Integration of 22 emerging stock markets:
A three-dimensional analysis

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ABSTRACT

We apply the three-dimensional analysis of wavelet coherency to examine the integration of 22 emerging stock markets with the U.S. market. We find a high degree of co-movement at relatively lower frequencies between the U.S. and the 22 individual emerging markets. Our results show that the strength of co-movement, however, differs by country. For example, we report a high degree of co-movement between the U.S. and Brazil, Mexico and Korea, but low co-movement with and Egypt and Morocco. Our analyses also document a general change in the pattern of the market relationship after 2006, where we detect co-movements at relatively higher frequencies. Co-movement at the highest frequencies is, however, weak for fluctuations with duration less than a year. Our findings imply that investing selectively in emerging markets may provide significant diversification benefits which, invariably, depend on the investment horizon.

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1. Introduction

Examining global stock market integration is a central issue in finance given the implied consequences for asset allocation decisions and portfolio diversification. A well-integrated international stock market implies low or no international diversification benefits. Internationally segmented stock markets, on the other hand, would enable portfolio managers to diversify and take advantage of the differences in the markets. Grubel (1968), using principles developed by Nobel Laureate Harry Markowitz (1952), shows that an internationally diversification portfolio yields higher rates of return or lower variances relative to a purely

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national diversification of assets. This conclusion is supported by Levy and Sarnat (1970), Agmon (1972), and Grauer and Hakansson (1987). These practical insights have heightened the interest of both finance academics and practitioners to gage the level of stock market integration. In this paper we re-examine the integration of 22 emerging stock markets using the powerful three-dimensional analysis of wavelet coherency.

A domain of the global stock market integration literature examines the co-movement of international stock prices.[1] The early literature shows low co-movement of market returns between countries (see Hilliard, 1979). The more contemporary literature, on the other hand, documents an increase in international co-movement of stock returns in global markets (see for example Brooks & Del Negro, 2004; Click & Plummer, 2005; Kizys & Pierdzioch, 2009, and Beirne, Caporale, Schulze-Ghattas, & Spagnolo, 2010) since the mid-1990s.[2] Lucey and Zhang (2009) further show that countries with smaller cultural distance have higher stock market co-movement. These studies also find that the degree of co-movement is not constant over time (which implies revolving risk exposure).

Most of the previous studies have evaluated the co-movement of stock returns through the correlation coefficient whilst investigating the evolving properties either through a rolling window correlation coefficient (see, for example, Brooks and Del Negro (2004)) or by considering non-overlapping sample periods (see, for example, King and Wadhwani (1990) and Lin, Engle, and Ito (1994)) without any investment horizon distinction.[3] Exceptions to this trend of analysis include Rua and Nunes (2009) who apply wavelet coherency and show that the strength of the co-movement of international stock returns is relatively high among developed markets.

Rua and Nunes (2009) also demonstrate that co-movements among developed markets differ by country but is contingent on the frequency level, with a higher strength in the co-movements of stock returns at lower frequencies suggesting greater benefits from international diversification in the short-term relative to the long-term. This confirms the need for stock markets co-movement analysis to also allow for a distinction between the short-term and long-term investor (Candelon, Piplack, & Straetmans, 2008). A frequency domain analysis would allow for this distinction (see e.g., A'Hearn & Woitek, 2001 and Pakko, 2004). From the point of view of portfolio diversification, short-term (long-term) investors would be more concerned with the co-movement of stock returns at higher (lower) frequencies.

The purpose of our study is to examine the co-movement of 22 emerging stock markets located in the Americas, Europe, Asia and Middle East/Africa with the U.S. stock market. For this reason we apply the three-dimensional analysis of wavelet coherency, which is beneficial since it allows for the identification of regions in a unified time interval-frequency band space where two stock markets co-vary. In such regions, the gains of portfolio diversification are relatively lower. The method concurrently allows for an assessment of the impact of investment horizon. These advantages enable fresh important insights into the broad characterisation of the level of integration in international stock markets.

The above-mentioned advantages suggest that wavelet coherency offers a refinement in terms of analysis. Given this some recent studies, mainly focusing on developed stock markets, have used the methodology in measuring market dependences.[4] In the stock integration literature, Rua and Nunes (2009) and Ranta (2009) apply wavelet analysis and find that co-movements involving stock market returns of Germany, Japan, the UK, and the US in this unified time-frequency framework vary by country and are stronger at lower frequencies. Graham and Nikkinen (2011) also find a high degree of co-movements of stock returns and volatilities at low frequencies between Finland and rest of the world. They also find high levels

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[1] This thread of literature is large and includes King, Sentana, and Sushil (1994), Lin, Engle and Ito (1994), Longin and Solnik (1995, 2001), Karolyi and Stulz (1996), Forbes and Rigobon (2002), and Brooks and Del Negro (2005, 2006).

[2] Explanations offered in the literature for the increase in international co-movement of returns include growing global industry factors (Baca, Garbe, & Weiss, 2000; Cavaglia, Brightman, & Aked, 2000), the stock market bubble of the late 1990s (Brooks & Del Negro, 2004), the increase in equity market integration in the 1990s (Ayuso & Blanco, 2001) and an increase in bilateral trade flows (Pretorius, 2002).

[3] As a measure of economic integration, a simple correlation coefficient can be a poor measure as pointed out by Pukthuanthong and Roll (2009).

[4] Wavelets are commonly applied for economic and financial time series. In a pioneering study, Ramsey and Lampart (1998a, b) use wavelets to investigate the relationship between several macroeconomic variables. Other studies have utilized this methodology to analyze the dynamic structure of Asian spot exchange rates over the Asian currency crisis in 1997 (Karuppiah & Los, 2005), the cross-dynamics of exchange rate expectations (Nikkinen, Pynnönen, Ranta, & Vähämaa, 2010), and contagion in international stock markets (Ranta, 2009).