A Structural VAR Analysis on The Linkages of China's Stock Market with Global Financial Markets

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Abstract

Economic theories suggest that financial variables are instantaneously affected by each other. To empirically analyse their contemporary relationships, we specify a structural vector autoregressive model that pairs China's equity market with Asian and European equity markets. The foreign exchange and money markets are also included for analysis since they are risk sources to stock markets. The empirical result indicates an increasing integration of China's stock market with the Asian stock markets through time, but it is not symmetrical; China's stock market has become more influenced by the Asian stock markets, while its influence on the Asian stock markets has not equally increased. The result also suggests that the shock of foreign exchange markets is a common risk source to the Asian stock markets. While China's and the European stock markets have no contemporary relationship once the common factor of US stock market was considered, the result suggests that the exchange rate and interest rate risks are cross-assets to equity and cross-regional between China and Europe in the global financial crisis period.

Key words: impulse response; variance decomposition; return spillover; volatility spillover; within-asset behaviour; cross-assets behaviour; transmission

JEL Classification Codes:

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1. Introduction

The seminal work of King and Wadhwani (1990) has led to a discussion in international finance literature about how shocks are transmitted across borders. A range of different methodologies has been proposed to assess the linkages of financial markets. Several terminologies, such as 'contagion', 'spillover', and 'interdependence', have also been coined and defined to study the comovement of financial asset prices in the international scale (e.g., Engle, Ito and Lin, 1994; Eichengreen et al., 1995; Forbes and Rigobon, 2002; Karolyi, 2003; Dungey and Martin, 2004; Boyer et al., 2006; Bekaert et al. 2009) .

With the rise of emerging economies, many subsequent studies have devoted to investigate how economic or financial shocks transmit from developed markets to emerging markets, for example, Wei et al. (1995), Liu and Pan (1997), Masih and Masih (1999), , Ng (2000), Miyakoshi (2003), Lee, Rui and Wang (2004), Worthington and Higgs (2004), Tai (2007), Kenourgios, Samitas, and Paltalidis (2011), Samarakoon (2011), Kotkatvuori-Örnberg, Nikkinen and Äijö (2013), Beirne et al. (2013), Bekaert et al. (2014), and Morales and Andreosso-O'Callaghan (2014). To further understand the issue, in this paper we analyse the linkage of China's stock market with other stock markets across the globe. In addition, we also look at the linkages of stock markets with other financial markets, i.e. foreign exchange markets and money markets. For doing this, we employ a two-stage analysis that was built up on the framework of factor models. In analysing the interdependence of asset returns, the factor models based on arbitrage pricing theory are usually applied, which state that the price of financial assets are determined by both common factors and idiosyncratic factors (Slonik, 1974; Mahieu and Schotman, 1994; Masson, 1999; Bekaert et al. 2005; Corsetti et al. 2005; Dungey and Gajurel, 2014; Kaminsky, et al. 2016). Given the dominant impact of US stock market on world's stock markets, on the first stage we apply a world-factor model to stock markets, with the world factor proxied by the S&P 500 index, in order to obtain the extra world-factor stock market risk that is not resulted from the common stock risk factor.

On the second stage, we pair China's stock market with another stock market while allowing for the relevant foreign exchange rate in currency market and interest rate differential in money markets to be included in the analysis. We focus on China because the Chinese economy has been one of the fastest growing economy since its shifting to market-based economy in 1978, with its stock exchange becoming one of the largest markets in the world in terms of market capitalisation since its re-establishment in 1990. There are also some literatures that focused on China's stock market, including, for example, Bailey (1994), Hu et al. (1997), Huang et al. (2000), Hatemi-J and Roca (2004), Wang and Firth (2004), Li (2007), and Wang and Di Iorio (2007), in which the general finding is that the US market plays an important role in the East Asian stock markets. Nonetheless, whether China's stock market was interdependent with international stock markets is inconclusive. More recent studies researched on the interactions between China's stock market and other stock markets still generate different results. Huyghebaert and Wang (2010), for example, find that China's stock market is neither influenced by the USA's nor affected by Hong Kong's and Singapore's stock markets after the Asian financial crisis. Wang and Wang (2010) instead find that, between 1994 and 2002, the Chinese market was connected with the US and Japan through volatility spillovers, which were bi-directional rather than uni-directional from the developed to developing markets. Zhou, Zhang and Zhang (2012) find that the US stock market has dominant volatility impacts on the world equity markets, while China's stock market also has had impacts on other markets since 2005. They also find that China's market is more connected to those markets with the same cultural background, i.e., Hong Kong and Taiwan, than with Western and other Asian markets. Although the studies on the linkages between China's and other major international stock markets have increased generally due to the increasing integration of the Chinese economy with the rest of the world, the literature is still relatively few.

Apart from the within-asset behaviour between stock markets, the extant literature also suggests some factors common to stock markets. For example, as argued by the Calvo (1996), herd mentality of global investors would lead to the simultaneous withdrawals from a group of related markets, resulting in the comovement of stock prices in emerging markets. Masson (1998) also argues that investor psychology and market sentiments can lead to the simultaneous movement of stock markets. By contrast, Eichengreen et al. (1996) suggest that spillover effects tend to appear in countries with close trade linkages, and Glick and Rose (1999) suggest that currency crises affect geographically- proximal countries tied together by international trade. Since the Asian economies export their goods to the common destinations, namely the US, Japan and China, the third-market competition would lead to the competitive devaluation of their currencies. Further, Hu et al. (1997) find that the volatility of foreign exchange market can explain the moments of stock return series, while Van Rijckeghem and Weder (2001) find that trade and financial linkages are highly correlated. More recently, Walti (2011) suggests that apart from trade and financial integrations, common monetary policy and the elimination of exchange rate volatility can also lead to stronger stock market synchronisation. Furthermore, Jansen and Tsai (2010) find that stocks in bear state respond more than stocks in bull state to a surprising monetary policy, while Baig and Goldfajn (1998) and Christopher et al. (2012) find that sovereign spreads and sovereign credit ratings influence regional stock and bond markets. The study of Panchenko and Wu (2009) finds the interdependence of stock market and credit market in emerging economies, whereas other studies, for example, Elyasiani and Mansur (1998), Johnson and Soenen (2002), and Lustig et al. (2011), find that interest rate differential between countries is an important common risk factor in currency markets and stock markets. By following the literature, we therefore also include two ‘international’ factors, namely foreign exchange rate and interest rate differential, in our analysis.[1] [2]

Given the large market value and the fast development pace of China’s stock market, much more researches are needed to understanding its linkages with other financial markets. However, the previous studies mainly focus on the interaction of China’s stock market with other stock markets. Our first contribution to the literature is that we extend the study on China’s stock market to include currency asset and money asset as well as equity asset.[3] Our study therefore is an effort to understand the within-asset behaviour of stock markets and cross-asset behaviour among stock market, currency market and money market.

Our second contribution is that we employ a Structural Vector Autoregressive model (SVAR). The SVAR models were originally applied in macroeconomical studies. While they have also been applied to financial economics, the studies are relatively few. Some examples include Hess and Lee (1999), Gallagher and Taylor (2002), Binswanger (2004) and Fraser and Groenewold (2006), which all focus on the relationship between stock prices and real economic variables. There are also some SVAR studies on the cross-assets behaviour and the within-asset behaviour of financial markets. For example, Ehrmann et al. (2011) apply a SVAR analysis to study the interactions of the stocks, bonds, money markets and exchange rates between the USA and the Euro area in the period of 1989 to 2008. In general, they find that the international cross-assets behaviours are significant, although the within-asset

[1] China adopted a managed floating exchange rate regime with reference to a basket of currencies in July 2005, but which currency is included in the Chinese yuan’s basket and the weight of each component currency have never been revealed.
[2] The People’s Bank of China abolished the upper limits on inter-bank lending rate in June 1996, which since then has been left to determine by the forces of transactions. In January 2007, the Shanghai Interbank Offered Rate was formally launched.
[3] The Chinese yuan has been heavily pegged to the US dollar, especially in the Global Financial Crisis period. However, there have also been some reforms; the original daily trading band of the Chinese yuan against the US dollar was $\pm 0.3\%$, which was widened to $\pm 0.5\%$ in May 2007 and $\pm 1.0\%$ in April 2012.

behaviours unsurprisingly provide the strongest international transmission of financial shocks. Dungey et al. (2010) apply their SGARCH model, which is a SVAR augmented with the multivariate GARCH(1,1) process for resolving the identification problem, to study the four stock markets of Hong Kong, Korean, Indonesia, and Thailand. They find that in the Asian crisis period Hong Kong and Korea became more contagious to others and Indonesia became more sensitive to others, while Thailand became more detached to others. However, their study only focuses on the within-asset behaviours of international equity markets. In Dungey et al. (2015), they extend the SGARCH model to embed smooth transition functions so as to dating the phases of crisis and non-crisis periods. Their model allows them to identify the different phases during the Global Financial Crisis as well as the interactions between financial markets. However, their study only focuses on the cross-assets behaviours between equity, REIT and Treasury bond in the USA. By contrast, our study focuses on the interactions of China’s stock market with other international stock markets, which, according to our survey, has never been analysed by the SVAR models. In other words, we analyse not only the cross-assets behaviours of China’s stock market with other financial markets but also its within-asset behaviours with other stock markets. Because the SVAR models are designed to resolve the simultaneity issue between endogenous variables, the methodology allows us to look beyond the modelling of data and look into the interactions of financial variables implied by economic theories.

Furthermore, we also contribute to the testing of return spillover and volatility spillover. To utilise the SVAR model, some assumptions must be made for the instantaneous relationships between financial assets. The classical economics explains that government’s economic behaviours will influence both the values of currency asset and money asset. In an efficient stock market, the investors would respond to local news and global news fairly quickly and hence, the structural shocks in foreign exchange market, money market as well as the stock market should all be the sources of risk to the stock market. With this economic reasoning, we specify a cause-effect relationship in our SVAR model that incorporates this view. In addition, the specification is over-identified that allows us to further test the significance of factor loadings in stock market. On one hand, we therefore can test the causality between stock markets, i.e., whether the stock returns relationship is unrelated, uni-directional or bi-directional. In other words, the structural form in our model can identify the contemporary 'return spillover' between financial markets. On the other hand, if one is willing to view the structural shocks of financial markets as risk sources to one another, then the immediate impulse response function of our SVAR model can be thought of as the measurement of 'volatility spillover' from one market to the other, while the instantaneous relationship between these financial variables can be thought of as the risk transmission channel. In addition to the test of the significance of risk sources, the forecast error variance decomposition function of the SVAR model can measure the relative magnitudes of these risk sources. Our analysis therefore not only examines the existence of 'volatility spillover', but it also provides information on the relative importance of financial variables in affecting each other.

Finally, for testing the general applicability of our model, the empirical analysis looks at the data range from the beginning of 2005 to the end of 2014, during which period the global financial environment has changed dramatically due to the Global Financial Crisis and the Eurozone Debt Crisis. Specifically, we apply the model to three subperiods; the pre-crisis period, the Global Financial Crisis period and the Eurozone Debt Crisis period. We also apply the empirical framework to a range of developed and developing markets across the globe. Our analysis is temporal through several global events and spatial in international scale, which makes contribution to better understanding the cross-assets and within-asset behaviours of financial variables.

The rest of the study is structured as follows. In section 2 we present the structural form of contemporary return relationship, and how it is to be tested based on a SVAR model. Section 3 discusses the data source and their preliminary statistics. Section 4 presents and discusses the empirical results, and in particular, we also discuss how the over-identified SVAR is used to determine the risk transmission channel based on a sequence of likelihood ratio tests. Section 5 then offers the concluding remarks.

2. Empirical Methodology

2.1 The simultaneous structural form

We begin the analysis by assuming that all stock markets share a common world factor that determines the average level of stock market returns across international markets. The proxy for the world factor in our model is the S&P500 index of the USA and therefore, the world-factor model can be written as:

$$R_i = \alpha_i + \beta_i w + y_i, \qquad y_i \sim \left(0, \sigma_y^2\right) \tag{1}$$

where R_i are the stock market returns of the sample country *i* and i = CHN, JPN, KOR, TWN, HKG, SGP, AUS, RUS, DEU, FRA or GBR, and the variable w represents the common world factor that impacts upon all stock markets with the loading β_i for the country i. The return of stock market not related to the common world shock is therefore split into two parts, α_i represents the expected excess return of stock market i above the return of the world market w, and y_i represents the extra world-factor risk. One advantage of using the single world-factor model is that the extra world-factor covariance is not zero because the model makes no assumption about the within-asset and cross-assets covariance, i.e., $\text{cov}(y_i, y_j) \neq 0, \forall i \neq j$.

