Stock-Price Volatilities and Macroeconomic Variables:
A Comparative Analysis of Japan, China and the United States

Yan ZHANG
Meiji Gakuin University, Japan
E-mail: ellie@k.meijigakuin.ac.jp

Abstract

In this paper, while focusing on the impact that the global financial crisis had on the stock markets of China, Japan, and the United States, the stock-price volatilities and linkage between these three countries are analyzed. In addition, the relationships between macroeconomic variables (real-economy variables and monetary-policy variables) and stock price volatility in each country are investigated.

The estimation results of the EGARCH model revealed that although China's stock price volatility was far greater than those of Japanese and US stock prices, China was less affected by the global financial crisis in 2007 than Japan and the United States. For China, stock price volatility was greater in the early 1990s, shortly after the stock market had been established, than in 2007 when the global financial crisis occurred. Furthermore, it has been revealed that the linkage of Chinese, Japanese, and US stock prices has increased since the global financial crisis. Moreover, Granger causality testing revealed China's real-economy variables and monetary-policy variables do not affect China's stock price volatility.

JEL Classification: C1, E5, F3, F5, F6, G1, O1, O5
Keywords: Stock-Price Volatility, Macroeconomic Variable, Linkage of Stock Prices, Global Financial Crisis, Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) Model

Ⅰ Introduction

Currently, the United States, China, and Japan are the top three countries in the world with respect to size of GDP, and they play important roles in the global economy. Moreover, the total market capitalization of the world's stock markets, as of the end of 2014, was approximately 23.5 trillion US dollars[1]. Of this, the United States accounted for 19.3 trillion dollars, Japan for 2.9 trillion dollars, and China for 1.3 trillion dollars, which as percentages of the global total were 51.5%, 7.7%, and 3.5%, respectively, and as percentages of their GDP, were 110.9%, 63.0%, and 12.4%, respectively[2]. Moreover, through globalization and the sharing of information in real time that has progressed in recent years, linkage within the global economy is increasing. The 2007 global financial crisis that originated in the United States affected the economies of China, Japan, and the United States in various ways. In the future, in conjunction with the further economic development of, and increased economic exchanges between China, Japan, and the United States, linkage between stock prices is expected to increase significantly. Considering the relationships between stock prices in these three countries is absolutely essential to predict the future development of their economies, and is important to ascertain the state of affairs in the global economy.

The stock markets of Japan and the United States have long histories and are mature, advanced markets. The level of efficiency and openness in both markets is high, domestic and overseas investors are free to invest in them, and they are fully accomplishing their economic function of being avenues for companies to raise funds. In contrast, even though China's stock market only began in earnest from 1990, it has grown quickly in conjunction with the rapid growth of the Chinese economy. Currently, they are attracting a lot of attention as stock markets of a developing nation, and they continue to have a significantly greater presence in the global marketplace. In February 2007, the market capitalization of Shanghai stock market was no more than approximately one quarter of that of Tokyo's, but stock prices in the United States and Japan suffered major declines, following a crash in the Shanghai stock market[3]. This was the first global decline in stock prices originating from China. In addition, together with the gains in the prices of Chinese stocks, the presence of Chinese companies listed on stock exchanges around the world has rapidly grown. While China's stock markets are continuing to grow, compared to Japan and the United States, they tend to experience major fluctuations in the value of

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[1] Refer to the World Federation of Exchanges for market capitalization.

[2] Refer to the IMF database for GDP.

[3] On 27 February 2007, the Shanghai Stock Exchange Composite Index (SSE Composite Index) fell 268 points (8.8%) on the previous day, the biggest decline in its history.

their stocks and repeatedly switch between sudden gains and slumps.

There has been much previous research on the linkage of stock prices.[4] For instance, Chan, Gup, and Pan (1997) examined the integration of international stock markets by studying eighteen nations, including Australia, the US, Japan, the UK, and Pakistan covering a 32-year period from January 1961 to December 1992. Ahlgren and Antell (2002) examined the evidence for cointegration among the stock prices of Finland, France, Germany, Sweden, the UK, and the US between January 1980 and February 1997. The study found that one cointegrating vector in monthly data and none in quarterly data. Forbes and Rigobon (2002) showed that there was no contagion during the 1997 Asian crisis, the 1994 Mexican devaluation, and the 1987 US market crash, but there was a high level of interdependence among East Asia, Latin America, and the Organization for Economic Co-operation and Development (OECD) in all periods. Fraser and Oyefeso (2005) examined long-run convergence between the US, the UK, and seven European stock markets. Boschi (2005) analyzed the effect of the financial contagion of the Argentine crisis by estimating VAR models and instantaneous correlation coefficients corrected for heteroscedasticity for Brazil, Mexico, Russia, Turkey, Uruguay, and Venezuela. No evidence of contagion was found. In addition, to examine the linkage of stock prices, Wang, Yang, and Bessler (2003) analyzed the African countries and the US; Eun and Shin (1989) analyzed nine countries, including Australia, Canada, France, Japan, the UK, and the US; Hamori and Imamura (2000) analyzed the G7; Tsutsui and Hirayama (2004a) analyzed Japan, the UK, and the US; and Tsutsui and Hirayama (2004b) (2005) analyzed Japan, the UK, Germany, and the US.[5]

In addition, recent research on the linkage of stock prices in Asian markets is as follows. Yang, Kolari and Min (2003) examined long-run relationships and short-run dynamic causal linkage among stock markets in the US, Japan and ten Asian emerging stock markets, paying particular attention to the 1997-1998 Asian financial crisis. An important implication of the analysis is that the degree of integration among countries tends to change over time, especially around periods marked by financial crises. To examine the linkage of stock prices, Chan, Gup and Pan (1992) analyzed Asian countries for 1983-87; Corhay, Rad and Urbain (1995) analyzed the Asia-Pacific region, including Japan, for 1972-1992; and Hung and Cheung (1995) analyzed the Asian stock markets, excluding Japan and the US, for 1981-1991. Ghosh, Saidi and Johnson (1999) analyzed the Asian

[4] Refer to Zhang (2011) (2012).

