediate oil prices to analyse the effect of

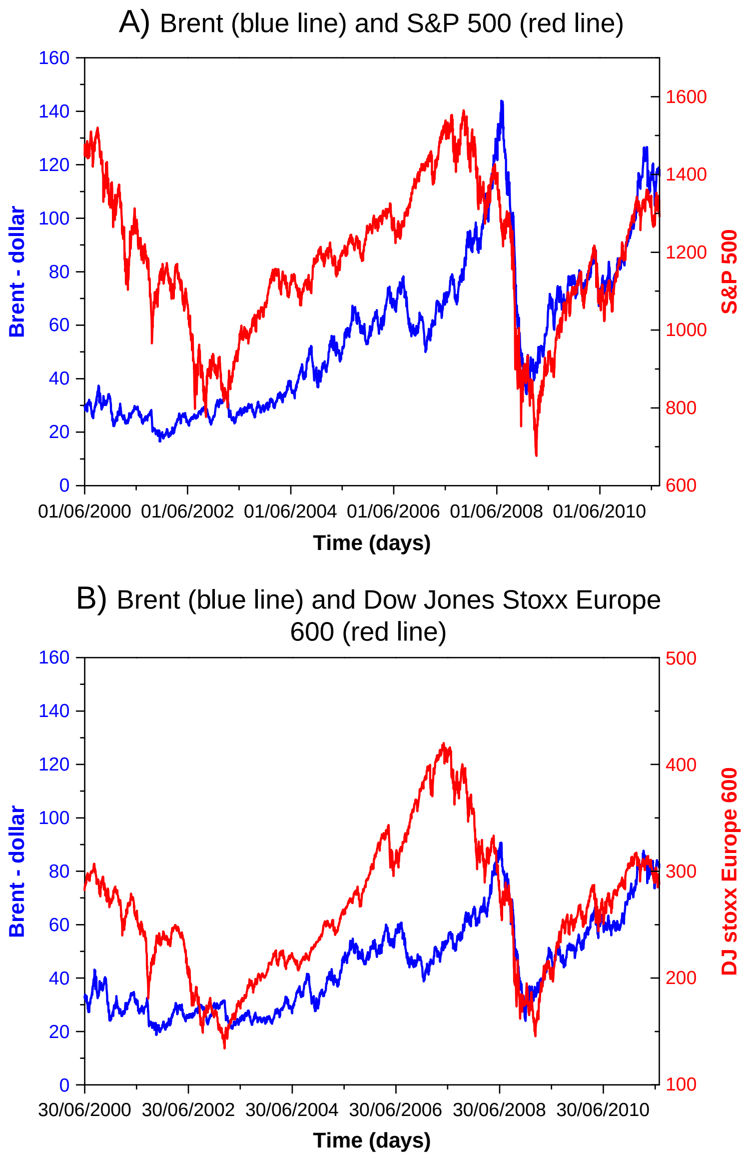

Fig. 1. Temporal evolutions for Brent oil price and the aggregate stock indexes. Panel A: Brent (blue line) and S&P 500 (red line). Panel B: Brent (blue line) and Dow Jones Stoxx Europe 600 (red line).