

Pre and Post-2008 Crisis Stock Market Linkage between U.S. and Asian Markets

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International stock market linkage is an issue of interest in the financial literature for numerous reasons. For investors, it has important implications for asset management and portfolio diversification. Stock market linkage or segmentation is an important factor when estimating the impact of liberalizations on the cost of capital through an international asset-pricing model with investment restrictions.

Such implications have sparked interest in the vast amount of literature that investigates stock market linkages both for developed countries and for emerging and transition economies, particularly the significant variation displayed in the co-movement patterns of stock markets due to dramatic changes in investment behavior following major economic events such as crises resulted from sudden and simultaneous materialization of risks. Indeed, the extent to which financial crises have structurally changed the inter-relationship across stock markets has been a focal point of many studies concerning the Asian financial crisis in 1997 and 1998 Russian financial crisis among others.

More recently, brought about by a crisis in the financial sector, synchronized global economic downturns emerged toward the end of 2008 with far-reaching consequences worldwide. The 2008 financial crisis has been deemed by many leading scholars to be the worst since the Great Depression of the 1930s. Stock markets have been seriously hit, with some indices reaching all-time lows. Given the profound influence of the recent financial turmoil and its potentially different implication from the previous crises, it is essential to investigate how and in what ways the 2008 crisis has affected international stock market linkages.

Accordingly, we examine both short-run dynamic causal linkages and long-run relationships among the US and seven Asian stock markets, namely Japan, China, Hong Kong, Korea, Singapore, Malaysia and Thailand, in relation to the 2008 global financial crisis. The data employed in our study are end-of-day stock price indices in local currencies of the Dow Jones Industrial Average (US), Nikkei 225 (Japan), Shanghai A-share index (China), Hang Seng Index (Hong Kong), Korea Composite Stock Price Index (South Korea), FTSE Straits Times Index (Singapore), Kuala Lumpur Composite Index (now known as FTSE Bursa Malaysia KLCI) and Stock Exchange of Thailand. Indices are collected from DataStream for the period from January 2004 to July 2011. We conduct comparative analysis of pre-crisis, crisis and post-crisis periods to evaluate how stock market linkages have been affected.

The structural break points when the market indices took a significant turn were estimated without prior information. Using a modified Stata software procedure taken from Stock and Watson (2007), we test the Quandt Likelihood Ratio (QLR) statistics where the maximum test statistics indicate possible structural break points. Critical values for the QLR statistics are obtained from the same source. Specifically, January 2004 to October 2007, May 2008 to January 2009 and March 2009 to July 2011 were identified as the pre-crisis, crisis and post-crisis periods, respectively.

For each period, we perform ADF and PP tests to determine the order of integration of the stock indices. The null hypothesis that

stock indices in the levels are non-stationary is not rejected for all the markets, while the null hypothesis using first log differences are strongly rejected. This indicates that the stock market indices of all eight economies were not stationary (i.e., non-stationary series at levels) and are integrated to order 1.

In addition, we find the returns from individual markets were positively correlated. In the pre-crisis period, Singapore and Hong Kong correlated strongly with most of the other economies under investigation. The US, on the other hand, evidenced modest relationships with other markets. China, which holds the third-largest market capitalization in Asia, was a relatively isolated market as it had weak correlations to all other seven markets. During the crisis, the pair-wise correlations between markets were strengthened. The return in the Hong Kong market was related to those of Japan, Korea, Singapore, Thailand and to a lesser extent China. Singapore's market return appears to have been strongly related to those of Hong Kong, Japan, Korea and Malaysia. The Shanghai and US markets still appear to have been less correlated to other Asian markets. In the post-crisis period, the bonds between most markets appear to have reverted but remained stronger than at the pre-crisis level. The Malaysian market displayed a higher correlation with both Hong Kong and the US. Meanwhile, the US also showed a strengthened relationship with the Japanese market.

Throughout the sample period the US remained an important leading market in the group as its market returns were found to Granger-cause most of the other markets' movements. The financial crisis in 2008 does not appear to have affected the relatively influential role of the US market over others. The Chinese market became more important in leading the regional stock market return after the financial crisis unfolded, but the impact died off for the post-crisis period.

We then look at the co-integrating relationships to examine the long-run linkages across the eight markets under investigation. The null hypothesis of no co-integration is consistently rejected at 5% level for pre- and post-crisis periods, indicating a long-term equilibrium relationship between stock market price indices. This means that the stock indices of the eight markets under investigation share one single common stochastic trend and that stock prices are aligned closely across markets, indicating that investors with long hold periods wishing to gain from international diversification across Asian and US markets should be more cautious. During the buildup to the crisis, it was the Hong Kong and Japanese markets that bore the brunt of short-

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Received November 26, 2013; **Accepted** November 28, 2013; **Published** December 02, 2013

Citation: Huang W, Zhang Y, Yang W (2013) Pre and Post-2008 Crisis Stock Market Linkage between U.S. and Asian Markets. J Stock Forex Trad 3: e125. doi:10.4172/2168-9458.1000e125

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run adjustments to the long-run equilibrium. All the markets except that of China became more responsive to the long-run equilibrium after the crisis, although with slower adjustment.

To further explore the dynamic property of stock market linkages, we use generalized impulse response functions to demonstrate the responses of stock indices to random innovation from other markets. These impulses trace the effect of a shock of one market return on the current and future movement of other markets. We find the influence of unanticipated foreign market shocks were generally felt within three trading days following the innovation. The responses during the crisis period to any random innovation were of a larger magnitude than those in the non-crisis period, particularly for the first few days immediately after the shocks. Moreover, the impact of foreign market innovation tended to be longer lived during the crisis as it generally took more trading days for the effect of the shocks to die off. This is in line with our findings that during the crisis period the market linkages among the eight economies became stronger and more profound.

The decomposition of forecast error variance based on the VAR system suggest that, for the pre-crisis period, at a 20-day planning horizon, for instance, the proportion of domestic stock return variance that could be collectively attributable to other markets ranged from 1.6% for the US, to 49.6% for Korea and 52.1% for Singapore. This indicates that for markets in Asia except that of China, a large proportion of domestic stock return variance could be attributable to foreign shocks,

hence strengthening the interdependence of stock market returns regionally and globally. This effect became more prominent during the crisis period, where these proportions grew much higher for all the markets. The linkage is also generally stronger in the post-crisis period than in the pre-crisis period. Our results appear to support the reduced degree of exogeneity of stock markets and the contagion effects of the crisis given the intensified responsiveness to innovations in other markets. After the crisis had run its course, the influences of foreign shock were moderated but remained higher than in the pre-crisis period.

Together, our study provides evidence on how the latest financial crisis has affected stock market intertemporal linkages between the US and seven Asian economies. Our result is robust to alternative structural break test - Quandt-Andrews test - and alternative measurement by translating all the indices to a common currency of USD. The finding in this paper of strengthened stock market linkages during the recent global financial crisis stands in sharp contrast to previous studies which have found that stock market integration was weakened or unaffected during the 1997-1998 Asian financial crises. Our results support the proposition by Bekaert and Harvey (1995) that stock market integration is time-varying, particularly around periods marked by financial crises. Consequently, the benefits of international diversification in times of crisis are substantially diminished.