[5] Tsutsui and Hirayama (2005) discussed three possible causes of international stock price linkage: 1) global common shocks, 2) portfolio adjustments by institutional investors, and 3) the importance of news on stock price crashes.

stock markets, including Japan and the US from March 1997 to December 1997; and Chen, Huang and Lin (2007) analyzed the US and the main Asian countries. The above analyses found no linkage of stock prices among Asian stock markets, or there was some linkage of stock prices among some markets. Zhang (2011) (2012) used vector autoregressive (VAR) techniques, i.e. the cointegration tests, the impulse response, and the forecast error variance decomposition, to analyze the linkage of stock prices in Asian markets, and the influence of both the Asian financial crisis and the global financial crisis on the Asian stock markets. The analysis demonstrated that the effects of the Japanese stock market and the Singapore stock market on the Asian markets are great, but the Chinese mainland market is little affected by other markets. It has been revealed that the interdependence in stock prices among the Asian markets has increased since the global financial crisis.

Moreover, prior research on the linkage of stock prices that focused on the stock markets in China, Japan, and the United States can be summarised as follows. Asako, Zhang and Liu (2014) newly advocated a non-linear-type co-integration analysis that allowed the creation, expansion, and collapse of a stock price bubble, and then actually verified it. Consequently, for example, a co-integration relationship between stock prices in Japan and the United States is fairly robustly rejected by the usual co-integration analysis. In this sense, the conclusion obtained here is that there is no co-movement. In contrast, when non-linearity is allowed, it was verified that long-term co-movement cannot be rejected. Nishimura, Tsutsui and Hirayama (2011) used high-frequency data from 15 July 2008 to 28 November 2008, and analyzed daily volatility in the stock markets of China (Chinese mainland and Hong Kong), Japan, and the United States. While after the outbreak of the global financial crisis, daily volatility rapidly increased in all markets, its impact was limited in China's stock markets, and its market risk was lower than that in stock markets in Japan and the United States. Furthermore, it was verified that following the collapse of Lehman Brothers, investors' long-term memories of daily volatility strengthened, and the impact that shocks in the form of a crash in stock prices have on volatility has weakened.

The main contribution of this paper is as follows. I not only analyze the stock-price volatilities and linkage between China, Japan, and the United States, while focusing on the impact that the global financial crisis had on their stock markets, but also investigate the relationships between macroeconomic variables (real-economy variables and monetary-policy variables) and stock price volatility in each country. Specifically, I use the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model to calculate stock price volatility in China, Japan, and the United States, and estimate the covariance between the stock markets. In addition, in order to consider the influences of the global financial crisis, I analyze the relationships between stock prices, while comparing them over different periods. Furthermore, I consider the effects of real-economy variables and monetary-policy variables on changes to stock price volatility in each country.

The composition of this paper is as follows. First, the EGARCH model used for the analysis is explained. Second, the stock-price volatilities and the linkage of China, Japan, and the United States are estimated. For this, first, the daily stock price indices used for the data are explained, and time series trends are observed. Next, to analyze the linkage of stock prices in China, Japan, and the United States, the EGARCH model is used to estimate stock price volatility, and the fundamental statistics are investigated. Furthermore, the effects of real-economy variables and monetary-policy variables on changes to stock price volatility in each country are considered. To do this, first, the data used is explained and then unit root tests are carried out to verify the stationarity of the data. Subsequently, Granger causality tests are conducted. Finally, the implications are derived based on the results of the empirical analyses.

Ⅱ Methodology

Stock price volatility is ascertained from the variance and the standard deviation of the rate of change of stock prices. Therefore, it is necessary to estimate it from stock price data. The prevailing concept of quantitative financial analysis is that volatility changes stochastically each day, and attention has been focused on models that analyze changes in volatility and that explicitly formulize this sort of volatility. Within the models, the EGARCH model is said to be the most suitable in analyzing changes in volatility.[6] The reasons for this are as follows.

Engle (1982) proposed the autoregressive conditional heteroskedasticity (ARCH) model, which was used to analyze inflation. However, it was subsequently used for financial time series analyses that showed conditional heteroskedasticity. Furthermore, the generalized ARCH (GARCH) model, which generalized the ARCH model, was proposed by Bollerslev (1986). As estimates can be easily made with the GARCH model using the maximum likelihood method, it is frequently used for analyzing asset prices.

However, the ARCH model and the GARCH model have major flaws as they express changes in stock price volatility. In stock markets, there is a tendency that stock price

[6] Refer to Wang (2010).

volatility increases less on the day after the day stock prices increase than the day after the day stock prices decline. However, the residual is squared in the ARCH model and the GARCH model, therefore, they cannot ascertain the asymmetry of this kind of change in volatility. The exponential GARCH (EGARCH) model proposed by Nelson (1991) is the model that takes into account this sort of phenomenon. Moreover, in the ARCH model and the GARCH model, it is possible that the volatility value will end up being negative even when only one parameter is negative. In the EGARCH model, volatility is not assumed to be a dependent variable; its logarithm value is assumed to be a dependent variable. Through this, it is possible to remove the non-negative constraint of the parameters. Therefore, in this paper, the EGARCH model is used to analyze stock price volatility in China, Japan, and the United States.

