International Review of Economics and Finance 43 (2016) 363–377

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

# Contagion and interdependence across Asia-Pacific equity markets: An analysis based on multi-horizon discrete and continuous wavelet transformations

Ginanjar Dewandaru [a,*], Rumi Masih [b], A. Mansur M. Masih [a,1]

[a] INCEIF, The Global University of Islamic Finance, Lorong University A, 59100 Kuala Lumpur, Malaysia
[b] Bank of New York Mellon Asset Management, One Wall Street, New York, NY 10286, USA

ARTICLE INFO

*Article history:*
Received 24 August 2014
Received in revised form 27 December 2015
Accepted 5 January 2016
Available online 13 January 2016

*Keywords:*
co-movement
Shock transmission
Financial crisis
Contagion
Wavelet analysis

ABSTRACT

Our study attempts to discover contagion amongst the Asia-Pacific equity markets (Japan, Hong Kong and Australia) during twelve major crises around the world. We apply both discrete and continuous wavelet decompositions to unveil the multi-horizon nature of co-movement and lead–lag relationship. We find that shocks were transmitted via excessive linkages, with the Asian crisis as the most influential in relation to a sudden stop. We also find that the subprime crisis revealed fundamentals-based contagion, due to the strengthening fundamental linkages, with a dominant role of the Japanese market. Finally, we find low co-movements in the short run, suggesting a partial convergence across the markets.



## 1. Introduction

The transmission of shocks across different markets during periods of financial crises has been an issue of great interest and recently generated a heated policy debate amongst market participants, central bankers, and governments. Many prior studies attempted to explain the nature of transmission mechanism across borders. Dornbusch, Park, and Claessens (2002) and Kaminsky and Reinhart (2000) mentioned the two distinctive characteristics between pure and fundamentals-based contagion. While the former is defined as an excessive transmission of shocks beyond any idiosyncratic disturbances and fundamental linkages (Bae, Karolyi, & Stulz, 2003; Eichengreen, Rose, & Wyplosz, 1996; Forbes & Rigobon, 2002), the latter is transmitted by way of financial market integration and trade linkages or interdependence (Calvo & Reinhart, 1996; N'Diaye, Zhang, & Zhang, 2010; Zhang, 2008). The strong debate of empirical findings centres on the evidence of these two channels.

Recently, the remarkable US born subprime crisis of 2007–08 that considerably hit the markets all over the world has raised a critical question on the capacity of the global financial system to maintain its financial stability in a meaningful way. Even in a region with lower exposures to US subprime mortgages, credit spreads in Asia noticeably increased along with those in United States and Europe (Brana & Lahet, 2010). The external shock was transmitted mainly via global and region-specific risk pricing

* Corresponding author at: INCEIF, The Global University of Islamic Finance, Malaysia. Tel.: +973 34517825.
*E-mail addresses:* gdewandaru@yahoo.com (G. Dewandaru), Rumi.Masih@BNYMellon.com (R. Masih), mansurmasih@gmail.com (A.M.M. Masih).
[1] Tel.: +60 173,841,464.

http://dx.doi.org/10.1016/j.iref.2016.01.002
1059-0560/

factors (Kim, Loretan, & Remolona, 2010), with a further impact on the equity markets. It seems that the Asian region still absorbed a contagious effect due to the deepening global financial and economic integration (Zhang, Zhang, & Han, 2010).

Given the presence of contagion effects in Asia, along with the different nature of their transmission channels, our study attempts to address this issue in the context of equity markets. There are three primary factors that govern the motivation of this empirical study. The first is to detect the evidence of contagion not only in the period of the recent subprime crisis but also during the earlier major crises. The finding may demonstrate on how the impact of one crisis differs from that of the other crises. The second is to identify whether each crisis reveals the evidence of fundamentals-based or pure contagion. We further examine the lead–lag relationship in order to capture the dynamic of transmission. The third is to investigate the evolution of short-run and long-run integration since well-integrated equity markets tends to have a higher exposure to external shocks. We analyse stock indices in three countries within the Asia-Pacific region that represent markets at vastly different phases of capital market integration, expanse and scope of their equity markets as well as vast differences in their levels of financial regulation, infrastructure and governance. These are, namely: Japan (NIKKEI), Hong Kong (Hang Seng), and Australia (AS200). The length of our daily observations is between 1970 and 2011 in order to capture all possible major crises around the world.