To analyse the contemporary effects of the cross-assets behaviour amongst stock market, foreign exchange market and money market as well as the within-asset behaviour between stock markets, we assume that the financial variables in interest have the following instantaneous relationship,

$$y_1 = \gamma_{12} y_2 + \delta_1 \varepsilon_1 \tag{2}$$

$$y_2 = \gamma_{21} y_1 + \gamma_{23} fx + \gamma_{24} id + \delta_2 \varepsilon_2 \tag{3}$$

$$fx = \gamma_{34} id + \delta_3 \varepsilon_{fx} \tag{4}$$

$$id = \delta_4 \varepsilon_{id} \tag{5}$$

where y_1 is the stock market returns of China and y_2 is the stock market return of one of the rest 10 countries acquired from the world factor model (1), fx is the depreciation rate of the Chinese currency with respect to country 2's currency, and id is the interest rate differential of China with respect to the corresponding country. The coefficient γ allows the model to catch the instantaneous response of a variable to another variable. For example, the significance of γ_{12} would indicate that China's stock market is contemporarily affected by the price change of country 2's stock market, while the significance of γ_{23} would indicate that country 2's stock market is contemporarily affected by the change of China-country 2 foreign exchange rate. The terms ε in the equations are idiosyncratic factors that are unique to the specific asset markets. The contributions of idiosyncratic shocks to the volatility of asset prices are determined by the loadings $\delta > 0$. These factors are assumed to be stochastic processes with zero mean and unit variance, i.e., $\varepsilon \sim (0,1)$.

To explain, notice from equation (5) that the variable id is assumed to be completely autonomous in the structure, while the variable fx is causally prior to the stock markets. The variable fx is set to be responsive to the change of the variable id in equation (4) because in macroeconomics the Mundell-Fleming model dictates that both variables would respond to government's economic policies, and in interest rate parity condition the change of interest rate differential would change the expectation of exchange rate. In equation (2) and (3), the setting of y_2 being responsive to the change of the variables id and fx suggests that country 2's stock market is more developed and opened and hence, investors respond more quickly to news in foreign exchange and money markets.

The above instantaneous relationship between the financial assets can be written in a structural form,

$$Ay = B\varepsilon \tag{6}$$

if we define,

$$y = \begin{bmatrix} y_1 & y_2 & fx & id \end{bmatrix}' \tag{7}$$

$$\varepsilon = \begin{bmatrix} \varepsilon_1 & \varepsilon_2 & \varepsilon_{fx} & \varepsilon_{id} \end{bmatrix}' \tag{8}$$

$$A = \begin{bmatrix} 1 & -\gamma_{12} & 0 & 0 \\ -\gamma_{21} & 1 & -\gamma_{23} & -\gamma_{24} \\ 0 & 0 & 1 & -\gamma_{34} \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{9}$$

$$B = \begin{bmatrix} \delta_1 & 0 & 0 & 0 \\ 0 & \delta_2 & 0 & 0 \\ 0 & 0 & \delta_3 & 0 \\ 0 & 0 & 0 & \delta_4 \end{bmatrix} \quad (10)$$

To complete the specification of the structural model, the idiosyncratic shocks should have the cross-sectional and temporal properties,

$$E_t \lfloor \varepsilon_{i,t} \varepsilon_{j,t} \rfloor = 0, \forall i \neq j \quad (11)$$

$$E_t \lfloor \varepsilon_{i,t} \varepsilon_{j,t'} \rfloor = 0, \forall i \neq j, t \neq t' \quad (12)$$

2.2 Structural Vector Autoregression

To satisfy the properties of idiosyncratic shocks (11) and (12), we write the equation (6) into a Structural Vector Autoregression (SVAR) model that catches the dynamics of the own autocorrelations and cross autocorrelations within the vector y_t,

$$Ay_t = v + A_1^* y_{t-1} + \cdots + A_p^* y_{t-p} + B\varepsilon_t \quad (13)$$

where the coefficient matrices, A_i^* for $i = 1, \ldots, p$, are structural coefficients, and the structural errors ε_t are white noise.

To transform the SVAR into a reduced form VAR for estimation, one can pre-multiply the above equation (13) by the inverse of *A* to get,

$$y_t = A^{-1}v + A^{-1}A_1^* y_{t-1} + \cdots + A^{-1}A_p^* y_{t-p} + A^{-1}B\varepsilon_t \quad (14)$$

With the operation, we thus have a stable four-dimensional VAR(p) process for empirical estimation. To see that equation (14) is a reduced form VAR that allows for estimation, we can define $c \equiv A^{-1}v$, $A_j \equiv A^{-1}A_j^{*}$ $(j=1,\dots p)$, and $u_t \equiv A^{-1}B\varepsilon_t$, so that,

$$y_t = c + A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t \tag{15}$$

where y_t is a (4×1) vector of the observed variables defined in equation (7), the A_j's (j=1,…, p) are the (4×4) reduced form coefficient matrices and c is a (4×1) vector of intercept terms allowing for the possibility of nonzero mean $E(y_t)$. Finally, u_t is 4-dimensional innovation process with $E(u_t)=0$, $E(u_t u_t')=\Sigma_u$ and $E(u_t u_s')=0, \forall s \neq t$.

The restrictions imposed on the matrices A and B in the SVAR equation (13) can be used to identify shocks and trace these out by employing impulse response functions and forecast error variance decomposition. For such purposes, it should be noted that the instantaneous relationship specified in equations (6) to (10) can be shifted to the interpretation of the unexpected part of their shocks ε_t, since in our case we have $Au_t = B\varepsilon_t$. More specifically, the reduced form residuals required for the estimation of impulse responses can be retrieved from the SVAR model by $u_t = A^{-1}B\varepsilon_t$, and the variance-covariance matrix required for the estimation of forecast error variance decomposition can be calculated based on $\Sigma_u = A^{-1}B\Sigma_\varepsilon B'A'^{-1}$. To allow the for the identification of the matrix B, we further assume that the structural innovations ε_t are orthonormal, i.e., its covariance matrix is an identity matrix $E[\varepsilon_t \varepsilon_t'] = I$, and therefore,

$$\Sigma_u = A^{-1}\mathrm{BB}'A'^{-1} \tag{16}$$

Due to the symmetry of the covariance matrix, the minimum number of restrictions for identification is $K^2 + K(K-1)/2$, where *K* is the dimension of the VAR system, and therefore we need to impose 22 restrictions in the SVAR for just-identification. In the specification of the matrix *B* in equation (10), there are 12 restrictions and hence, the matrix *A* requires another 10 restrictions for just-identification. The specification of the matrix *A* has 11 restrictions, and therefore we have an over-identified SVAR with one degree of freedom. To estimate the parameters specified in the matrices *A* and *B*, one then can minimise the negative of the concentrated log-likelihood function,

$$\ln L_c(A,B) = -\frac{KT}{2}\ln(2\pi) + \frac{T}{2}\ln|A|^2 - \frac{T}{2}\ln|B|^2 - \frac{T}{2}tr\left(A'B'^{-1}\tilde{\Sigma}_u B^{-1}A\right) \qquad (17)$$

where K is the dimension of the system, T is the sample size, $|A|$ and $|B|$ are the determinants of the matrices, $\tilde{\Sigma}_u$ is the sample estimate of the variance-covariance matrix for the reduced formed error process Σ_u, and $tr(.)$ is the trace of the indicated matrix.

3. Data and Preliminary Statistics

For the analysis, we collect from the Datastream three data sets with daily frequency for the period from the 31st of December 2004 to the 31st of December 2014. The first data set comprises of the daily closing price index for 12 stock exchanges across the globe, including SSE Composite Index of China, TOPIX of Japan, KOSPI of Korea, TAIEX of Taiwan, HANG SENG Index of Hong Kong, STI of Singapore, ASX200 of Australia, MICEX Index of Russia, DAX30 of Germany, CAC40 of France, FTSE100 of the UK, and S&P500 of the USA. The daily stock market returns, R_i, of each country are the logarithmic first difference of the stock price index multiplied by 100. The second data set are the foreign exchange indices of the Chinese currency with respect to country 2's currency, where country 2 is one of the 11 countries listed above.[4] The depreciation rate of the Chinese currency with respect to country 2's currency, fx, is calculated as the logarithmic first difference of the foreign exchange index multiplied by 100. The third data set are the short-term interest rates of each country, including the interbank overnight of China, the uncollateral overnight of Japan, the overnight call rate of Korea, the overnight repo rate of Taiwan, the overnight deposit of Hong Kong, the interbank call of Singapore, the overnight deposit of Australia, the overnight deposit of Russia, the overnight interbank of Germany, the Eu-Franc short-term deposit of the France, the LIBID/LIBOR overnight of the UK, and the overnight repo of the USA.[5] The interest rate differential of China with respect to country 2 id is calculated as the difference between the Chinese interest rate and country 2's interest rate multiplied by 100.

For the problem of non-synchronous trading hours, whereby the opening and closing hours with reference to the Greenwich Mean Time of various stock markets are different, we adopt a simple method similar to Cai et al. (2009) by lagging one day on the US and European data sets. With regard to the different sample observations in different countries due to each country's specific holiday and institutional arrangements, we follow the existing literature, for example, Wang and Firth (2004) and Wang and Wang (2010), by excluding the dates when any one of the stock markets was closed.

Because there have been several dramatic changes in the financial environment faced by international markets during the full period, we split the full sample into three sub-periods; namely, the pre-crisis period from the 31st of December 2004 to the 8th of August 2007, the Global Financial Crisis (GFC) period from the 9th of August 2007 to the 8th of May 2010, and

[4] Due to the data availability, we apply the cross rate calculations to acquire the exchange rate of the Chinese currency with respect to the Russian, South Korean or Taiwanese currency, whereby the common currency for calculation is the US dollar.
[5] Most of the overnight rates are middle rates, except for Germany and China where the rates are offered rates.

the Eurozone Debt Crisis (EDC) period from the 9th of May 2010 to the 31st of December 2014. The dates chosen for splitting the full sample are based on the information acquired from the Fulltime of the Financial Crisis released by the Federal Reserve Bank of St. Louis. The 9th of August 2007 was the key date that marked the beginning of the Global Financial Crisis when the banking system was seized by the information that the derivatives they held were actually worth a lot less than they previously imagined, and consequently the banks stopped doing business with each other. The 9th of May 2010 was the key date that marked the beginning of the Eurozone Debt Crisis when the global economy was threatened by the possible solvency of the governments in the Eurozone. With the division, the sample sizes for these three sub-periods are 495, 525, and 884 respectively.

Table 1 reports the preliminary statistics of each period for the 12 sampled stock markets. The sample mean of the pre-crisis period for each of the stock markets is positive and relatively large, while the sample means of the two crises periods are generally smaller or even non-profitable. The standard deviation is generally highest in the GFC period and lowest in the pre-crisis period. Only Russia's stock market has standard deviations higher than those of China's stock market, and interestingly, the standard deviations of both markets in the pre-crisis period are higher than those in the EDC period. The rest of the basic statistics also indicate that the impacts of both crises on the global stock markets are substantial, and the investment in China's stock market is generally risker than in other stock markets.

Table 2 reports the correlate of China's stock market with the global financial markets. The upper of the table displays the correlation between China's stock market and one of the other 11 stock markets. Overall, the correlations of stock markets are highly significant, although in the pre-crisis period the correlations between China and the Western markets are not significant. The middle of the table displays the correlation between China's stock market and the relevant foreign exchange market. The correlation generally has become highly significant after the outburst of the global financial crisis. The interesting case is Hong Kong where none of the correlations in three periods is significant. The lower of the table displays the correlation between China's stock market and the relevant interest rate differential in money markets. There is some evidence that China's stock market has become more correlated to money markets after the global financial crisis.

4. Empirical Evidence

4.1 The world-factor model

The estimation of the world-factor model in equation (1) is reported in Table 3. The non-significance of α indicates that there is no expected excess return against the return of the US stock market for each of the stock markets.[6] The significance and the magnitude of β suggest that China's stock market is less integrated to USA's stock market, while the Japan's and all the European stock markets are more integrated with the USA's than those of other Asian stock markets. The magnitude of the loading of extra world-factor risk, i.e., σ_y, suggests that the unique risk of Russia's stock market is higher than that of China's stock market.

After acquiring the extra world-factor risk y for each of the stock market from the residual series of the world-factor model, we proceed to estimate the VAR process in equation (15).

4.2 SVAR estimates

[6] The world-factor model is estimated with the full sample size. The basic assumption is that the interdependence between China and world's financial markets is constant and therefore, any change of parameter estimates throughout three sub-periods in the subsequent estimation of matrix A should ascribe to the contagion phenomena of financial markets.

To choose the appropriate lag length *p* for the VAR process, we use the log-likelihood ratio test with the maximum leg length being 50, thereby roughly catching one season's dynamic in the system. For the VAR process to satisfy the stability condition, we make sure that all of the characteristic roots lies within the unit circle. We also test the autocorrelation LM test for up to 50 lags, and make sure that the null of no serial correlation is adhered to.[7]

As explained in the previous section, the matrix *A* in equation (9) is over-identified with one degree of freedom, and hence we can test the possibility that either γ_{13} or γ_{14} is non-zero. In other words, the over-identified SVAR system allows us to test whether China's stock market is contemporarily affected by the relevant foreign exchange or money market. For testing the possibility, we apply the likelihood ratio test with its statistic,

$$\lambda_{LR1} = -2\left[\ln L_c(A,B)_{R1} - \ln L_c(A,B)_u\right] \qquad (18)$$

where $\ln L_c(A,B)_u$ and $\ln L_c(A,B)_{R1}$ are the concentrated log-likelihood functions for the just-identified SVAR and the over-identified SVAR with one degree of freedom, with their estimates computed by the equation (17). It can be shown that λ_{LR1} has an asymptotic X^2-distribution with one degree of freedom, and its critical value of 5% significance level is roughly equal to 3.8415, i.e., $\mathrm{X}^2_{0.05}(1) \approx 3.8415$. We therefore reject the null of the restricted model and then proceed to estimate the unrestricted model if $\lambda_{LR1} > X^2_{0.05}(1)$.

For the stock markets in the European zone, because today's price in China cannot possibly affect yesterday's price in Europe, we impose the restriction $\gamma_{21} = 0$. As a result, we have a different *A* matrix for the European countries, that is,

[7] The result is available upon request.

$$A=\begin{bmatrix}1 & -\gamma_{12} & 0 & 0\\ 0 & 1 & -\gamma_{23} & -\gamma_{24}\\ 0 & 0 & 1 & -\gamma_{34}\\ 0 & 0 & 0 & 1\end{bmatrix} \tag{19}$$

The matrix in equation (19) is obviously over-identified with 2 degrees of freedom. The specification therefore allows us to test the possibility that either γ_{13} or γ_{14} is non-zero or both of them are non-zero. We start the test by applying the following likelihood ratio test with its statistic,

$$\lambda_{LR2}=-2\left[\ln L_c(A,B)_{R2}-\ln L_c(A,B)_{R1}\right] \tag{20}$$

where $\ln L_c(A,B)_{R2}$ is the concentrated log-likelihood function for the over-identified SVAR with two degree of freedoms. The variable λ_{LR2} has the X^2-distribution with one degree of freedom, so we reject the null of two restrictions SVAR and then proceed to estimate the one restriction SVAR if $\lambda_{LR2} > X^2_{0.05}(1)$. Following the same logic, we then compare the one restriction SVAR with the just-identified SVAR by applying equation (18). If the procedure further takes us to select the just-identified SVAR, then this would suggest that China's stock market responds instantaneously to the changes of exchange rate and interest rate differential.

Table 4 reports the parameter estimates of the matrix *A* in the pre-crisis period for each of the 10 countries paired with China. The non-significance of γ_{12} for most of the estimations indicates that in general China's stock market was not contemporarily affected by other stock markets in the pre-crisis period. The general non-significance of γ_{21} also suggests that China's stock market did not contemporarily affect other stock markets. Nonetheless, the non-zero of γ_{13} and γ_{14} as well as the high significance of γ_{23} and γ_{24} for several Asian countries suggest that the Asian stock markets were interdependent with each other through their instantaneous connections in the foreign exchange and money markets. The loadings of idiosyncratic shocks δ suggest that the investment in stock market is much riskier than the investments in foreign exchange and money markets. The result also suggests that China's stock market has higher unique risk than other stock market does, except for Russia's.

Table 5 reports the parameter estimates of the matrix *A* in the GFC period. The estimates of γ_{12} and γ_{21} suggest that China's stock market has become contemporarily affected by other stock markets, and in a lesser degree, China's stock market also has had more significant influences on other Asian stock markets. The non-zero of γ_{13} and γ_{14} as well as the high significance of γ_{23} and γ_{24} for the European countries suggest that both China's and the European's stock markets have become more sensitive to the risk in the relevant foreign exchange and money markets in the GFC period. In addition, the high significance of the estimates of γ_{23} for the Asian countries suggests that the Asian stock markets in general were sensitive to the change of foreign exchange rates. The loadings of idiosyncratic shocks δ obviously show that investments in any of the financial market, including the stock exchange, foreign exchange and money markets, have become much riskier in the GFC period. China's stock market in this period again has a higher unique risk when compared to other stock markets, except for Russia's.

Table 6 reports the parameter estimates of the matrix *A* in the EDC period. The estimate of γ_{12} suggests that China's stock market has become even more sensitive to other Asian stock markets, while the role of the European stock markets on China's is minor. However, China's stock market is indirectly connected to the European stock markets through the contemporary connections of stock market with foreign exchange and money markets, as indicated by the relevance of γ_{13}, γ_{14}, γ_{23} and γ_{24}. The general significance of γ_{23} again suggests that the

Asian stock markets were sensitive to the change of foreign exchange rates. The estimate of δ suggests that the unique risk of stock markets as well as that of foreign exchange markets have become smaller, while the unique risk of money markets has become larger in the EDC period, when compared to GFC period.

Altogether, the three tables suggest that after the GFC period China's stock market generally has become more integrated with the Asian stock markets. In the pre-crisis period, only Korea's stock market has bi-directional 'return spillover' effect with China's, and only Australia's stock market has uni-directional 'return spillover' effect to China's. The interesting case is Hong Kong where none of the γ parameters is significant, indicating the isolation between China's and Hong's stock markets in this period. Our result is consistent with that of Huyghebaert and Wang (2010) who find no evidence of stock market integration between China and other Asian markets after the Asian financial crisis.[8] In the GFC period, however, the bi-directional 'return spillover' effect is found for the cases of Korea and Australia, while the uni-directional 'return spillover' effect is found from Japan's and Singapore's stock markets to China's. In the EDC period, the bi-directional 'return spillover' effect is found to exist in three cases, namely Taiwan, Singapore and Australia, whereas the uni-directional 'return spillover' effect is found to spread from the stock markets of Japan, Korea and Hong Kong to China's stock market. The three tables suggest that China's stock market and the European stock markets have been generally non-sensitive to each other through time, but they also suggest that foreign exchange and money markets have been the important channels in transmitting risk between China's and the European stock markets after the GFC period.

4.3 Impulse response function

[8] Their empirical evidence is for the study between 1st of July, 1992 and 30st of June, 2003.

As can be seen in the previous section, the unexpected part of the SVAR system, i.e., $B\varepsilon_t$ in equation (13), will reach its impacts on the observed vector y_t via the instantaneous relation $Au_t = B\varepsilon_t$ through the VAR system (14) to the regressand. The structure of the matrix A therefore can be thought of as the risk transmission channel through which the magnitude of idiosyncratic shocks $B\varepsilon_t$ casts its immediate impacts on the current prices of financial markets, and then with the dynamics of the VAR system its subsequent impacts on the future prices of financial markets. The dynamic system of transmitting risk can be expressed more clearly if we rewrite the VAR system (15) into a Wold moving average representation,

$$y_t = u_t + \Phi_1 u_{t-1} + \Phi_2 u_{t-2} + \cdots \qquad (21)$$

where,

$$\Phi_s = \sum_{j=1}^{s} \Phi_{s-j} A_j \qquad (22)$$

with $\Phi_0 = I_K$

Accordingly, the impulse response function that can be calculated based on the Wold MV decomposition for a stable VAR(p) process has the immediate impulse response equal to $u_t = A^{-1}B\varepsilon_t$. The product of matrices $A^{-1}B$ therefore can be thought of as the measurement of whether each element of the idiosyncratic shocks ε_t has significant immediate impacts on the financial markets. In other words, the immediate impulse response functions allow us to differentiate the sources of risk to stock markets.

Table 7 reports the immediate impulse response functions of China's stock market to four idiosyncratic shocks, namely the shocks of China's stock market, country 2's stock market, the relevant foreign exchange market and interest rate differential. Since ε_1 is the idiosyncratic shock of China's stock market, it is not surprising that the parameter estimates of immediate impulse response of China's stock market to its own shock, i.e., the numbers in the two columns beneath ε_1, are all highly significant. The estimates of immediate impulse response of China's stock market to country 2's stock market shock, i.e., the numbers in the two columns beneath ε_2, suggest that in general China's stock market responded immediately to the Asian stock market shocks, especially in the two crises period. The estimates of immediate impulse response of China's stock market to the European stock market shocks, however, are not significant except for Russia's and UK's in the GFC period. With respect to the foreign exchange shocks, the estimates of immediate impulse response of China's stock market are generally significant, especially in the two crises periods. As for the money market, there is also some evidence that China's stock market responded immediately to the shock of interest rate differential.

Table 8 reports the immediate impulse response functions of global stock markets to the four idiosyncratic shocks in the three sub-periods. Since ε_2 is the idiosyncratic shock of country 2's stock market itself, it is not surprising that the parameter estimates of immediate impulse response of country 2's stock market to its own shock, i.e., the numbers in the two columns beneath ε_2, are all highly significant. The estimates of immediate impulse response of country 2's stock market to China's stock market shock, i.e., the numbers in the two columns beneath ε_1, suggest that in general the Asian stock markets were not instantaneously responsive to China's stock market shock, although Australia's stock market was a special case that responded immediately to China's in all three sub-periods. Notice that the estimates of immediate impulse response of the European stock markets to China's stock market shock are zero. The reason is we impose in the matrix A in equation (19) the element $\gamma_{21} = 0$

since there exists the problem of non-synchronous trading hours between China's and the European stock markets. The estimates of immediate impulse response of the Asian stock markets to the foreign exchange shocks are overall highly significant, while the immediate impulse response of the European stock markets to the foreign exchange shocks is generally weak. Finally, although the immediate impulse response of stock markets to the money market shocks is not strong, the European stock markets seemingly are more responsive to the money market shocks than the foreign exchange shocks.

Altogether, the two tables suggest that the volatility of financial assets provides an increasing important role in connecting China's stock market with other Asian stock markets. Before the GFC period, there were two cases of bi-directional 'volatility spillover' effect with China, namely the stock markets of Korea and Australia. Since the GFC period, however, there has been more cases of bi-directional 'volatility spillover' effect with China, including Korea, Australia, and Singapore in the GFC period, and Australia, Singapore and Taiwan in the EDC period. While there was no uni-directional 'volatility spillover' effect from China's stock market to others in any sub-period, there were some cases of uni-directional 'volatility spillover' effect from others to China's stock market. These include the case of Japan in the GFC period, and the cases of Japan, Hong Kong, and Korea in the EDC period. There were also the uni-directional 'volatility spillover effect' from Russia and UK's stock markets to China's in the GFC period. The empirical evidence overall suggests that the linkage of China's stock market with the Asian stock markets has become stronger through time, but the volatility spillover effect is not symmetrical; China's stock market has become more influenced by the volatility of other stock markets, while its influence on others has not increased as equally.

As mentioned previously, the structure of the matrix *A* can be thought of as the risk transmission channel, and correspondingly the immediate impulse response functions can be used to identify the sources of risk to stock markets. From this perspective, Table 7 and Table 8 together suggest that the most important source of risk to stock market is its own idiosyncratic shock. The results also suggest that the idiosyncratic shocks of the Asian stock markets are important sources of risk to China's stock market. In contrary, the idiosyncratic shock of China's stock market seems not to be as important as a source of risk to the Asian stock markets. Interestingly, the result also strongly suggests that the idiosyncratic shock of foreign exchange markets is a common source of risk to both China's and the Asian stock markets. With regard to the European financial markets, there is no evidence that the idiosyncratic shock of the European stock markets is a source of risk to China's stock market. There is some evidence, however, that the idiosyncratic shock of the relevant foreign exchange markets is a source of risk to China's stock market. Finally, there is also some weak evidence that the idiosyncratic shock of the relevant money markets is a source of risk to the European stock markets.

4.3 Forecast error variance decomposition

After the identification of the sources of risk to stock markets, a complementary question one can ask is how relatively important each of these sources of risk is to the stock markets. To answer this question, we employ the forecast error variance decomposition since it separates the variation in an endogenous variable into the component shocks to the VAR system. In our study, we display the relative importance of each idiosyncratic shock to stock market for roughly up to one-month time, i.e., 20 periods, since the relative contribution of each idiosyncratic shock to stock market has become quite stable thereafter.

Table 9 displays the variance decomposition of China's stock market in the pre-crisis period. As expected, the most important source of risk to China's stock market is its own idiosyncratic shock, i.e., ε_1. Moreover, by looking at the columns beneath ε_2, the variance decomposition recognises that the idiosyncratic shocks of Australia's, Korea's and Japan's stock markets are important sources of risk to China's stock market, while the idiosyncratic shocks of the European stock markets and other Asian stock markets are much less important. Table 10 displays the variance decomposition of China's stock market in the GFC period. The result suggests that the idiosyncratic shocks of Australia's, Singapore's, Korea's and Hong Kong's stock markets are important sources of risk to China's stock market, apart from the own idiosyncratic shock of China's stock market. Table 11 displays the variance decomposition of China's stock market in the EDC period. The major sources of risk to China's stock market are still its own idiosyncratic shock and the idiosyncratic shocks of Asian stock markets, except for that of Japan's stock market.

The three tables altogether suggest that China's stock market has become more influenced by the idiosyncratic shocks of Asian stock markets through time. The inspection of individual country further suggests that the stock markets of Hong Kong, Singapore and Taiwan have become more important in contributing to the variation of China's stock market through time, while the stock markets of Japan and Korea have become less important. Our result therefore is consistent to the results of Hatemi-J and Roca (2004) and Zhou, Zhang and Zhang (2012) that the Chinese cultural background provides a risk factor in China's stock market. With regard to the European stock markets, the result suggests that the idiosyncratic shocks of the European stock markets generally play very minor roles in determining the variation of China's stock market. The result is consistent with that of impulse response functions in Table 7. Furthermore, the results from the columns beneath ε_{fx} and ε_{id} in the three tables suggest that the idiosyncratic shocks of foreign exchange and money markets, whether from Asia or from Eurpore, are not important sources of risk to China's stock market.

To investigate the influences of China's stock market shock on the global stock markets, we now turn to Tables 12 to 14. Table 12 shows the variance decomposition of the global stock markets in the pre-crisis period. As expected, the most important source of risk to any country's stock market is its own idiosyncratic shock, represented by ε_2. The result also suggests that the idiosyncratic shock of China's stock market is generally an important source of risk to other Asian stock markets, while it plays a very minor role in contributing to the variation of European stock markets. Table 13 shows the variance decomposition of the global stock markets in the GFC period. The own idiosyncratic shock is unsurprisingly the most important source of risk to a country's stock market. The result also suggests that the idiosyncratic shock of China's stock market is an important source of risk to Australia's, Singapore's and Hong Kong's stock markets. Table 14 shows the variance decomposition of the global stock markets in the EDC period. The role of China's stock market as the risk source to the Asian stock markets has generally diminished, although it is still important for Australia's and Hong Kong's stock markets. The three tables also suggest that China's stock market is not an important source of risk to the European stock markets. Altogether we therefore find no empirical evidence that China's stock market has become more influential to the global stock markets through time.

Further inspection of the influence of China on other Asian countries suggests that China's stock market is not an important risk source to Taiwan's and Singapore's stock markets, despite in the GFC period Singapore's stock market showed vulnerability to the idiosyncratic shock of China's. By contrast, Hong Kong's stock market has been greatly influenced by the variation of China's stock market throughout the samples. Combined with the results in

Tables 9 to 11, our study suggests that there are different degrees of integration with the Chinese culture cluster. Interestingly, Australia's stock market also shows high integration with China's stock market, which may be due to China being the largest trade partner of Australia. Finally, the role of China's stock market in determining the variation of Japan's and Korea's stock markets is diminishing. The overall results from Table 9 to 14 therefore suggest that only Australia's and Hong Kong's stock markets show evidence of integration with China's stock market.

In particular, the results from the columns beneath ε_{fx} in Tables 12 to 14 suggest that most of the Asian stock markets are greatly influenced by the idiosyncratic shocks of foreign exchange markets, except for Hong Kong. The reason for the minor influence of China-Hong Kong exchange rate on Hong Kong's stock market might be because China and Hong Kong both heavily peg their currencies to the U.S. dollar. Further inspection suggests that the idiosyncratic shock of foreign exchange market in some cases is even more important than the shock of China's stock market. For example, Taiwan's stock market has been more influenced by the shock of China-Taiwan exchange rate than by the shock of China's stock market throughout the sample, and Japan's and Korea's stock markets are also more vulnerable to the shocks in currency markets than the shock of China's stock market in both crises period. By contrast, for the European stock markets the risk emanating from currency market is much less important; only Russia's stock market in the GFC period is critically influenced by the shock of the relevant foreign exchange market. In addition, despite the impulse response function suggests that some European stock markets, for example, Germany, France and the U.K. in the GFC period, and Russia in the EDC period, are sensitive to idiosyncratic shocks in money markets, the variance decomposition suggests that the money markets are not important sources of risk.

In essence, the result of forecast error variance decomposition suggests that the degree of China's stock market being influenced by Asian stock markets is greater than the degree of influence it has on the Asian stock markets. It also suggests that the foreign exchange and money markets are not risk sources to China's stock market, while the foreign exchange markets are the important sources of risk to other Asian stock markets. In addition, the result suggests that the European stock markets are quiet disconnected from China's stock market even in the crisis period. Although there is some evidence from the impulse response functions that foreign exchange and money markets are the sources of risk to the China's and European's stock markets in crises period, the magnitudes of these risks arrived in the stock markets are actually minor. In short, the result of variance decomposition not only is consistent with that of the impulse response functions, but it also provides some further evidence for inspecting the extent to which the idiosyncratic shock of financial markets transmits to each other.

5. Conclusion

Finding out the causality of a national equity market with international financial markets is an empirical question of great importance to both policy makers and investors. With the increasing liberalisation of China's capital markets, many researchers have devoted to the study of the 'spillover' effect between China's stock market and international stock markets. In this paper, we specified a structural form that determines the instantaneous relationship among equity, currency and money markets, which was then analysed by a SVAR model. In other words, we used the SVAR model to test the 'return spillover' as well as 'volatility spillover' effects between stock markets, with the preview that currency and money markets may function as the linkages between stock markets.

The empirical evidence from the test of ‘return spillover’ suggested that China’s stock market has become more integrated with the Asian stock markets since the global financial crisis. The evidence also showed that there was no contemporary ‘return spillover’ effect between China’s and the European stock markets, although the currency and money markets may have functioned as the linkages between them since the global financial crisis. The empirical evidence from the test of ‘volatlity spillover’ also indicated that the integration of China’s stock market with the Asian stock markets has become stronger, with further suggestion that the effect is not symmetrical; China’s stock market has become more influenced by the volatility of the Asian stock markets through time, but China’s influence on Asia has not increased as equally. In addition, the volatility of China’s stock market is generally unrelated to the volatility of the European stock markets, although in the global financial crisis there was the uni-directional ‘volatility spillover’ from Russia and UK to China.

Furthermore, the SVAR model allowed us to identify the idiosyncratic shocks specified in the structural form system. With this perspective, the immediate impulse response functions can be viewed as a test on the statistical significance of the risk sources of financial markets and the forecast error variance decompositions can be viewed as an examination on the relative importance of the risk sources, while the structural relationship among financial markets can be thought of as the risk transmission channel. The most important risk source of China’s stock market, as suggested by the immediate impulse response functions, is the own idiosyncratic shock, followed by the shocks in the Asian stock markets. By contrast, the idiosyncratic shock of China’s stock market is not an important source of risk to both the Asian and European stock markets. Interestingly, the impulse response functions also suggested that currency markets were a common source of risk to both China’s and the Asian stock markets. The forecast error variance decompositions further suggested that China’s stock market has become more influenced by the stock markets with the Chinese culture background, including Hong Kong, Singapore and Taiwan. However, in these three Chinese culture markets, only Hong Kong showed bi-directional integration with China. The other stock market in Asia that showed bi-directional integration with China is Australia's. Interestingly, in spite of being insensitive to China's stock market, Japan's, Korea's and Taiwan's stock markets displayed sensitivity to the shocks in the relevant currency markets. Economically, this may result from the heavy peg of China's currency to the US currency, and hence the ostensibly high sensitivity of these three stock markets to the shocks of currency markets is actually a response to the volatility of the US currency.

In summary, we found that the within-asset behaviour of equity unsurprisingly provides the strongest international transmission of financial shocks, but it is not cross-regional between China and the European zone, once the common world factor of the US stock market has been taken into account. We also found that the international cross-assets behaviour between equity and currency is significant within Asia, and it is also cross-regional between China and the European zone in the global financial crisis. Finally, we also found some evidence that the cross-assets behaviour between equity and money is cross-regional in the global finical crises, although in general it has very minor role in the determination of the variation of equity asset.

References

King, M. and Wadhwani, S., 1990. Transmission of volatility between stock markets. *Review of Financial Studies*, 3, pp. 5-33.

Engle, R.F., Ito, T. and Lin, W.L., 1990. Meteor showers or heat waves? Heteroskedastic intra-daily volatility in the foreign exchange market. *Econometrica*, 58, pp. 525-542.

Eichengreen, B., Rose, A.K., Wyplosz, C., Dumas, B. and Weber, A., 1995. Exchange market mayhem: the antecedents and aftermath of speculative attacks. *Economic policy*, pp.249-312.

Forbes, K.J. and Rigobon, R., 2002. No contagion, only interdependence: measuring stock market comovements. *The journal of finance*, *57*(5), pp.2223-2261.

Karolyi, G.A., 2004. Does international financial contagion really exist?. *Journal of Applied Corporate Finance*, *16*(2-3), pp.136-146.

Dungey, M. and Martin, V.L., 2004. A multifactor model of exchange rates with unanticipated shocks: measuring contagion in the East Asian currency crisis. *Journal of Emerging Market Finance*, *3*(3), pp.305-330.

Boyer, B.H., Kumagai, T. and Yuan, K., 2006. How do crises spread? Evidence from accessible and inaccessible stock indices. *The Journal of Finance*, *61*(2), pp.957-1003.

Bekaert, G., Hodrick, R.J. and Zhang, X., 2009. International stock return comovements. *The Journal of Finance*, *64*(6), pp.2591-2626.

Wei, K. C., Liu, Y., Yang, C. and Cheung, G., 1995. Volatility and price change spillover effects across the developed and emerging markets. *Pacific-Basin Finance Journal*, 3, pp.113−136.

Liu, Y.A., and Pan, M.S., 1997. Mean and volatility spillovers effects in the US and Pacific-Basin stock markets. *Multinational Finance Journal*, 1, pp.47-62.

Masih, A., and Masih, R., 1999. Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets. *Pacific-Basin Finance Journal*, 7, pp.251-282.

Ng, A., 2000. Volatility spillover effects from Japan and the US to the Pacific–Basin. *Journal of International Money and Finance*, 19, pp.207−233.

Miyakoshi, T., 2003. Spillovers of stock return volatility to Asian equity markets from Japan and the US. *International Financial Markets, Institutions and Money*, 13, pp.383−399.

Lee, B., Rui, O. M. and Wang, S. S., 2004. Information transmission between the NASDAQ and Asian second board markets. *Journal of Banking and Finance*, 28, pp.1637−1670.

Worthington, A. and Higgs, H. , 2004. Transmission of equity returns and volatility in Asian developed emerging markets: a multivariate GARCH analysis. *International Journal of Finance and Economics,* 9, pp.71-80.

Tai, C.S., 2007. Market integration and contagion: Evidence from Asian emerging stock and foreign exchange markets. *Emerging Markets Review*,*8*(4), pp.264-283.

Kenourgios, D., Samitas, A. and Paltalidis, N., 2011. Financial crises and stock market contagion in a multivariate time-varying asymmetric framework. *Journal of International Financial Markets, Institutions and Money*, *21*(1), pp.92-106.

Samarakoon, L.P., 2011. Stock market interdependence, contagion, and the US financial crisis: The case of emerging and frontier markets. *Journal of International Financial Markets, Institutions and Money*, *21*(5), pp.724-742.

Kotkatvuori-Örnberg, J., Nikkinen, J. and Äijö, J., 2013. Stock market correlations during the financial crisis of 2008–2009: Evidence from 50 equity markets. *International Review of Financial Analysis*, *28*, pp.70-78.

Beirne, J., Caporale, G.M., Schulze-Ghattas, M. and Spagnolo, N., 2013. Volatility spillovers and contagion from mature to emerging stock markets. *Review of International Economics*, 21(5), pp.1060-1075.

Bekaert, G., Ehrmann, M., Fratzscher, M. and Mehl, A., 2014. The global crisis and equity market contagion. *The Journal of Finance*, *69*(6), pp.2597-2649.

Morales, L. and Andreosso-O'Callaghan, B., 2014. The global financial crisis: World market or regional contagion effects?. *International Review of Economics & Finance*, *29*, pp.108-131.

Bailey, W., 1994. Risk and Return on China's new stock markets: some preliminary evidence. *Pacific-Basin Finance Journal*, 2, pp.243-260.

Hu, J.W.S., Chen, M.Y., Fok, R.C. and Huang, B.N., 1997. Causality in volatility and volatility spillover effects between US, Japan and four equity markets in the South China growth triangular. *Journal of International Financial Markets, Institutions and Money*, *7*(4), pp.351-367.

Huang, B.N., Yang, C.W., Hu, J.W.S., 2000. Causality and cointegration of stock markets among the United States, Japan, and the South China growth triangle. *International Review of Financial Analysis*, 9 (3), pp.281–297.

Hatemi-J, A. and Roca, E.D., 2004. Do birds of the same feather flock together?: The case of the Chinese states equity markets. *Journal of International Financial Markets, Institutions and Money*, *14*(3), pp.281-294.

Wang, S.S., and Firth, K., 2004. Do bears and bulls swim across oceans? Market information transmission between Greater China and the rest of world. *Journal of International Financial Markets, Institutions and Money*, 14, pp.235-254.

Li, H., 2007. International linkages of the Chinese stock exchanges: a multivariate GARCH analysis. *Applied Financial Economics*, *17*(4), pp.285-297.

Wang, Y. and Di Iorio, A., 2007. Are the China-related stock markets segmented with both world and regional stock markets?. *Journal of International Financial Markets, Institutions and Money*, 17(3), pp.277-290.

Huyghebaert, N. and Wang, L., 2010. The co-movement of stock markets in East Asia: Did the 1997–1998 Asian financial crisis really strengthen stock market integration?. *China Economic Review*, 21(1), pp.98-112.

Wang, P. and Wang, P., 2010. Price and volatility spillovers between the Greater China Markets and the developed markets of US and Japan. *Global Finance Journal*, 21(3), pp.304-317.

Zhou, X., Zhang, W. and Zhang, J., 2012. Volatility spillovers between the Chinese and world equity markets. *Pacific-Basin Finance Journal*, 20(2), pp.247-270.

Solnik, B.H., 1974. The international pricing of risk: An empirical investigation of the world capital market structure. *Journal of Finance*, pp.365-378.

Mahieu, R. and Schotman, P., 1994. Neglected common factors in exchange rate volatility. *Journal of Empirical Finance*, 1(3), pp.279-311.

Masson, P., 1999. Contagion: macroeconomic models with multiple equilibria. *Journal of International Money and Finance*, *18*(4), pp.587-602.

Bekaert, G., Harvey, C.R. and Ng, A., 2005. Market Integration and Contagion. *Journal of Business*, *78*(1).

