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Frequency aspects of information transmission in a network of three western equity markets

Harald Schmidbauer [a,*], Angi Rösch [b], Erhan Uluceviz [c]

[a] *BRU-IUL, ISCTE Business Research Unit, ISCTE-IUL, Avenida das Forças Armadas, 1649-026, Lisboa, Portugal*
[b] *FOM University of Applied Sciences, Arnulfstr. 30, 80335 München, Germany*
[c] *Gebze Technical University, 41400, Gebze – Kocaeli, Turkey*

HIGHLIGHTS

- Our network has three stock markets (nodes) and daily shock spillovers (edges).
- Propagation values measure the relative importance of a market as a volatility creator.
- Cross-wavelet analysis reveals changes in the frequency of propagation values.
- The US market is mostly in anti-phase with the UK and the euro area markets.
- The UK and the euro area markets are mostly in phase with each other.

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ABSTRACT

Cycles in the behavior of stock markets have been widely documented. There is an increasing body of literature on whether stock markets anticipate business cycles or its turning points. Several recent studies assert that financial integration impacts positively on business cycle comovements of economies.

We consider three western equity markets, represented by their respective stock indices: DJIA (USA), FTSE 100 (UK), and Euro Stoxx 50 (euro area). Connecting these three markets together via vector autoregressive processes in index returns, we construct "propagation values" to measure and trace, on a daily basis, the relative importance of a market as a volatility creator within the network, where volatility is due to a return shock in a market.

A cross-wavelet analysis reveals the joint frequency structure of pairs of the propagation value series, in particular whether or not two series tend to move in the same direction at a given frequency. Our main findings are: (i) From 2001 onwards, the daily propagation values of markets have been fluctuating much less than before, and high frequencies have become less pronounced; (ii) the European markets are in phase at business cycle frequency, while the US market is not in phase with either European market; (iii) in 2008, the euro area has taken over the leading role. This approach not only provides new insight into the time-dependent interplay of equity markets, but it can also replicate certain findings of traditional business cycle research, and it has the advantage of using only readily available stock market data.

* Corresponding author.
E-mail addresses: harald@hs-stat.com (H. Schmidbauer), angi@angi-stat.com (A. Rösch), erhan@uluceviz.com (E. Uluceviz).

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1. Introduction

Efforts to understand cyclical behavior of economic time series go back to as early as the 19th century, with researchers aiming to forecast the future of economies. Among the first to identify economic cycles and their synchronicity was Juglar [1] in 1862. He proposed 7–11 year cycles of fixed capital investments which were more or less synchronous for France, the UK and the US. Beginning with the 20th century, several other cycles have been identified: (i) the Kitchin [2] cycles with 3–5 years of periodicity arising from fluctuations of inventories, (ii) the Kuznets [3] swings of 15–25 years associated with infrastructure investments and (iii) the Kondratieff [4] "Long Waves" of 40–60 years along with smaller cycles of 3–4 and 7–10 years. The beginning of the modern analysis could be attributed to the formalization of the notion of business cycle by Burns and Mitchell [5], who define it as "…a type of fluctuation found in aggregate economic activity".

With its focus on GDP, the prime target of classical business cycle analysis is to investigate domestic aspects of an economy, see Altug [6], but business cycle research has recently also been undertaken to study cross-country differences and similarities of macroeconomic fluctuations. Various factors that could be affecting business cycle synchronization have been proposed in the literature, including trade relations, specialization, monetary integration, financial relations and fiscal policy, see de Haan et al. [7] for an extended survey of studies on business cycle synchronization in the euro area. The channels of synchronization, common dynamic properties of business cycles across countries and evolution of the degree of global cyclical interdependence are also investigated in Imbs [8] and Kose et al. [9,10], respectively. Only recently, Aguiar-Conraria et al. [11] have suggested using cross-wavelet methodology to identify the joint frequency content of multivariate macroeconomic data, pointing out that wavelet analysis, unlike Fourier analysis, is able to detect structural changes across time. Aguiar-Conraria and Soares [12] and Crowley and Mayes [13] apply wavelet-based methods to monthly, respectively quarterly, macroeconomic data to study the cyclical behavior of economies within the euro area.

The cyclical behavior of stock markets has also been widely documented. The patterns identified are, among other things: (i) the "Halloween effect", also known as "Sell in May and Go Away", which refers to returns during winter (November–April) exceeding those during summer (May–October), see e.g. Bouman and Jacobson [14], Dichtl and Drobetz [15]; (ii) the "January effect" that leads to abnormally large returns on stocks in January of most years, see e.g. Gu [16], Haug and Hirschey [17]; and (iii) the four-year US Presidential Election Cycle that implies US stock prices are tracking US presidential elections, see e.g. Wong and McAleer [18], Booth and Booth [19].

Early opinions on whether stock markets help predict business cycles span a large spectrum ranging from Fischer and Merton [20] who find that "stock price changes are the best single variable predictor of the business cycle" to Stock and Watson's [21] verdict that "although there is some evidence that the stock market improves forecasting performance, this improvement is slight". More recent studies have suggested that the stock market anticipates business cycle turning points, based on the conception that the investors' behavior reflects their assessment of the state of the economy; see Chauvet [22], Chauvet et al. [23] and Andreou et al. [24]. Franz [25] concludes that "the S&P 500 is highly consistent in anticipating contractions and expansions in economic activity, as measured by near-term changes in real GDP". Similarly, Angelidis et al. [26] provide evidence that stock market return dispersion has significant predictive power for the business cycles across a data set of G7 economies.

Financial integration often goes along with the opening of potential transmission channels between economies, and indeed Imbs [8,27] and Kose et al. [9] show that financial integration impacts positively on business cycle comovements. Olivero and Madak [28] find that financial integration within Europe does matter for the international transmission of business cycles, and "as the European economies become more integrated among themselves, European business cycles start to decouple from those in the US". As for cycle length, Fidrmuc et al. [29] find that, for European countries, "financial integration is insignificant at short-term frequencies and peaks at business-cycle frequencies for business cycles". The results of the latter two studies, although obtained with different data and a different set of methods, are in line with our results.

The cross-country analysis of business cycles is conceptually close to the study of "contagion" and "interconnectedness" of economies; see, for example, Forbes [30]. In a similar vein, the idea of information transmission in networks of equity markets, in particular: shocks creating volatility across the network, lends itself to studying "importance cycles" in such a network. Many stochastic models assume that shocks (news; "residuals" after the model has been fitted) drive stock market returns. Certain network models of equity markets allow for shock spillovers such that a return shock in one market creates volatility elsewhere in the network. Based on such models, it can be shown that, on a given day, not all markets in a network are equally important with respect to network volatility creation via return shocks, or equivalently, with respect to information transmission: a shock in a "central" market may spark massive repercussions throughout the network, while a shock in an isolated market may go almost unnoticed. This concept is used in Schmidbauer et al. [31] to investigate the impact of sanctions during the Ukrainian crisis on the Russian stock market. In the present study, our focus is not on the assessment of singular events, but rather on investigating periodic patterns of importance in a network of stock markets: Are there cycles in the relative importance of a stock market as news (or shock) propagator? Which cycles (or periods) are dominating at a given point in time? When the relative importance of one stock market increases, what can be said about the others?

The present study is thus an effort to investigate frequency aspects with respect to information transmission, focusing on a network consisting of three western stock markets, each represented by a stock index: DJIA (US), FTSE 100 (UK) and Euro Stoxx 50 (proxy for the euro area). To that end, departing from the Diebold–Yilmaz [32–34] connectedness framework, and extensions detailed in Schmidbauer et al. [31,35], we undertake the following steps: