Return spillovers around the globe: A network approach

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ARTICLE INFO

ABSTRACT

We study the connectedness of a sample of 40 stock markets across five continents using daily closing prices and return spillovers based on Granger causality. All possible 1560 return spillovers between 40 markets create a complex network of relationships between equity markets around the world. Apart from analyzing the topological and time-varying properties of the created networks, we also identify the determinants of the connectedness of equity markets over time. Adjusting for non-synchronous trading, our modelling approach leads to evidence that the probability of return spillover from a given stock market to other markets increases with market volatility and market size and decreases with higher foreign exchange volatility. We empirically show that the temporal proximity between closing hours is important for information propagation; therefore, choosing markets that trade during similar hours bears an additional risk to investors because the probability of return spillovers increases.

1. Introduction

It is crucial to understand the transmission mechanism of stock market returns "spilling over" among international markets to quantify risk in financial decision making, both for investors and policy makers. In the current state of economic and financial liberalization, it is widely believed that equity market returns tend to move together, and many researchers are trying to quantify the extent of stock market co-movements around the world. The underlying idea is that high correlations among equity returns increase the overall risk of investors' portfolios; thus, if stock markets are highly integrated, they provide only limited opportunities to effectively diversify idiosyncratic risk.

Since the early works of Grubel (1968) and Solnik (1974), many markets have implemented financial liberalization policies to become more integrated. However, they have also become more vulnerable to international risk and shock propagation. Many researchers have questioned the benefits of international stock market integration, using a wide spectrum of methodologies, from simple Granger causality tests (Arshanapalli and Doukas, 1993) to correlations (Longin and Solnik, 2001), co-integration techniques (Mylonidis and Kollias, 2010), various forms of multivariate GARCH models (Cappiello et al., 2006), copula models (Aloui et al., 2011), and the most recent stream of methodologies based on variance decompositions from approximating models (Diebold and Yilmaz, 2014).

Although studies differ in their use of methodologies, sample periods, markets or sampling frequencies, the general consensus tends to strongly favor strengthening stock market linkages among most of the world's equity markets. A couple recent examples of observable return spillovers are the Greek crisis and the meltdown of the Chinese stock market in 2015.

Using a sample of daily returns over the period from January 2, 2006 to December 31, 2014 in 40 developed, emerging, and frontier markets, we test for Granger causality among returns while controlling for the size of multiple Granger causality tests. We also carefully address the problem of return alignment with respect to non-synchronous trading effects, which is especially important when using daily data to estimate directional relationships. The return spillovers form a network of relationships of worldwide market linkages. To understand such complex structures, our methodological approach is based on financial econometrics, graph theory and spatial modeling.

Our analysis is conducted in five steps: (1) adjustment for non-synchronous trading on the world markets (2) ARFIMA-GARCH filtering of the adjusted time-series, (3) identification of spillovers by estimating Granger causality from standardized residuals, (4) construction of networks and analyzing information from their topology as well as evolution over time and (5) explanation of the interconnectedness between markets within the networks by spatial models.

The motivation for this paper may be illustrated using Fig. 1a–c. Fig. 1a captures a complex network of daily return spillovers, consisting of approximately 900 relationships, based on Granger causality. Fig. 1b
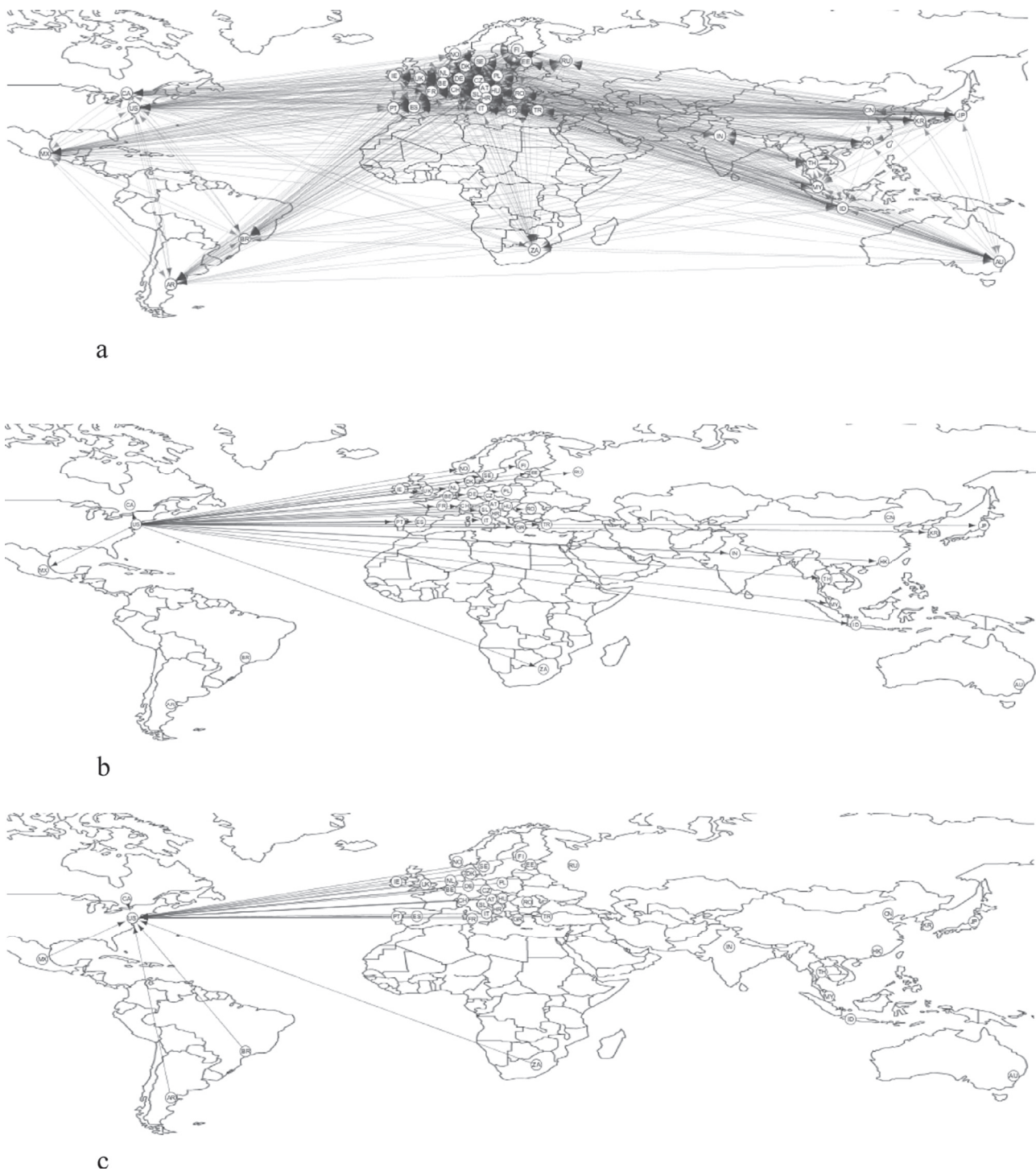
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a

b

c

Fig. 1. a: Complex network of return spillovers in 2008. b: Sub-network of return spillovers in 2008 from US to other markets. c: Sub-network of return spillovers in 2008 from other markets to US.

and c shows a subset of all Granger causalities, namely, those from the US to other markets, or vice versa. It is clear from Fig. 1b that, as expected, US market returns affect trading both in Asian and European markets, where trading opens on the next calendar day.

Fig. 1c, depicting the effects of other markets on trading in the US, is more interesting. Clearly, developed European markets affect returns in the US, as they close their trading sessions before the US. In this regard, Asian stock markets do not appear to be influential, even though they are much larger and more developed (South Korea, Hong Kong, Japan) than some of the emerging stock markets in South Africa, Brazil and even

Argentina (a frontier market), which do appear to influence the US stock market.

This evidence provides motivation to explore the significance of temporal proximity in return spillovers on world stock markets. It also raises the need to address the problem of non-synchronicity of trading on international stock markets to avoid a substantial look-ahead bias that might influence the estimation of directional spillovers.

While the non-synchronicity of trading has been addressed in the literature, our first contribution lies in the quantification of the effect of differences in closing hours on the existence of return spillovers among