As to the methodology, we examine co-movement and lead–lag relationship amongst the equity indices. There are two main reasons of using co-movement to address our research objectives. Firstly, many prior studies identified the evidence of contagion by observing the changing correlations across different markets during crises periods (Candelon, Piplack, & Straetmans, 2008; Chakrabarti & Roll, 2002; and so on). Secondly, the phases of financial integration also can be reflected through the increased cross-country correlations (Goetzmann, Li, & Rouwenhorst, 2002; Bekaert, Harvey, & Ng, 2005; Bekaert & Harvey, 1995; Baele, 2005; and so on).

Our study is different from most of prior studies, where we emphasize on the multi-horizon nature of co-movement. We perform multi-timescale analysis using wavelet decompositions as one of the latest techniques in finance to decompose any observed variable on scale-by-scale basis. The decomposition may capture both time series and frequency domain simultaneously. This may provide an ability to distinguish between higher frequencies and lower frequencies. The concept is similar to prior studies by Bodart and Candelon (2009) and Orlov (2009) that examined contagion by associating high and low frequencies with contagion and interdependence. In addition, to observe the phases of stock market integration, our study uses wavelet coherence with a rolling-window in the multi-horizon nature to evaluate the changing co-movement across the different equity markets.

The paper is organized as follows. Section 2 presents some literature reviews associated with the issue of financial contagion and integration. Section 3 introduces wavelet decomposition analysis both discrete and continuous wavelet transform. Section 4 presents and discusses the empirical results. Section 5 provides some overarching interpretations, conclusions and policy implications.

## 2. Literature review

Our literature review is structured as follows. The first is to present the theoretical underpinnings on financial contagion and interdependence, along with some empirical findings of contagion effects in Asia. The second is to present some established methods of measuring contagion.

### *2.1. Financial contagion and interdependence*

Previous studies suggest that financial crisis may reveal the evidence of either financial contagion or interdependence. Specifically, Dornbusch et al. (2002) and Kaminsky and Reinhart (2000) have mentioned the two distinctive characteristics between “fundamental-based” and “pure” or excessive contagion.

The pure or excessive contagion is defined as an excessive transmission of shocks from the crash in origin country into others beyond any idiosyncratic disturbances and fundamental linkages (Bae et al., 2003; Eichengreen et al., 1996; Forbes & Rigobon, 2002). The pure contagion tends to be relatively fast and dissipate in a short-term period (Ait-Sahalia, Cacho-Diaz, & Laeven, 2010).The sentiment shift of investors, unrelated to economic fundamentals (Dailami, Masson, & Padou, 2008; Kumar & Persaud, 2002), may lead to a general reversal of funds and eventually trigger financial crises (Forbes & Rigobon, 2002; Kleimeier & Sander, 2003). The role of herd behaviour may burst asset bubbles created by self-fulfilling expectations, moral hazard, or government guarantees, either implied or explicit (Krugman, 1998). Gonzalez-Hermosillo (2008) mention some global market risk factors that may explain the risk appetite of the global investors, which are the default risk, the market liquidity risk, the funding liquidity premium, and volatility.

There are mainly three mechanisms of shocks transmission. The first is the transmission of information from markets with more rapid price discovery, where the effect of news may spread investors' sentiment across borders (Kaminsky & Schmukler, 1999). In that case, the shocks in one market may represent the economic news which directly gives the impact on the cash flows or collateral values linked to assets in other markets. Secondly, negative returns in one market may increase the risk premium in other markets, resulting in simultaneous drop of assets prices (Acharya & Pedersen, 2005; Longstaff, 2008; Vayanos, 2004). Thirdly, liquidity shock across countries plays an important role in contagion through a flight-to-quality (Allen & Gale, 2000; Brunnermeier & Pedersen, 2009). Investors who suffer in one market will have difficulty to raise fund, thus the flight-to-quality plays an important role in absorbing the overall market liquidity.

In another study, Masson (1999a) points out three factors of contagion with respect to crisis periods. Firstly, the monsoonal effect or the common shock gives a simultaneous impact on a number of countries due to the oil price, the interest rate of