Corsetti, G., Pericoli, M. and Sbracia, M., 2005. 'Some contagion, some interdependence': More pitfalls in tests of financial contagion. *Journal of International Money and Finance*, 24(8), pp.1177-1199.

Dungey, M. and Gajurel, D., 2014. Equity market contagion during the global financial crisis: Evidence from the world's eight largest economies. *Economic Systems*, *38*(2), pp.161-177.

Kaminsky, G.L. and Vega−García, P., 2016. Systemic and Idiosyncratic Sovereign Debt Crises. *Journal of the European Economic Association*, 14(1), pp.80-114.

Calvo, G., 1996. Capital inflows and macroeconomic management: Tequila lessons. *International Journal of Finance and Economics*, 1, pp.207-223.

Masson, M.P.R., 1998. *Contagion: Monsoonal Effects, Spillovers, and Jumps Between Multiple Equilibria* (No. 98-142). International Monetary Fund.

Eichengreen, B., Rose, A. and Wyplosz, C., 1996. Contagious currency crises: final tests. *Scandinavian Journal of Economics*, 38, pp.463–494.

Glick, R. and Rose, A.K., 1999. Contagion and trade: Why are currency crises regional?. *Journal of international Money and Finance*, 18(4), pp.603-617.

Van Rijckeghem, C. and Weder, B., 2001. Sources of contagion: is it finance or trade?. *Journal of International Economics*, 54(2), pp.293-308.

Wälti, S., 2011. Stock market synchronization and monetary integration.*Journal of International Money and Finance*, *30*(1), pp.96-110.

Jansen, D.W. and Tsai, C.L., 2010. Monetary policy and stock returns: Financing constraints and asymmetries in bull and bear markets. *Journal of Empirical finance*, *17*(5), pp.981-990.

Baig, M.T. and Goldfajn, M.I., 1998. *Financial market contagion in the Asian crisis* (No. 98-155). International Monetary Fund.

Christopher, R., Kim, S.J. and Wu, E., 2012. Do sovereign credit ratings influence regional stock and bond market interdependencies in emerging countries?. *Journal of International Financial Markets, Institutions and Money, 22*(4), pp.1070-1089.

Panchenko, V. and Wu, E., 2009. Time-varying market integration and stock and bond return concordance in emerging markets. *Journal of Banking & Finance*, *33*(6), pp.1014-1021.

Elyasiani, E. and Mansur, I., 1998. Sensitivity of the bank stock returns distribution to changes in the level and volatility of interest rate: A GARCH-M model. *Journal of Banking & Finance*, *22*(5), pp.535-563.

Johnson, R. and Soenen, L., 2002. Asian economic integration and stock market comovement. *Journal of Financial Research*, *25*(1), pp.141-157.

Lustig, H., Roussanov, N. and Verdelhan, A., 2011. Common risk factors in currency markets. *Review of Financial Studies*, *24*(11), pp.3731-3777.

Hess, P.J. and Lee, B.S., 1999. Stock returns and inflation with supply and demand disturbances. *Review of Financial Studies*, *12*(5), pp.1203-1218.

Gallagher, L.A. and Taylor, M.P., 2002. Permanent and temporary components of stock prices: Evidence from assessing macroeconomic shocks. *Southern Economic Journal*, pp.345-362.

Binswanger, M., 2004. How important are fundamentals? Evidence from a structural VAR model for the stock markets in the US, Japan and Europe. *Journal of International Financial Markets*, *Institutions and Money*, *14*(2), pp.185-201.

Fraser, P. and Groenewold, N., 2006. US share prices and real supply and demand shocks. *The Quarterly Review of Economics and Finance*, *46*(1), pp.149-167.

Ehrmann, M., Fratzscher, M. and Rigobon, R., 2011. Stocks, bonds, money markets and exchange rates: measuring international financial transmission. *Journal of Applied Econometrics*, 26(6), pp.948-974.

Dungey, M., Milunovich, G. and Thorp, S., 2010. Unobservable shocks as carriers of contagion. *Journal of Banking & Finance*, *34*(5), pp.1008-1021.

Dungey, M., Milunovich, G., Thorp, S. and Yang, M., 2015. Endogenous crisis dating and contagion using smooth transition structural GARCH. *Journal of Banking & Finance*, *58*, pp.71-79.

Cai, Y., Chou, R.Y. and Liu, D., 2009. Explaining international stock correlations with CPI fluctuations and market volatility. *Journal of Banking and Finance*, 33 (11), pp.2026-2035.

Table 1. The preliminary statistics for the sampled stock markets

	Period	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis	Jarque-Bera
CHN	Pre	0.1340	1.7050	7.8904	-9.2561	-0.7136	7.4149	443.1306
	GFC	-0.1327	2.2588	8.8874	-8.0436	-0.0816	4.1650	30.2728
	EDC	-0.0186	1.1976	4.2336	-5.5826	-0.3076	5.3157	211.4654
JPN	Pre	0.0474	1.0084	3.5403	-3.6444	-0.3420	4.3816	48.9166
	GFC	-0.0663	2.0064	12.8647	-10.0071	0.0099	8.3664	629.9691
	EDC	0.0194	1.2803	6.4275	-9.9519	-0.8314	9.8984	1854.6710
KOR	Pre	0.1162	1.1124	3.4489	-4.1766	-0.5315	4.0920	47.8004
	GFC	-0.0570	1.9580	11.2844	-11.1720	-0.6600	9.3559	921.7980
	EDC	0.0310	1.0768	4.9000	-6.4202	-0.2873	6.9028	573.2122
TWN	Pre	0.0547	0.9890	2.9030	-4.3504	-0.8803	6.3498	294.7734
	GFC	-0.0094	1.7138	6.5246	-5.9333	-0.1575	4.3853	44.1487
	EDC	0.0321	0.9779	4.4594	-5.7422	-0.3694	6.0161	355.1738
HKG	Pre	0.0954	0.9265	2.8292	-4.0792	-0.5561	4.8068	92.6578
	GFC	-0.0564	2.2886	12.0580	-8.6647	0.1342	5.5753	146.6565
	EDC	-0.0033	1.1260	5.4778	-5.3917	-0.2075	5.1101	170.3421
SGP	Pre	0.0782	0.9117	3.5139	-3.7373	-0.7047	5.7174	192.8756
	GFC	-0.0694	1.7442	7.5305	-8.6960	-0.1730	5.9159	188.6062
	EDC	0.0203	0.7957	3.2896	-3.7693	-0.4563	5.4148	245.4586
AUS	Pre	0.0763	0.7895	2.0691	-3.3597	-0.4895	4.1171	45.4126
	GFC	-0.0507	1.5499	5.6282	-6.8976	-0.0925	4.4712	48.0984
	EDC	0.0177	0.9396	3.5767	-4.0832	-0.2095	4.1979	59.3159
RUS	Pre	0.1553	2.0108	10.1454	-10.1439	-0.6986	7.3920	437.2252
	GFC	-0.0025	3.3981	25.2261	-19.1777	0.5830	13.9648	2659.7080
	EDC	-0.0047	1.4162	5.5070	-11.4189	-0.8240	8.9939	1423.3190
DEU	Pre	0.0708	0.9330	2.6051	-3.4633	-0.3383	3.6569	18.3035
	GFC	0.0210	1.9066	10.7975	-7.0828	0.6075	8.9940	818.2100
	EDC	0.0271	1.2677	5.1566	-5.9947	-0.2428	4.9929	154.9723
FRA	Pre	0.0500	0.8700	2.4225	-3.2272	-0.3422	3.8764	25.4510
	GFC	0.0084	1.9647	10.5946	-7.0633	0.5845	7.8139	536.8150
	EDC	-0.0053	1.3274	5.5785	-5.6346	-0.2661	4.9883	156.0453
GBR	Pre	0.0381	0.7416	2.6045	-3.1975	-0.4094	5.0205	97.8354
	GFC	0.0190	1.8050	9.3843	-7.4291	0.4147	7.2507	410.2899
	EDC	0.0079	0.9725	3.9430	-4.5936	-0.2492	4.7203	118.1569
USA	Pre	0.0552	0.6874	2.3864	-2.6946	-0.2174	4.2684	37.0065
	GFC	-0.0141	1.9562	10.9572	-9.4695	0.0514	8.9133	765.1409
	EDC	0.0553	0.9832	4.6317	-4.9002	-0.2127	6.6633	500.9634

Pre is pre-crisis period, GFC is the global financial crisis period, and EDC is the Eurozone debt crisis period. Std.Dev is the standard deviation.

Table 2. The correlate of China's stock market with the global financial markets

$\rho(R_1,R_2)$	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR	USA
Pre	0.1538***	0.1911***	0.1572***	0.2692***	0.1967***	0.1519***	0.0392	0.0429	0.0412	0.0464	0.0525
	(3.4532)	(4.3185)	(3.5303)	(6.2011)	(4.4507)	(3.4091)	(0.8696)	(0.9518)	(0.9138)	(1.0292)	(1.1664)
GFC	0.2926***	0.3352***	0.3199***	0.4931***	0.3331***	0.3014***	0.1562***	0.1403***	0.1557***	0.1861***	0.1988***
	(6.9973)	(8.1365)	(7.7212)	(12.9607)	(8.0802)	(7.2280)	(3.6164)	(3.2409)	(3.6038)	(4.3294)	(4.6405)
EDC	0.2494***	0.3664***	0.3699***	0.5548***	0.3640***	0.3852***	0.1135***	0.1656***	0.1582***	0.1610***	0.2121***
	(7.6485)	(11.6952)	(11.8086)	(19.8037)	(11.6051)	(12.3982)	(3.3922)	(4.9871)	(4.7589)	(4.8461)	(6.4460)

$\rho(R_1,fx)$	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR	USA
Pre	-0.0364	0.1048***	0.0128	-0.0587	0.0129	0.0485	-0.0162	0.0240	0.0240	0.0190	-0.0445
	(-0.8079)	(2.3378)	(0.2828)	(-1.3050)	(0.2851)	(1.0769)	(-0.3597)	(0.5326)	(0.5326)	(0.4225)	(-0.9889)
GFC	-0.0337	0.2509***	0.1613***	-0.0247	0.1518***	0.1622***	0.1899***	0.1263***	0.1263***	0.1135***	-0.0365
	(-0.7705)	(5.9267)	(3.73801)	(-0.5642)	(3.5127)	(3.7600)	(4.4228)	(2.9119)	(2.91191)	(2.6134)	(-0.8347)
EDC	-0.0849***	0.2992***	0.2417***	-0.0426	0.2451***	0.3024***	0.1013***	0.1739***	0.1739***	0.1166***	-0.1101***
	(-2.5318)	(9.3121)	(7.3981)	(-1.2671)	(7.5081)	(9.4210)	(3.0231)	(5.2453)	(5.2453)	(3.4879)	(-3.2893)

$\rho(R_1,id)$	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR	USA
Pre	0.0731	-0.0123	0.0673	-0.0222	0.0060	0.0151	-0.0207	-0.0355	-0.0398	0.0419	-0.0432
	(1.6267)	(-0.2735)	(1.4953)	(-0.4931)	(0.1326)	(0.3360)	(-0.4597)	(-0.7883)	(-0.8838)	(0.9291)	(-0.9585)
GFC	-0.1210***	0.0617	-0.0469	-0.0770	-0.1249***	0.07908	-0.0803	0.0538	0.0577	0.0743	-0.0271
	(-2.7868)	(1.4143)	(-1.0739)	(-1.7651)	(-2.8785)	(1.8142)	(-1.8414)	(1.2314)	(1.3212)	(1.7035)	(-0.6196)
EDC	-0.0613***	-0.0317	-0.0603	-0.0615	-0.0607	-0.0314	-0.0813***	-0.0429	-0.0443	-0.0596	-0.0621
	(-1.8226)	(-0.9430)	(-1.7941)	(-1.8314)	(-1.8053)	(-0.9344)	(-2.4237)	(-1.2745)	(-1.3159)	(-1.7732)	(-1.8482)

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

$\rho(R_1,R_2)$ is the correlation coefficient between China's and the indicated country's stock markets. $\rho(R_1,fx)$ is the correlation coefficient between China's stock market and the foreign exchange market of China with respect to the indicated country. $\rho(R_1,id)$ is the correlation coefficient between China's stock market and the interest rate differential of China with respect to the indicated country.

Table 3. The world-factor model with the S&P 500 being proxy for the world-factor

	CHN	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR
α	-0.0188	-0.018774	0.0128	0.0118	-0.0008	-0.0020	-0.0044	0.0147	0.0111	-0.012494	-0.0019
	(0.0380)	(0.0285)	(0.0290)	(0.0255)	(0.0299)	(0.0246)	(0.0207)	(0.0488)	(0.0246)	(0.0259)	(0.0223)
β	0.2314***	0.6032***	0.4427***	0.4078***	0.5317***	0.3473***	0.5102***	0.6273***	0.7106***	0.7010***	0.5718***
	(0.0298)	(0.0223)	(0.0228)	(0.0200)	(0.0232)	(0.0193)	(0.0162)	(0.0383)	(0.0193)	(0.0203)	(0.0175)
σ_y	1.6576	1.2423	1.2651	1.1121	1.4273	1.0744	0.9012	2.1272	1.0734	1.1309	0.9734

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

α is the expected excess return of the indicatd stock market above the return of the US stock market. β is the loadings of common world factor on the indicated stock market. σ_y is the magnitude of the loading of extra world-factor risk.

Table 4. Parameter estimates of Matrix A that measures the return spillover between China and the indicated country in the pre-crisis period

	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR
Υ_{12}	0.8733	1.2360***	-0.1648	-0.3551	0.0184	2.1920**	-0.0212	0.0088	0.0303	0.0491
	(0.5903)	(0.3730)	(0.2900)	(1.0178)	(1.0283)	(0.9665)	(0.0387)	(0.0923)	(0.0977)	(0.1234)
Υ_{13}				-1.4794						
				(0.7677)						
Υ_{14}	3.6134**		5.7192***							
	(1.5709)		(1.3761)							
Υ_{21}	-0.2117	-0.3770**	0.114178	0.1712	0.08954	-0.3140				
	(0.2219)	(0.1769)	(0.0818)	(0.1895)	(0.2326)	(0.1867)				
Υ_{23}	-0.3241***	0.7119***	1.1193***		0.3002**	0.03379	0.2468	0.0124	-0.0034	-0.0968
	(0.1118)	(0.1934)	(0.1658)		(0.1475)	(0.0717)	(0.4197)	(0.0777)	(0.0733)	(0.0597)
Υ_{24}	1.7021	4.1609***	-1.0141	-0.3871	0.1098	2.6537***	0.0062	-0.5707	-0.5526	0.1827
	(1.3198)	(1.2744)	(0.8555)	(0.2960)	(0.5054)	(0.9307)	(0.2470)	(0.6930)	(0.6684)	(0.4549)
Υ_{34}	-0.1020	0.0874	0.1724	0.0030	-0.0088	0.5974	-0.0211	0.0274	0.0686	0.3246
	(0.4394)	(0.3267)	(0.2041)	(0.0401)	(0.1581)	(0.4466)	(0.0272)	(0.4235)	(0.4328)	(0.3540)
δ_1	1.7895***	1.8924***	1.7140***	1.8147***	1.6739***	2.0048***	1.6710***	1.6118***	1.6363***	1.7015***
	(0.1980)	(0.1923)	(0.0799)	(0.3030)	(0.1637)	(0.3666)	(0.0546)	(0.0541)	(0.0549)	(0.0559)
δ_2	1.0905***	1.2794***	0.8881***	0.7838***	0.7943***	0.8732***	1.9959***	0.8285***	0.7943***	0.6391***
	(0.1821)	(0.1956)	(0.0319)	(0.0550)	(0.0261)	(0.2136)	(0.0652)	(0.0278)	(0.0267)	(0.0210)
δ_3	0.5260***	0.3755***	0.2544***	0.1064***	0.2484***	0.5808***	0.2198***	0.5063***	0.5144***	0.4978***
	(0.0177)	(0.0126)	(0.0085)	(0.0032)	(0.0081)	(0.0195)	(0.0072)	(0.0170)	(0.0173)	(0.0164)
δ_4	0.0568***	0.05455***	0.0589***	0.1134***	0.0725***	0.0616***	0.3738***	0.0567***	0.0564***	0.0653***
	(0.0019)	(0.0018)	(0.0020)	(0.0034)	(0.0024)	(0.0021)	(0.0122)	(0.0019)	(0.0019)	(0.0021)
$\ln L_c(A,B)_{R2}$							-2050.356#	-1072.220#	-1064.704#	-1080.655#
$\ln L_c(A,B)_{R1}$	-1184.912	-1016.528#	-847.3352	-851.963#	-914.1897#	-1060.169#	-2050.340	-1072.030	-1064.282	-1080.368
$\ln L_c(A,B)_U$	-1182.996#	-1015.701	-839.2107#	-851.962	-913.6987	-1060.167	-2049.894	-1069.079	-1062.119	-1076.491

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

$\ln L_c(A,B)_{R2}$, $\ln L_c(A,B)_{R1}$, and $\ln L_c(A,B)_u$ are the concentrated log-likelihood estimates for the over-identified SVAR with 2 degree of freedoms, the over-identified SVAR with 1 degree of freedom, and the just-identified SVAR respectively. # is the parameterisation of Matrix A selected by using likelihood ratio test.

For the case of Hong Kong, we re-parameterise the first and second rows because the original parameterisation does not hold up.

Table 5. Parameter estimates of Matrix A that measures the return spillover between China and the indicated country in the GFC period

	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR
Υ_{12}	0.5069**	0.5998***	0.3986	0.0924	1.2267***	1.7051***	0.0874**	0.0493	0.0224	0.1439
	(0.2430)	(0.1401)	(0.2250)	(0.2825)	(0.3588)	(0.4047)	(0.0368)	(0.0753)	(0.0724)	(0.0769)
Υ_{13}							0.4585***	0.4048***	0.4783***	0.4372***
							(0.1665)	(0.1442)	(0.1458)	(0.1249)
Υ_{14}						-2.9524	1.0353***			4.9467**
						(1.6365)	(0.3438)			(2.0137)
Υ_{21}	-0.133470	-0.1394**	-0.0153	0.4365	-0.4929	-0.4270***				
	(0.1277)	(0.0693)	(0.0963)	(0.2472)	(0.2526)	(0.1519)				
Υ_{23}	-0.5142***	0.6695***	1.4958***	-3.6814***	1.2977***	0.4450***	-0.4956**	0.0306	-0.0294	0.040010
	(0.0918)	(0.0627)	(0.2213)	(1.0128)	(0.3469)	(0.0912)	(0.2053)	(0.0869)	(0.0918)	(0.0738)
Υ_{24}	-1.8811	0.6127	-0.0048	0.1110	-0.7395	2.6085***	0.8450**	4.1803***	3.3877**	3.6949***
	(1.3523)	(1.2157)	(1.0234)	(0.8775)	(1.6542)	(0.8221)	(0.4246)	(1.2498)	(1.4232)	(1.1788)
Υ_{34}	0.6040	-0.6685	0.1572	-0.0120	0.4549	0.0591	0.1448	0.3914	-0.4632	0.4625
	(0.7055)	(0.9557)	(0.2152)	(0.0360)	(0.3112)	(0.5951)	(0.0942)	(0.6593)	(0.7103)	(0.7257)
δ_1	2.1466***	2.2262***	2.1841***	2.0336***	2.3728***	2.6142***	2.2151***	2.2066***	2.2411***	2.1877***
	(0.0947)	(0.0815)	(0.0699)	(0.2680)	(0.2724)	(0.2747)	(0.0715)	(0.0716)	(0.0726)	(0.0703)
δ_2	1.5269***	1.4729***	1.3955***	1.8915***	1.9619***	1.5614***	2.7472***	1.3298***	1.4106***	1.2935***
	(0.1046)	(0.0734)	(0.0693)	(0.0714)	(0.3840)	(0.2394)	(0.0887)	(0.0431)	(0.0457)	(0.0416)
δ_3	0.8000***	1.1587***	0.2936***	0.0776***	0.3713***	1.1449***	0.6108***	0.7018***	0.7043***	0.7966***
	(0.0256)	(0.0369)	(0.0093)	(0.0023)	(0.0119)	(0.0370)	(0.0197)	(0.0228)	(0.0228)	(0.0256)
δ_4	0.05128***	0.0546***	0.0614***	0.0893***	0.0542***	0.0878***	0.2960***	0.0488***	0.0454***	0.0499***
	(0.0016)	(0.0017)	(0.0020)	(0.0026)	(0.0017)	(0.0028)	(0.0096)	(0.0016)	(0.0015)	(0.0016)
$\ln L_c(A,B)_{R2}$							-2779.149	-1608.948	-1616.598	-1698.785
$\ln L_c(A,B)_{R1}$	-1762.317#	-1983.110#	-1367.380#	-1219.862#	-1374.698#	-2036.253	-2774.768	-1605.043#	-1611.277#	-1650.590
$\ln L_c(A,B)_{U}$	-1762.269	-1982.158	-1366.476	-1219.225	-1373.459	-2034.331#	-2770.276#	-1604.058	-1611.268	-1689.592#

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

$\ln L_c(A,B)_{R2}$, $\ln L_c(A,B)_{R1}$, and $\ln L_c(A,B)_u$ are the concentrated log-likelihood estimates for the over-identified SVAR with 2 degree of freedoms, the over-identified SVAR with 1 degree of freedom, and the just-identified SVAR respectively. # is the parameterisation of Matrix A selected by using likelihood ratio test.

Table 6. Parameter estimates of Matrix A that measures the return spillover between China and the indicated country in the EDC period

	JPN	KOR	TWN	HKG	SGP	AUS	RUS	DEU	FRA	GBR
Υ_{12}	0.2136**	0.4669***	0.7082***	0.9831***	0.8887***	0.9639***	0.0319	0.0475	0.0340	-0.0059
	(0.0903)	(0.0899)	(0.1328)	(0.3158)	(0.1701)	(0.1694)	(0.0323)	(0.0427)	(0.0418)	(0.0578)
Υ_{13}								0.2199***	0.2263***	0.2604***
								(0.0670)	(0.0670)	(0.0915)
Υ_{14}	-0.5263**									
	(0.2640)									
Υ_{21}	-0.0370	-0.0834	-0.1986**	-0.4550	-0.1546**	-0.2362***				
	(0.0785)	(0.0569)	(0.0856)	(0.5132)	(0.0724)	(0.0842)				
Υ_{23}	-0.7278***	0.9263***	1.5637***	-0.6605	0.7730***	0.4494***	-0.0040	0.06222	0.0931	-0.1476***
	(0.0595)	(0.0646)	(0.1652)	(0.4229)	(0.0866)	(0.0521)	(0.0422)	(0.0537)	(0.0548)	(0.0547)
Υ_{24}	-0.1912	-0.2815	-0.2056	-0.9627**	-0.1606	-0.0861	0.5279**	0.2102	0.2861	0.1395
	(0.2394)	(0.1877)	(0.1989)	(0.4614)	(0.1642)	(0.1656)	(0.2066)	(0.2054)	(0.2075)	(0.1574)
Υ_{34}	0.0406	-0.0071	-0.0590	0.0227	-0.2602***	-0.3345**	0.2506	-0.2538	-0.2183	-0.2249**
	(0.1393)	(0.1079)	(0.0471)	(0.0278)	(0.0750)	(0.1336)	(0.1674)	(0.1306)	(0.1293)	(0.0993)
δ_1	1.1241***	1.0972***	1.1309***	1.0072***	1.1129***	1.1421***	1.1425***	1.1206***	1.1194***	1.1328***
	(0.0277)	(0.0280)	(0.0377)	(0.1024)	(0.0374)	(0.0466)	(0.0276)	(0.0271)	(0.0271)	(0.0277)
δ_2	1.0041***	0.8195***	0.8784***	1.2800***	0.7037***	0.7802***	1.2062***	0.8970***	0.9152***	0.6776***
	(0.0296)	(0.0290)	(0.0512)	(0.4471)	(0.0433)	(0.0550)	(0.0292)	(0.0217)	(0.0221)	(0.0166)
δ_3	0.5946***	0.4716***	0.2086***	0.1125***	0.3242***	0.6320***	0.9785***	0.5714***	0.5714***	0.4286***
	(0.0145)	(0.0115)	(0.0050)	(0.0025)	(0.0079)	(0.0155)	(0.0237)	(0.0138)	(0.0138)	(0.0105)
δ_4	0.1473***	0.1512***	0.1500***	0.1261***	0.1489***	0.1638***	0.2001***	0.1497***	0.1511***	0.1492***
	(0.0036)	(0.0037)	(0.0036)	(0.0028)	(0.0036)	(0.0040)	(0.0048)	(0.0036)	(0.0037)	(0.0036)
$\ln L_c(A,B)_{R2}$							-3728.377#	-2760.069	-2784.863	-2231.881
$\ln L_c(A,B)_{R1}$	-2818.824	-2413.639#	-1803.936#	-1341.952#	-1914.835#	-2574.965#	-3727.020	-2754.709#	-2779.195#	-2227.850#
$\ln L_c(A,B)_U$	-2816.844#	-2413.475	-1803.405	-1341.887	-1914.683	-2574.934	-3726.092	-2754.279	-2778.575	-2226.865

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

$\ln L_c(A,B)_{R2}$, $\ln L_c(A,B)_{R1}$, and $\ln L_c(A,B)_u$ are the concentrated log-likelihood estimates for the over-identified SVAR with 2 degree of freedoms, the over-identified SVAR with 1 degree of freedom, and the just-identified SVAR respectively. # is the parameterisation of Matrix A selected by using likelihood ratio test.