The EGARCH (*p*,*q*) model is expressed by equation (1) shown below.

$$\log \sigma_t^2 = w + \sum_{i=1}^{p} (\alpha_i |\varepsilon_{t-i}| + \gamma_i \varepsilon_{t-i}) + \sum_{j=1}^{q} \beta_j \log \sigma_{t-j}^2 \qquad (1)$$

Here, ε_t is the standardized shock. The left side of equation (1) is the logarithm of the conditional variance, so the non-negativity of the conditional variance is guaranteed. α and γ are the coefficients of the ARCH terms. The asymmetry of a positive and a negative shock (the existence of the leverage effect) can be tested through hypothesis $\gamma_i < 0$. If $\gamma_i \neq 0$, this effect is asymmetrical. The persistence of the volatility (shock relative to the conditional variance) is represented by the coefficient β of the GARCH term.

As a special case, the EGARCH (1,1) model is represented by equation (2) below.

$$\log \sigma_t^2 = w + \alpha_1 |\varepsilon_{t-1}| + \gamma_1 \varepsilon_{t-1} + \beta_1 \log \sigma_{t-1}^2 \qquad (2)$$

In the case of a positive shock, or, in other words, when $\varepsilon_{t-1} > 0$, equation (2) becomes equation (3).

$$\log \sigma_t^2 = w + (\alpha_1 + \gamma_1) |\varepsilon_{t-1}| + \beta_1 \log \sigma_{t-1}^2 \qquad (3)$$

Conversely, in the case of a negative shock, or, in other words, when $\varepsilon_{t-1} < 0$, equation (2) becomes equation (4).

$$\log \sigma_t^2 = w + (\alpha_1 - \gamma_1)|\varepsilon_{t-1}| + \beta_1 \log \sigma_{t-1}^2 \qquad (4)$$

If $\gamma_i < 0$, volatility reacts to a negative shock to a greater extent.

Ⅲ Stock-price Volatility and Linkage

3.1 *Data*

The data consist of day-end stock market index observations.[7] This paper uses the Shanghai stock exchange composite index (Chinese mainland), the Nikkei 225 Index (Japan), and the S&P 500 Composite Stock Price Index (US). The indices are taken from the Yahoo Finance database and are corrected in logs. The sample period is from 1 January 1991 to 31 December 2014. The number of observations is 6262. If a value is missing, data of the previous day are used. To examine the influence of the global financial crisis, two periods are analyzed: before the global financial crisis, the period from 1 January 1991 to 14 August 2007;[8] and after the global financial crisis, the period from 15 August 2007 to 31 December 2014.

3.2 *Time Series Transition of Stock Prices*

First, the movement of stock prices in each market is analyzed. Figure 1 shows a time series transition of stock prices in each market.

[7] The data are from Mondays to Fridays.

[8] BNP Paribas, a bank major company in France, froze the subsidiary fund due to the US subprime loan problem on 15 August 2007, so the subprime loan problem came up.

Figure 1. Stock Prices of Each Market (level, in log)

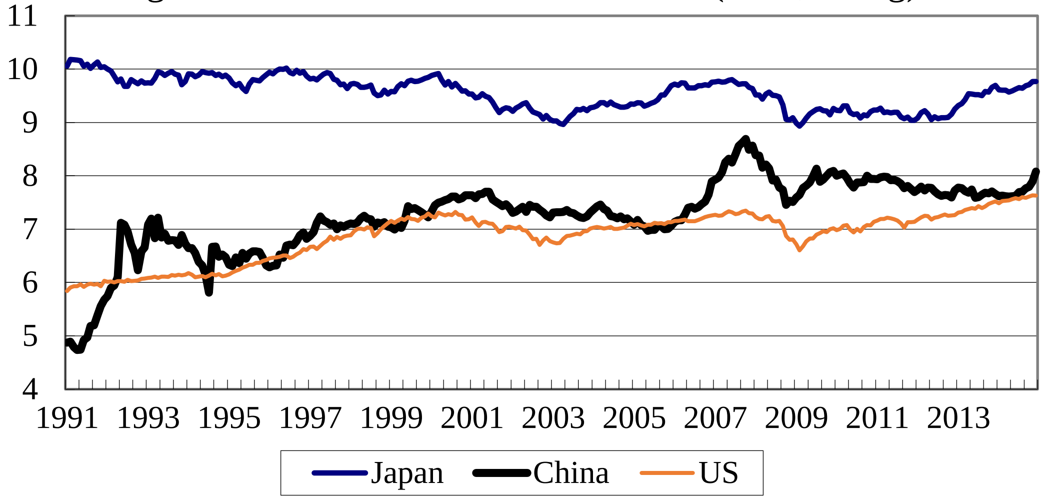
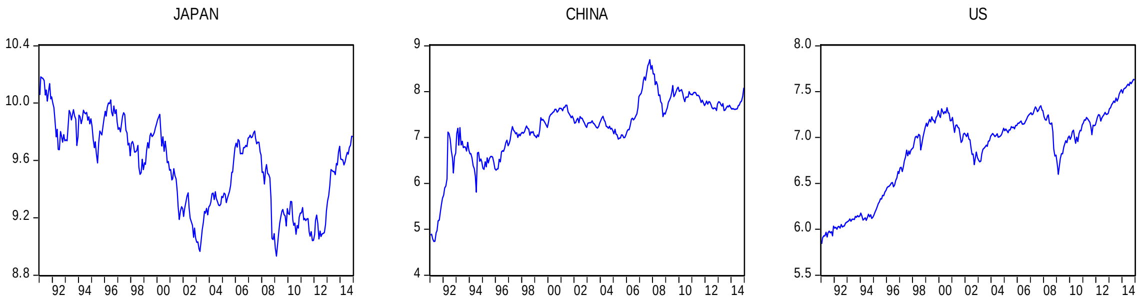


Figure 1 shows that, in general, Japanese stock prices have fallen slowly, US stock prices have risen steadily in the long run, and Chinese stock prices have risen most rapidly of all. In addition, stock prices in all markets fell sharply from about October 2007 to February 2009.

Next, Figure 2 shows the concrete transition of stock prices in each market.

Figure 2. Transition of Stock Prices (level, in log)



In Japan, after repeated falls and rises in the 1990s, stock prices fell away after March 2000 and reached their lowest value in April 2003. Thereafter, they rose gradually. Following the lost ten years, the recovery of the economy and the increase in the number of stock market participants, including foreign investors, had led to a rise in stock prices until the global financial crisis happened in 2007. Stock prices in Japan plummeted after the 2007 sub-prime mortgage crisis, and now have recovered.

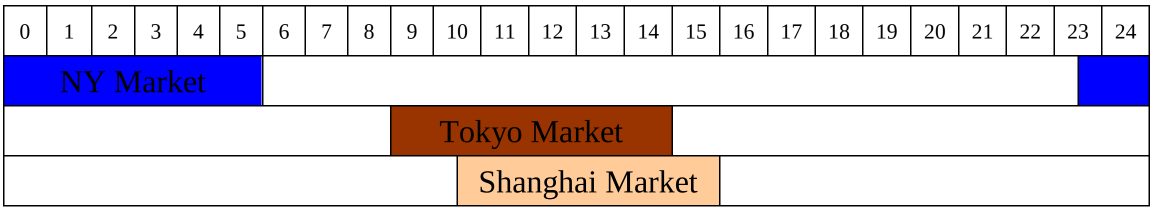
Although stock prices in the Chinese mainland experienced a fall on several occasions after May 1992, in general, they have kept rising, reaching an all-time historic high in

October 2007. The rise in stock prices in the Chinese mainland from May 2005 to October 2007 is thought to be a result of excess liquidity arising from expectations of a Yuan appreciation, the increase in the foreign reserves, a series of security reforms, the reinforcement of the real estate speculation regulations, and the new listing of the large-scale enterprises. However, stock prices in China fell under the influence of the global financial crisis after October 2007, and have experienced rises and falls.

US stock prices rose in the 1990s because of the economic expansion and the information technology revolution, but after reaching a peak in August 2000, they fell sharply until September 2002. The fall after August 2000 is regarded as a result of the bursting of the information technology bubble. Afterwards, the economy recovered, and stock prices soared in 2007, but fell sharply due to occurrence of a subprime loan problem. Recently, because of the effects of the recovery for domestic economy and quantitative easing, stock prices have risen again.

Furthermore, I consider the trading time of each market. Figure 3 shows the stock trading opening and closing times in Japan standard time.

Figure 3. Stock Trading Opening and Closing Times (Japan Standard Time)



The Tokyo market in Japan opens at 9 a.m., and the Shanghai market in China opens at 10:30 a.m.[9] In addition, the Tokyo market closes at 3 p.m., and the Shanghai market closes at 4 p.m. The New York market in the United States opens at 11:30 p.m., and closes at 6 a.m. the following morning[10]. The Tokyo market starts trading three hours after the New York market closes, and there is therefore a strong possibility that the New York closing price is reflected in the next day's Tokyo market closing price and Shanghai market closing price.

3.3 *Estimation*

3.3.1 Estimation Model

[9] The time difference between China and Japan is 1 hour.

[10] The time difference between the eastern US and Japan is 14 hours, and it is one hour less when Daylight Saving Time is in force.

In order to actually obtain stock price volatility, the AR(k)-EGARCH(p,q) model is estimated.[11] The AR (k) model is represented by equation (5), and the EGARCH (p,q) model is represented by equation (6).

$$Y_t = \theta_0 + \sum_{i=1}^{k} \theta_i Y_{t-i} + u_t \qquad u_t | I_{t-1} \sim N(0, \sigma_t^2) \tag{5}$$

$$\log \sigma_t^2 = c + \sum_{i=1}^{p} (\alpha_i |\varepsilon_{t-i}| + \gamma_i \varepsilon_{t-i}) + \sum_{j=1}^{q} \beta_j \log \sigma_{t-j}^2 \tag{6}$$

Equation (5) is a mean equation that expresses the AR(k) model. Here, θ_0 is the constant, k is the length of the lag, u_t is the error term, and I_{t-1} represents the information that can be used for the period (t-1). Equation (6) is a variance equation that expresses the EGARCH(p,q) model. Here, p is the number of ARCH terms, and q is the number of GARCH terms. Moreover, c is the constant, ε_t is in accordance with the normal distribution of mean 0 and variance 1. ε_t and σ_t are statistically independent, and $\varepsilon_t = u_t / \sigma_t$.

3.3.2 Estimation Results

The EGARCH model analyzes the changes in stock price volatility. Therefore, the stock-price earnings ratio is obtained as the rate of increase of the stock price index. For the estimates from AR(k)-EGARCH(p,q), it is necessary to determine the orders k*, p*, and q*. The method of applying the orders is shown as follows. First, the estimates in the AR(k) model are carried out, and the order k* is selected in order to minimize the Schwarz Criterion (SC). Next, in the AR(k*)-EGARCH(p,q) model, the optimal lag orders of p* and q* are selected in order to minimize the SC. In addition, the null hypothesis that there is no serial correlation in the residuals is tested.

The estimation results of the AR-EGARCH model for China, Japan, and the United States are shown in Table 1.[12] For China, the AR(3)-EGARCH(1,3) model, for Japan, the AR(1)-EGARCH(2,2) model, and for the United States, the AR(1)-EGARCH(3,3) model are selected, respectively. In addition, from the results of the LM tests, the p values of China, Japan, and the United States are obtained as 0.2287, 0.6669, and 0.7348, respectively. The null hypothesis, which indicates that there is no serial correlation,

[11] It indicates the autoregressive-exponential generalized autoregressive conditional heteroskedasticity (AR-EGARCH) model.

[12] The maximum lag is set equal to 3.

cannot be rejected. In other words, there is no serial correlation for the error terms of China, Japan, and the United States.

Table 1. Estimation Results of EGARCH Models

	China	Japan	US
Model	AR (3)-EGARCH (1,3)	AR (1)-EGARCH (2,2)	AR (1)-EGARCH (3,3)
Mean Equation			
$\theta 0$	0.0477 (0.0000)	0.0048 (0.7484)	0.0291 (0.0021)
$\theta 1$	0.0112 (0.2404)	-0.0277 (0.0249)	-0.0220 (0.0564)
$\theta 2$	0.0595 (0.0023)		
$\theta 3$	0.0806 (0.0000)		
Variance Equation			
c	-0.0771 (0.0000)	-0.0361 (0.0000)	-0.0056 (0.0001)
$\alpha 1$	0.1211 (0.0000)	0.0750 (0.0000)	-0.0802 (0.0001)
$\alpha 2$	0.0062 (0.0003)	-0.0216 (0.2416)	0.2609 (0.0000)
$\lambda 1$	1.9425 (0.0000)	-0.1639 (0.0000)	-0.1735 (0.0000)
$\lambda 2$	-1.8716 (0.0000)	0.1452 (0.0000)	-0.2067 (0.0000)
$\beta 1$	0.9249 (0.0000)	1.6553 (0.0000)	0.2535 (0.0000)
$\beta 2$		-0.6626 (0.0000)	-0.0507 (0.0467)
$\beta 3$			1.9533 (0.0000)
$\beta 4$			-1.0071 (0.0000)
$\beta 5$			0.0532 (0.6398)
Diagnostic			
LM	2.9511 (0.2287)	0.8101 (0.6669)	0.6162 (0.7348)
SC	5.7561	4.1842	4.1420

Note: The figures in the parentheses represent the *p* values.

3.3.3 Summary Statistics of Stock Price Volatility

Table 2 displays the basic statistics describing stock price volatility.

Table 2. Basic Statistics of Stock Price Volatility

Sample: 1 January 1991 to 31 December 2014						
	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis
China	5.3183	10.2646	255.9581	0.1699	7.8007	107.5738

Japan	2.1412	2.0223	38.6752	0.3062	6.8439	78.9013
US	1.1677	1.5436	22.7747	0.0613	5.4213	45.3926
Sample: 1 January 1991 to 14 August 2007						
	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis
China	6.2149	12.0554	255.9581	0.1699	6.7343	79.6406
Japan	1.9614	1.2418	9.8858	0.3062	1.6888	7.0470
US	0.9471	0.8479	8.5805	0.0613	2.4448	11.7298
Sample: 15 August 2007 to 31 December 2014						
	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis
China	3.3015	3.0999	21.8266	0.5013	2.0917	8.0117
Japan	2.5457	3.0967	38.6752	0.3095	5.6226	43.2732
US	1.6642	2.4026	22.7747	0.1537	3.8833	21.3498

During the whole sample period (1 January 1991 to 31 December 2014) and before the global financial crisis (1 January 1991 to 14 August 2007), the stock price volatility average and standard deviation in China are significantly larger than those in Japan and the United States. Furthermore, the stock price volatility average and standard deviation in Japan are generally larger than those in the United States.

The stock price volatility averages and standard deviations in Japan and the United States after the global financial crisis (15 August 2007 to 31 December 2014) increased compared to those before the crisis. Furthermore, the stock price volatility average and standard deviation in China after the global financial crisis significantly decreased compared to those before the crisis.

3.3.4 Covariance of Chinese, Japanese, and US Stock Prices

Furthermore, Figure 4 illustrates the conditional variance-covariance of Chinese, Japanese, and US stock prices obtained by the EGARCH model.[13]

[13] Var(JAPAN), Var(CHINA) and Var(US) indicate the variance of Japan, China and the US, respectively. Cov(JAPAN, CHINA), Cov(JAPAN, US), and Cov(CHINA, US) indicate the covariance between Japanese and Chinese stock prices, Japanese and the US stock prices, and Chinese and the US stock prices, respectively.

Figure 4. Conditional Variance-Covariance

Figure 4-1. Conditional Variance-Covariance (1991-2014)

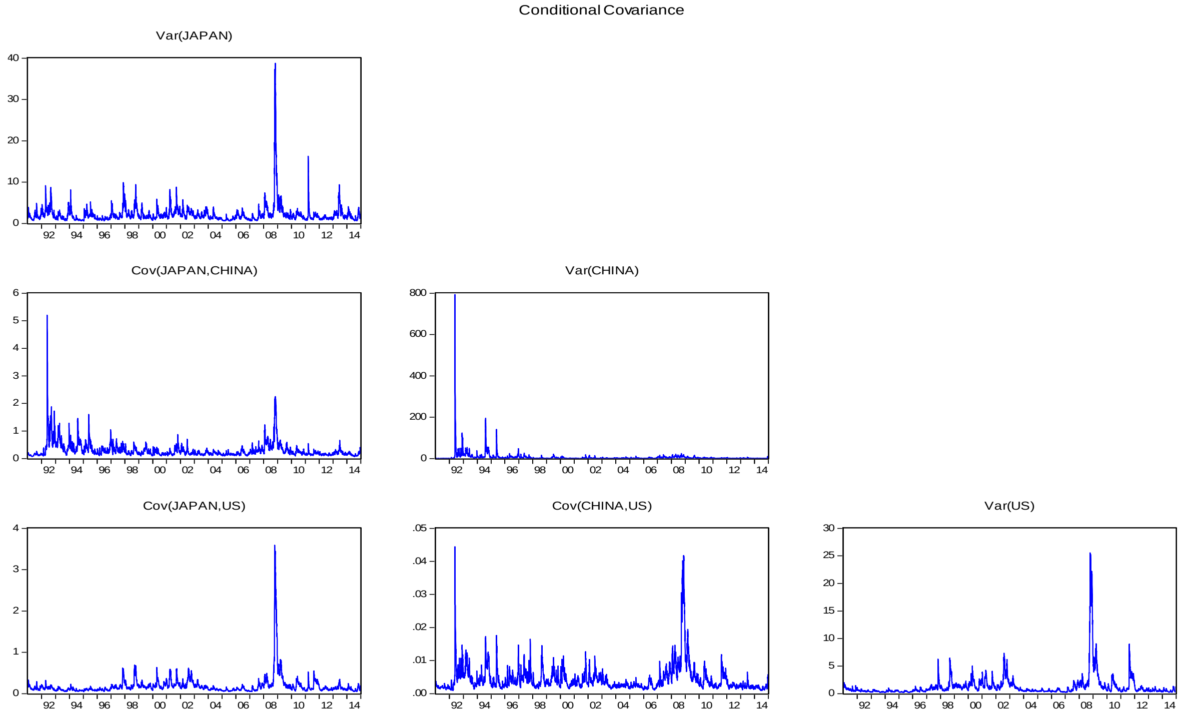


Figure 4-1 illustrates the conditional variance-covariance of Chinese, Japanese, and US stock prices during the period from 1991 to 2014. Concretely, after the global financial crisis hit the world in 2007, Japan and the US's stock price volatilities increased sharply. As a result, the conditional covariance of Japanese and US stock prices rose dramatically after the global financial crisis. China's stock price volatility sharply increased in the early 1990s, particularly in 1992, not after the shock of the global financial crisis in 2007. When the Shanghai Stock Exchange and the Shenzhen Stock Exchange opened in 1990, the number of listed companies was only 8 and 2, respectively.[14] Shortly after the establishment of the stock exchanges, stock prices repeatedly experienced sharp jumps and falls. In particular, immediately after the foundation of the stock exchanges, stock prices were highly volatile.

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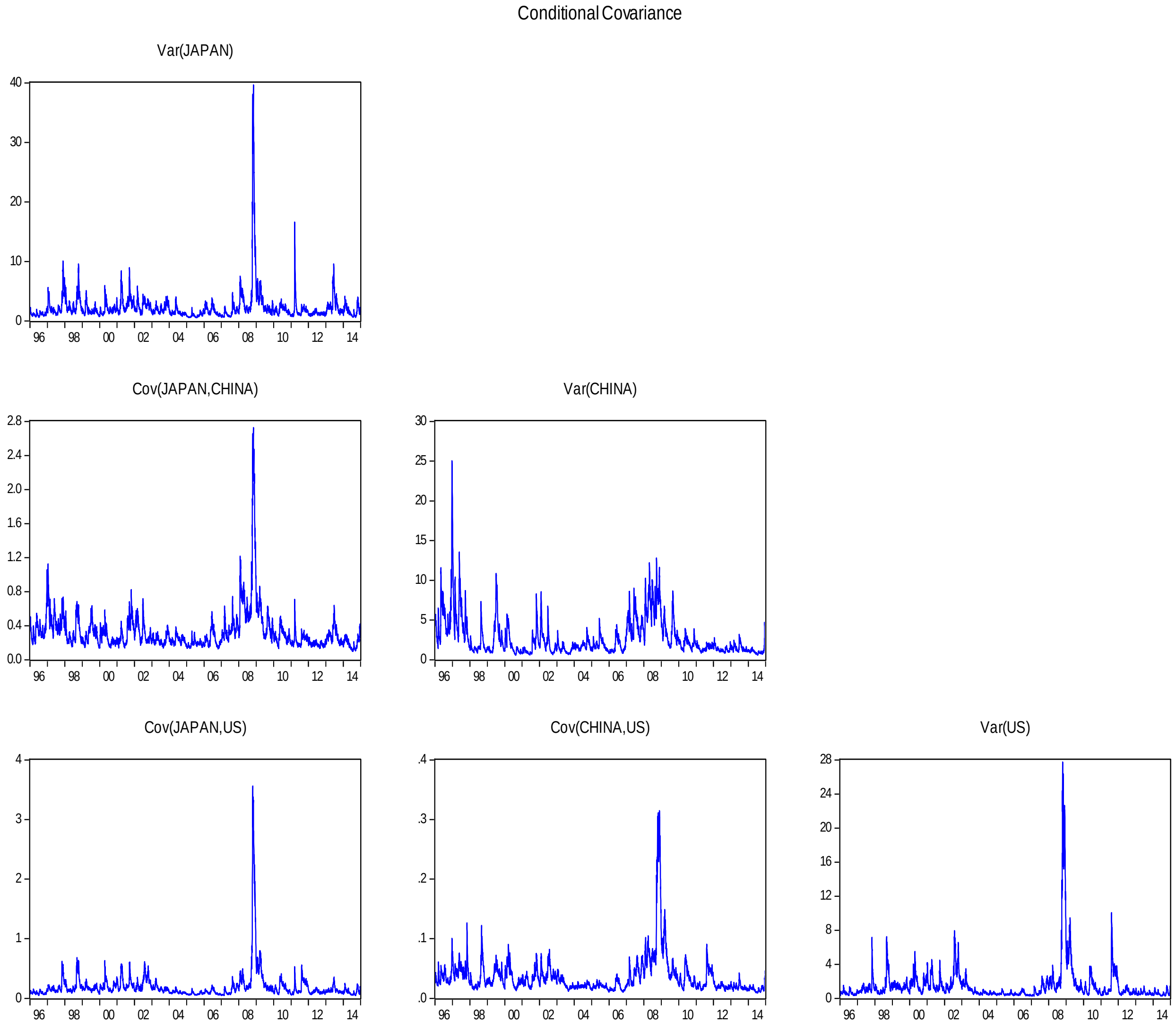
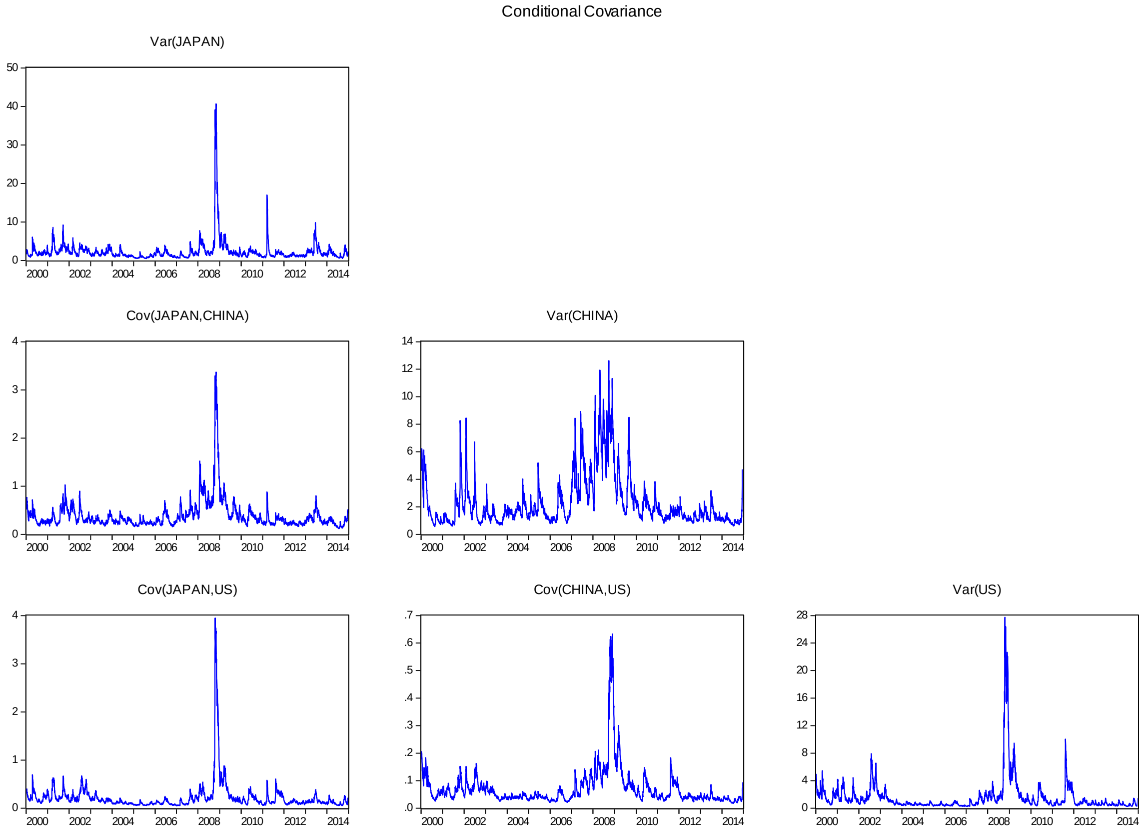
[14] Refer to the China Securities and Futures Statistical Yearbook and the websites of the Shanghai Stock Exchange and the Shenzhen Stock Exchange.

Figure 4-2. Conditional Variance-Covariance (1996-2014)



Furthermore, the conditional covariance of Chinese, Japanese, and US stock prices, excluding the early 1990s when Chinese stock prices became increasingly volatile, is examined. Figure 4-2 illustrates the conditional variance-covariance of Chinese, Japanese, and US stock prices during the period from 1996 to 2014. Japan and the US's stock price volatilities and their conditional covariance sharply increased in the aftermath of the global financial crisis in 2007; this is not different from what is illustrated in Figure 4-1. China's stock price volatility also became increasingly volatile in the wake of the global financial crisis in 2007, but it was quite higher in late December 1996.