Table 7. Parameter estimates of Matrix $A^{-1}B$ that measures the volatility spillover from the indicated country to China's stock market

	Unique Shocks	ε_1	ε_2	ε_{fx}	ε_{id}		Unique Shocks	ε_1	ε_2	ε_{fx}	ε_{id}
JPN	Pre	1.5103***	0.8038	-0.1256	0.2459***	AUS	Pre	1.1875***	1.1338***	0.0255	0.2140***
		(0.2521)	(0.4593)	(0.0813)	(0.0818)			(0.2905)	(0.2986)	(0.0542)	(0.0779)
	GFC	2.0106***	0.7249**	-0.1953**	-0.0534		GFC	1.5127***	1.5406***	0.5027***	0.0783
		(0.1378)	(0.3264)	(0.0938)	(0.0416)			(0.2319)	(0.2174)	(0.0999)	(0.1012)
	EDC	1.1153***	0.2128***	-0.0917***	-0.0837**		EDC	0.9303***	0.6126***	0.2230***	-0.0304
		(0.0329)	(0.0894)	(0.0392)	(0.0394)			(0.0656)	(0.0890)	(0.0387)	(0.0230)
KOR	Pre	1.2909***	1.0787***	0.2254***	0.1942***	RUS	Pre	1.6710***	-0.0423	-0.0012	0.0000
		(0.1973)	(0.2250)	(0.0695)	(0.0662)			(0.0546)	(0.0772)	(0.0029)	(0.0020)
	GFC	2.0544***	0.8151***	0.4293***	0.0050		GFC	2.2151***	0.2402***	0.2536***	0.3462***
		(0.1024)	(0.1776)	(0.1005)	(0.0415)			(0.0715)	(0.1014)	(0.1020)	(0.1030)
	EDC	1.0561***	0.3683***	0.1963***	-0.0196		EDC	1.1425***	0.0385	-0.0001	0.0034
		(0.0374)	(0.0688)	(0.0388)	(0.0149)			(0.0276)	(0.0390)	(0.0013)	(0.0037)
TWN	Pre	1.6823***	-0.1437	-0.0461	0.3387***	DEU	Pre	1.6118***	0.0073	0.0001	-0.0003
		(0.0605)	(0.2482)	(0.0799)	(0.0807)			(0.0541)	(0.0764)	(0.0007)	(0.0030)
	GFC	2.1708***	0.5529	0.1740	0.0056		GFC	2.2066***	0.0656	0.2851	0.0178
		(0.1078)	(0.3107)	(0.1009)	(0.0263)			(0.0716)	(0.1001)	(0.1017)	(0.0206)
	EDC	0.9915***	0.5453***	0.2025***	-0.0277		EDC	1.1206***	0.0426	0.1274***	-0.0070
		(0.0578)	(0.0906)	(0.0384)	(0.0203)			(0.0271)	(0.0383)	(0.0384)	(0.0054)
HKG	Pre	1.7108***	-0.2623	-0.1484**	0.0142	FRA	Pre	1.6363***	0.0241	-0.0001	-0.0009
		(0.1202)	(0.7091)	(0.0737)	(0.0417)			(0.0549)	(0.0776)	(0.0012)	(0.0033)
	GFC	2.1190***	0.1821	-0.0275***	0.0013		GFC	2.2411***	0.0316	0.3364***	-0.0066
		(0.0181)	(0.1428)	(0.0011)	(0.1952)			(0.0726)	(0.1021)	(0.1033)	(0.0193)
	EDC	0.6959***	0.8695***	-0.0505	-0.0837***		EDC	1.1194***	0.0366	0.1314***	-0.0059
		-(0.2431)	-(0.1939)	-(0.0294)	-(0.0330)			(0.0271)	(0.0383)	(0.0384)	(0.0055)
SGP	Pre	1.6766***	0.0146	0.0014	0.0001	GBR	Pre	1.7015***	0.0314	-0.0024	0.0005
		(0.0552)	(0.8195)	(0.0769)	(0.0081)			(0.0559)	(0.0789)	(0.0061)	(0.0019)
	GFC	1.4787***	1.4998***	0.3683***	-0.0062		GFC	2.1877***	0.1861**	0.3529***	0.2836***
		(0.2894)	(0.2776)	(0.0964)	(0.0701)			(0.0703)	(0.0996)	(0.1004)	(0.1015)
	EDC	0.9784***	0.5498***	0.1958***	-0.0421**		EDC	1.1328***	-0.0040	0.1120***	-0.0089
		(0.0602)	(0.0935)	(0.0383)	(0.0213)			(0.0277)	(0.0391)	(0.0391)	(0.0051)

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

Table 8. Parameter estimates of Matrix $A^{-1}B$ that measures the volatility spillover from China to the indicated country's stock market

	Unique Shocks	ε_1	ε_2	ε_{fx}	ε_{id}		Unique Shocks	ε_1	ε_2	ε_{fx}	ε_{id}
JPN	Pre	-0.3197	0.9204***	-0.1439***	0.0465	AUS	Pre	-0.3729***	0.5172***	0.0116	0.0976***
		(0.2830)	(0.1019)	(0.0465)	(0.0468)			(0.1319)	(0.0946)	(0.0246)	(0.0303)
	GFC	-0.2683	1.4302***	-0.3853***	-0.1053		GFC	-0.6460***	0.9036***	0.2948***	0.1980***
		(0.2406)	(0.0631)	(0.0669)	(0.0671)			(0.1346)	(0.0950)	(0.0516)	(0.0528)
	EDC	-0.0412	0.9962***	-0.4294***	-0.029412		EDC	-0.2197***	0.6355***	0.2313***	-0.0316
		(0.0869)	(0.0245)	(0.0360)	(0.0375)			(0.0640)	(0.0259)	(0.0239)	(0.0235)
KOR	Pre	-0.4866***	0.8728***	0.1824***	0.1572***	RUS	Pre	0.0000	1.9959***	0.0543	0.0004
		(0.1566)	(0.0887)	(0.0454)	(0.0452)			(0.0000)	(0.0652)	(0.0923)	(0.0923)
	GFC	-0.2865**	1.3592***	0.7159***	0.0083		GFC	0.0000	2.7472***	-0.3027***	0.2289
		(0.1317)	(0.0497)	(0.0666)	(0.0692)			(0.0000)	(0.0887)	(0.1258)	(0.1264)
	EDC	-0.0881	0.7888***	0.4205***	-0.0419		EDC	0.0000	1.2062***	-0.0039	0.1054***
		(0.0578)	(0.0201)	(0.0293)	(0.0310)			(0.0000)	(0.0292)	(0.0413)	(0.0414)
TWN	Pre	0.1921	0.8717***	0.2795***	-0.0097	DEU	Pre	0.0000	0.8285***	0.0063	-0.0324
		(0.1352)	(0.0407)	(0.0432)	(0.0442)			(0.0000)	(0.0278)	(0.0393)	(0.0393)
	GFC	-0.0333	1.3870***	0.4365***	0.0141		GFC	0.0000	1.3298***	0.0215	0.2048***
		(0.2078)	(0.0444)	(0.0640)	(0.0654)			(0.0000)	(0.0432)	(0.0610)	(0.0614)
	EDC	-0.1969***	0.7701***	0.2860***	-0.0392		EDC	0.0000	0.8970***	0.0356	0.0291
		(0.0745)	(0.0257)	(0.0278)	(0.0279)			(0.0000)	(0.0217)	(0.0307)	(0.0307)
HKG	Pre	0.2928	0.7390***	-0.0254	-0.0415	FRA	Pre	0.0000	0.7943***	-0.0017	-0.0312
		(0.3057)	(0.1234)	(0.0293)	(0.0323)			(0.0000)	(0.0267)	(0.0377)	(0.0377)
	GFC	0.9251	1.9710***	-0.2978***	0.0144		GFC	0.0000	1.4106***	-0.0207	0.1546***
		(0.5464)	(0.2597)	(0.0906)	(0.0826)			(0.0000)	(0.0457)	(0.0647)	(0.0649)
	EDC	-0.3166	0.8844***	-0.0513**	-0.0852***		EDC	0.0000	0.9152***	0.05321	0.0402
		(0.2469)	(0.0899)	(0.0281)	(0.0289)			(0.0000)	(0.0221)	(0.0313)	(0.0314)
SGP	Pre	0.1501	0.7956***	0.0747**	0.0078	GBR	Pre	0.0000	0.6391***	-0.0482	0.0099
		(0.3906)	(0.0778)	(0.0374)	(0.0369)			(0.0000)	(0.0210)	(0.0297)	(0.0298)
	GFC	-0.7289***	1.2226***	0.3003***	-0.0050		GFC	0.0000	1.2935***	0.0319	0.1853***
		(0.2339)	(0.1404)	(0.0654)	(0.0572)			(0.0000)	(0.0416)	(0.0588)	(0.0591)
	EDC	0.1513***	0.6187***	0.2203***	0.0474**		EDC	0.0000	0.6776***	-0.0633***	0.025777
		(0.0624)	(0.0208)	(0.0226)	(0.0227)			(0.0000)	(0.0166)	(0.0235)	(0.0235)

**significance at the 5 percent level. ***significance at the 1 percent level. Standard errors in parentheses.

Table 9. Variance decomposition of China's stock market in the pre-crisis period

Effect from	Period	Sources of shocks				Effect from	Period	Sources of shocks			
		ε_1	ε_2	ε_{fx}	ε_{id}			ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	75.9497	21.5107	0.5256	2.0140	AUS	1	51.4267	46.8792	0.0237	1.6705
	2	74.8593	21.6493	1.2190	2.2723		2	51.0001	45.8641	0.0609	3.0749
	3	74.5418	21.6504	1.2181	2.5897		3	51.3072	45.5210	0.0695	3.1024
	10	71.5815	21.1204	3.0748	4.2232		10	50.4438	42.4594	1.8410	5.2558
	20	68.3369	20.6563	4.4426	6.5642		20	46.8075	41.3826	5.9916	5.8183
KOR	1	57.0981	39.8682	1.7410	1.2927	RUS	1	99.9359	0.0640	0.0000	0.0000
	2	56.6706	40.0426	1.7629	1.5239		2	99.5544	0.3482	0.0502	0.0472
	3	55.7906	39.3527	3.2303	1.6264		3	99.0094	0.6553	0.2565	0.0788
	10	52.5122	36.4312	6.5248	4.5318		10	93.4300	2.4106	3.0005	1.1589
	20	50.8008	35.5874	7.4677	6.1441		20	87.0509	4.7628	5.7260	2.4604
TWN	1	95.3666	0.6954	0.0715	3.8666	DEU	1	99.9980	0.0020	0.0000	0.0000
	2	94.6880	0.6901	0.2397	4.3821		2	96.4363	0.0104	2.1845	1.3687
	3	93.8618	0.9049	0.8495	4.3838		3	95.6689	0.7182	2.2070	1.4059
	10	87.0991	3.1701	2.1308	7.5999		10	90.5917	2.4795	4.2077	2.7212
	20	80.5413	6.0293	3.8471	9.5823		20	81.0338	4.8657	8.1411	5.9593
HKG	1	96.9832	2.2803	0.7298	0.0067	FRA	1	99.9784	0.0216	0.0000	0.0000
	2	96.4458	2.4643	0.7544	0.3355		2	96.2854	0.0208	2.8073	0.8864
	3	96.2996	2.5067	0.7820	0.4117		3	94.3489	1.9484	2.7585	0.9442
	10	90.4169	4.3873	3.8829	1.3129		10	89.4524	3.5648	4.5576	2.4252
	20	85.4555	5.4964	5.9985	3.0496		20	81.9710	4.9495	8.6066	4.4729
SGP	1	99.9923	0.0076	0.0001	0.0000	GBR	1	99.9658	0.0340	0.0002	0.0000
	2	98.3120	0.2452	1.3067	0.1361		2	99.4287	0.1499	0.3873	0.0342
	3	96.7609	1.6322	1.4429	0.1640		3	98.7810	0.4458	0.6291	0.1440
	10	92.8767	3.9841	1.9266	1.2126		10	94.7173	2.1442	1.6364	1.5021
	20	84.5638	6.5511	5.8111	3.0740		20	85.9769	2.9176	6.6791	4.4264

Table 10. Variance decomposition of China's stock market in the GFC period

Effect from	Period	Sources of shocks				Effect from	Period	Sources of shocks			
		ε_1	ε_2	ε_{fx}	ε_{id}			ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	87.7083	11.4023	0.8276	0.0618	AUS	1	46.5047	48.2351	5.1358	0.1245
	2	87.1023	11.3632	1.4647	0.0697		2	44.9773	48.8720	5.9655	0.1852
	3	86.4186	11.3703	2.0797	0.1314		3	44.8931	48.8253	6.0847	0.1969
	10	82.6011	12.7301	3.6468	1.0221		10	43.0869	46.7238	8.7467	1.4426
	20	78.0087	12.3579	5.7443	3.8892		20	42.6597	45.0735	9.9255	2.3413
KOR	1	83.2578	13.1061	3.6356	0.0005	RUS	1	95.3026	1.1206	1.2491	2.3277
	2	82.6797	13.4687	3.8467	0.0050		2	94.6824	1.3055	1.7008	2.3113
	3	82.4180	13.5901	3.9590	0.0329		3	91.7512	1.3565	2.1241	4.7683
	10	78.1094	13.8900	6.4941	1.5065		10	88.9991	2.9090	2.7909	5.3010
	20	75.3429	14.6120	7.7710	2.2742		20	85.1249	4.2089	4.8698	5.7963
TWN	1	93.3444	6.0552	0.5997	0.0006	DEU	1	98.2659	0.0869	1.6408	0.0064
	2	93.1930	6.2030	0.6021	0.0019		2	96.5188	0.5068	2.3143	0.6601
	3	92.9801	6.1973	0.7922	0.0304		3	95.8971	0.5127	2.5250	1.0653
	10	89.0738	8.9093	1.3079	0.7090		10	90.8339	4.0296	2.8118	2.3247
	20	84.5724	9.6937	3.1740	2.5600		20	84.9841	7.4085	4.5562	3.0512
HKG	1	99.2505	0.7328	0.0167	0.0000	FRA	1	97.7763	0.0195	2.2034	0.0008
	2	97.9840	1.1684	0.0165	0.8311		2	96.9066	0.0213	3.0637	0.0083
	3	97.0296	1.2337	0.8194	0.9173		3	96.6176	0.1803	3.0571	0.1450
	10	90.2132	3.4623	2.7057	3.6188		10	92.1959	2.5825	3.2878	1.9338
	20	81.9907	6.3439	5.6595	6.0059		20	86.4935	6.1941	4.2592	3.0531
SGP	1	47.8288	49.2030	2.9674	0.0008	GBR	1	95.2329	0.6889	2.4779	1.6003
	2	45.9412	47.7176	5.6564	0.6849		2	95.0278	0.6823	2.4660	1.8239
	3	45.3670	47.9171	5.5775	1.1384		3	93.8751	0.9060	2.9805	2.2384
	10	44.1263	45.6822	7.8381	2.3535		10	88.8756	3.7159	4.2849	3.1237
	20	43.5615	41.9939	10.6898	3.7548		20	84.5158	5.5369	5.9566	3.9906

Table 11. Variance decomposition of China's stock market in the EDC period

Effect from	Period	Sources of shocks				Effect from	Period	Sources of shocks			
		ε_1	ε_2	ε_{fx}	ε_{id}			ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	95.3466	3.4706	0.6447	0.5381	AUS	1	67.0170	29.0610	3.8504	0.0716
	2	94.7306	3.9518	0.7605	0.5571		2	66.3692	29.6143	3.9365	0.0800
	3	94.6000	3.9140	0.7853	0.7006		3	65.9088	29.2814	4.3550	0.4549
	10	91.3051	4.5495	2.7976	1.3478		10	64.0232	28.8327	5.5360	1.6082
	20	87.9429	6.2010	3.3668	2.4894		20	61.4820	28.7377	7.2361	2.5442
KOR	1	86.4686	10.5139	2.9878	0.0297	RUS	1	99.8857	0.1135	0.0000	0.0009
	2	86.1979	10.7797	2.9745	0.0479		2	99.6600	0.1455	0.1586	0.0359
	3	85.6727	10.7381	3.2722	0.3170		3	98.8934	0.2588	0.6105	0.2373
	10	83.1420	12.8084	3.4390	0.6105		10	95.0445	1.2970	2.8663	0.7922
	20	78.9618	13.4906	5.8529	1.6947		20	89.7028	1.9837	6.6427	1.6707
TWN	1	74.3460	22.4931	3.1027	0.0582	DEU	1	98.5803	0.1424	1.2735	0.0038
	2	74.2627	22.5461	3.1331	0.0582		2	98.1168	0.5028	1.3741	0.0063
	3	73.8950	22.3667	3.3637	0.3747		3	97.0600	0.6800	1.6289	0.6310
	10	71.6820	23.1982	4.4313	0.6884		10	95.2885	1.9318	2.0091	0.7705
	20	70.6563	22.7054	4.7362	1.9021		20	90.8266	2.5095	4.6566	2.0073
HKG	1	38.7496	60.4859	0.2038	0.5608	FRA	1	98.5338	0.1052	1.3583	0.0027
	2	38.9008	60.3063	0.2020	0.5909		2	97.9534	0.5727	1.4583	0.0156
	3	38.8893	59.9209	0.4741	0.7158		3	96.9291	0.6450	1.6752	0.7507
	10	38.4312	58.4781	1.9358	1.1550		10	95.0106	1.9957	2.0669	0.9268
	20	36.7301	56.2301	3.6277	3.4122		20	90.4492	2.9339	4.6242	1.9927
SGP	1	73.6571	23.2568	2.9500	0.1362	GBR	1	99.0248	0.0012	0.9679	0.0061
	2	73.3538	23.4619	3.0191	0.1652		2	97.8472	0.7685	1.2036	0.1807
	3	72.6518	23.1071	3.5025	0.7385		3	96.2745	1.5314	1.5370	0.6571
	10	71.5709	23.2992	4.1260	1.0039		10	93.0510	3.3764	2.6398	0.9328
	20	68.7648	23.1914	5.6165	2.4273		20	89.7455	4.1572	3.7574	2.3399

Table 12. Variance decomposition of the indicated country's stock market in the pre-crisis period

Effect on	Period	Sources of shocks ε_1	ε_2	ε_{fx}	ε_{id}	Effect on	Period	Sources of shocks ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	10.5141	87.1341	2.1292	0.2227	AUS	1	33.4012	64.2760	0.0325	2.2904
	2	10.8581	86.3321	2.1092	0.7006		2	31.2880	65.1421	0.6272	2.9426
	3	11.2656	85.3253	2.1383	1.2709		3	30.3105	63.4646	3.2654	2.9595
	10	11.6266	79.6392	3.9516	4.7826		10	28.9131	60.5506	5.5261	5.0101
	20	11.1058	75.7380	7.9166	5.2396		20	27.6089	56.8589	8.5309	7.0014
KOR	1	22.4134	72.1003	3.1485	2.3379	RUS	1	0.0000	99.9262	0.0738	0.0000
	2	23.1159	71.3556	3.2164	2.3121		2	0.2924	99.5098	0.1833	0.0145
	3	23.4452	70.8906	3.3677	2.2965		3	0.4697	97.8688	1.4495	0.2121
	10	24.5059	67.0124	3.7094	4.7724		10	4.2084	89.9325	2.3473	3.5118
	20	23.5476	63.3525	7.7446	5.3553		20	5.5639	85.8864	4.7601	3.7897
TWN	1	4.2168	86.8434	8.9291	0.0108	DEU	1	0.0000	99.8420	0.0058	0.1523
	2	4.4976	85.5768	9.8249	0.1007		2	0.0553	98.1520	0.6662	1.1265
	3	4.4866	85.2365	9.9251	0.3518		3	0.0867	96.9157	1.0812	1.9164
	10	6.0993	78.3536	11.1907	4.3564		10	1.7451	92.8437	2.2715	3.1397
	20	8.3508	73.0212	12.4590	6.1691		20	3.6624	84.7328	6.3431	5.2618
HKG	1	13.5153	86.1119	0.1017	0.2711	FRA	1	0.0000	99.8457	0.0005	0.1539
	2	15.5608	83.2054	0.1330	1.1009		2	0.0027	99.2082	0.3767	0.4124
	3	15.7964	82.5173	0.1784	1.5080		3	0.0035	99.2032	0.3772	0.4160
	10	21.4007	74.7566	1.6393	2.2035		10	2.9882	92.8359	0.9202	3.2557
	20	20.9292	72.2668	3.1437	3.6602		20	4.5320	84.6293	4.6963	6.1424
SGP	1	3.4091	95.7382	0.8435	0.0092	GBR	1	0.0000	99.4106	0.5656	0.0238
	2	5.1068	93.0195	1.5318	0.3419		2	0.1502	98.9043	0.7382	0.2073
	3	5.1475	91.3408	3.1703	0.3414		3	0.1692	98.1875	1.4298	0.2135
	10	7.6284	84.4607	5.2147	2.6961		10	2.8156	94.0351	2.2449	0.9044
	20	9.6169	79.6527	7.7292	3.0013		20	5.2445	86.4559	4.6926	3.6070

Table 13. Variance decomposition of the indicated country's stock market in the GFC period

		Sources of shocks						Sources of shocks			
Effect on	Period	ε_1	ε_2	ε_{fx}	ε_{id}	Effect on	Period	ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	3.1627	89.8307	6.5199	0.4867	AUS	1	30.6865	60.0389	6.3926	2.8821
	2	3.0420	89.7341	6.6941	0.5298		2	29.1947	61.1687	6.1064	3.5302
	3	3.1247	89.5298	6.7795	0.5660		3	29.3007	60.4236	6.1701	4.1057
	10	5.2222	84.2244	7.5874	2.9660		10	28.6930	58.2461	8.4542	4.6067
	20	8.0369	77.8651	9.0743	5.0237		20	28.4221	54.6943	10.8992	5.9844
KOR	1	3.3609	75.6510	20.9852	0.0028	RUS	1	0.0000	98.1274	1.1913	0.6813
	2	3.6428	74.8482	20.9923	0.5168		2	0.0062	88.9699	9.4528	1.5712
	3	4.2172	73.9923	20.8092	0.9813		3	0.0204	88.2373	9.9919	1.7504
	10	4.7606	65.6350	28.0750	1.5294		10	1.3701	82.3316	9.3250	6.9734
	20	7.3705	56.6648	32.1643	3.8004		20	8.1293	71.3652	13.5144	6.9911
TWN	1	0.0523	90.9322	9.0062	0.0093	DEU	1	0.0000	97.6593	0.0255	2.3153
	2	0.1014	90.6421	9.0319	0.2247		2	0.0085	97.4856	0.3476	2.1583
	3	0.1671	89.4786	8.7697	1.5846		3	0.4460	96.6137	0.7549	2.1854
	10	0.5363	86.0154	10.4246	3.0237		10	0.8517	90.5355	2.2122	6.4006
	20	3.2543	78.6575	12.4277	5.6605		20	4.0995	85.1971	3.3743	7.3291
HKG	1	17.7191	80.4400	1.8366	0.0043	FRA	1	0.0000	98.7921	0.0213	1.1865
	2	18.2591	79.7137	1.8192	0.2080		2	0.0438	98.5663	0.0828	1.3071
	3	18.5526	78.7234	2.0320	0.6921		3	0.1921	98.4188	0.0827	1.3064
	10	18.4538	74.9543	3.6297	2.9622		10	1.2959	90.6434	2.5603	5.5004
	20	17.2887	71.0860	6.8437	4.7816		20	7.5886	80.5266	3.1466	8.7382
SGP	1	25.1039	70.6349	4.2600	0.0012	GBR	1	0.0000	97.9309	0.0595	2.0097
	2	24.8238	70.4098	4.5132	0.2532		2	0.2000	97.0695	0.6960	2.0345
	3	24.8120	69.4262	4.6047	1.1570		3	0.2719	96.1463	0.7456	2.8362
	10	25.8368	63.6247	6.5799	3.9586		10	0.7923	94.0296	1.2917	3.8864
	20	24.4966	59.0592	10.2451	6.1991		20	6.8388	83.9194	1.4941	7.7477

Table 14. Variance decomposition of the indicated country's stock market in the EDC period

Effect on	Period	Sources of shocks ε_1	ε_2	ε_{fx}	ε_{id}	Effect on	Period	Sources of shocks ε_1	ε_2	ε_{fx}	ε_{id}
JPN	1	0.1440	84.1514	15.6312	0.0734	AUS	1	9.5271	79.7146	10.5618	0.1965
	2	0.1392	82.4217	17.3673	0.0718		2	9.3879	79.2943	10.6964	0.6214
	3	0.1452	82.2258	17.4533	0.1757		3	9.3900	79.2918	10.6961	0.6221
	10	0.8361	79.2436	18.6221	1.2982		10	10.1061	76.8324	10.9763	2.0853
	20	1.4755	76.6933	19.4117	2.4196		20	12.4354	72.0171	12.7771	2.7704
KOR	1	0.9602	76.9541	21.8682	0.2175	RUS	1	0.0000	99.2409	0.0010	0.7581
	2	1.0165	77.1601	21.5908	0.2326		2	1.9824	96.3749	0.9062	0.7366
	3	1.2635	76.5022	21.8995	0.3347		3	2.0046	95.9666	1.3004	0.7284
	10	2.1405	74.6967	21.6140	1.5487		10	1.9926	91.6954	4.7056	1.6063
	20	3.0436	71.2705	22.8433	2.8426		20	2.9781	87.3604	7.0950	2.5665
TWN	1	5.4223	82.9244	11.4386	0.2147	DEU	1	0.0000	99.7384	0.1567	0.1050
	2	5.6509	82.6743	11.4598	0.2150		2	0.4928	98.1116	1.2793	0.1162
	3	5.7024	82.6297	11.4242	0.2437		3	0.5602	97.9487	1.3044	0.1867
	10	6.3248	81.3440	11.5759	0.7553		10	1.1220	94.7572	2.5679	1.5529
	20	6.9356	78.4822	12.6561	1.9261		20	1.9261	92.3195	2.8589	2.8954
HKG	1	11.2364	87.6556	0.2953	0.8126	FRA	1	0.0000	99.4722	0.3362	0.1915
	2	10.9939	87.8821	0.2882	0.8358		2	0.4893	97.0085	2.2505	0.2517
	3	11.0759	87.5810	0.4990	0.8441		3	0.5294	96.8138	2.2562	0.4006
	10	11.1174	86.0398	1.5139	1.3289		10	1.6752	92.9747	3.6845	1.6657
	20	11.3279	82.4483	3.5906	2.6332		20	2.7680	90.4742	4.0257	2.7321
SGP	1	5.0150	83.8573	10.6367	0.4910	GBR	1	0.0000	98.9941	0.8626	0.1433
	2	4.9754	83.4543	11.0216	0.5488		2	2.1400	96.5935	0.8977	0.3688
	3	5.0103	83.1396	10.9842	0.8659		3	2.1385	96.5622	0.9252	0.3741
	10	5.7826	79.5481	13.2615	1.4078		10	2.2285	93.9023	1.9881	1.8810
	20	7.3223	76.5228	14.2705	1.8844		20	4.4690	90.0438	2.7486	2.7385