Figure 4-3. Conditional Variance-Covariance (2000-2014)



Lastly, the conditional covariance of Chinese, Japanese, and US stock prices after the 2000s is examined. Figure 4-3 illustrates the conditional variance-covariance of Chinese, Japanese, and US stock prices during the period from 2000 to 2014. As illustrated in the figure, although China's stock price volatility became higher after the global financial crisis in 2007, Chinese stock prices were comparatively less affected by the crisis than Japanese and US stock prices. In addition, in the aftermath of the global financial crisis, the conditional covariance of Japanese and Chinese stock prices, the conditional covariance of Chinese and US stock prices, and the conditional covariance of US and Japanese stock prices also increased rapidly, which suggests a rise in the linkage of stock prices.

After 2000, particularly after WTO accession in December 2001, China has undergone more active capital exchanges both within and outside the country and a closer integration into the world market. Amidst such a situation, China implemented a wide range of reforms for the internationalization and liberalization of stock markets to have advantages in global competition.[15] Concretely, in 2000, the stock flotation system was changed

[15] Refer to Zhang (2011) and (2012) for the Chinese stock markets. This is also relevant for

from a screening-based model by artificial allotment to a sanction-based model, which was a significant step to market liberalization. In July 2002, the Chinese government lifted the ban on the establishment of foreign-owned joint venture securities firms and investment trusts, and liberalized stock brokerage commission of securities firms. In addition, in China, stocks are divided into A-shares and B-shares. Initially, only foreign investors were permitted to buy B-shares; however, in February 2001, B share stock market was also opened to domestic investors.[16] Moreover, initially, only Chinese investors were permitted to invest in A-shares. However, the qualified foreign institutional investors (QFII) system was introduced in 2002, which enabled foreign institutional investors to buy A-shares. This succession of reforms made the Chinese stock market more vulnerable to asset price movements in other countries than before, although the Chinese stock market has not completely been internationalized and liberalized yet. Consequently, the linkage of the Chinese, Japanese, and US stock prices became higher after the global financial crisis in 2007.

Ⅳ Effects of Macroeconomic Variables on Stock Price Volatility

4.1 *Data*

In this section, the effects that macroeconomic variables have on stock price volatility are analyzed using monthly data. First, monthly stock price volatility (*V*) is gotten from the values of daily stock price volatility obtained from the EGARCH model in the previous section. The effects of macroeconomic variables on stock price volatility (*V*) are considered from two aspects: real-economy variables and monetary-policy variables. For the real-economy variables, the rate of increase in industrial production (*Y*) and the rate of increase in the consumer price index (*P*) are used. For the monetary-policy variables, the rate of increase in M2 (*M*) is used as the money supply variable, and the one-year lending interest rate (*I*) is used as the interest rate variable. The data are taken from the IMF database. The estimation period is from January 1991 to December 2014. Below, the analyses are carried out in the following order: China, Japan, and the United States.

4.2 *Unit Root Tests*

related descriptions in other parts of this paper.

[16] B-shares began to be issued as a means for businesses to directly procure foreign currencies on the Shanghai Stock Exchange and the Shenzhen Stock Exchange in 1992, when foreign currencies were in short supply in China. B-shares are traded in US dollars on the Shanghai Stock Exchange and in Hong Kong dollars on the Shenzhen Stock Exchange.

First, in order to test whether the data series used is stationary, unit root tests are conducted. Here the unit root tests are carried out using the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for the two cases, with both a trend and a constant, and with a constant only. The lags are based on the Schwarz information criterion in the ADF tests and on the Newey-West bandwidth in the PP tests. The unit root test results are presented in Table 3.[17]

Table 3-1, 3-2 and 3-3 show the results of the unit root tests for China, Japan and the United States, respectively. As presented in tables, the null hypotheses proposing that unit roots are present are all rejected in the first differences of the variables represented by *Δ*. That is, the first differences of the variables are all stationary, and all the variables are considered as I (1) processes. In the following analyses, the first differences are used to establish the stationarity of the data.

Table 3. Unit Root Tests

Table 3-1. Unit Root Tests (China)

	ADF test		PP test	
	With trend and constant	With constant	With trend and constant	With constant
VC Lag	-6.4542*** 0	-5.8891*** 0	-6.5436*** 9	-5.9756*** 9
ΔVC Lag	-11.2430*** 4	-11.2583*** 4	-60.2534*** 183	-60.8069*** 178
YC Lag	-3.4187* 3	-2.8758** 3	-12.1594*** 12	-10.5075*** 12
ΔYC Lag	-13.7542*** 3	-13.7789*** 3	-59.2352*** 27	-59.4087*** 27
PC Lag	-2.1188 12	-1.7417 12	-2.2323 10	-1.8678 10
ΔPC Lag	-5.4059*** 11	-5.4120*** 11	-14.2720*** 9	-14.2733*** 9
MC Lag	-1.5356 12	-1.0909 12	-2.3367 4	-1.8161 4

17 Here, ***, **, and * show that the null hypothesis proposing that unit roots exist is rejected at the significance level of 1 %, 5 %, and 10 %, respectively.

ΔMC Lag	-7.7431*** 11	-7.7586*** 11	-14.4601*** 0	-14.4853*** 0
IC Lag	-1.2004 0	-1.0527 0	-1.6636 10	-1.3288 10
ΔIC Lag	-15.4991*** 0	-15.5224*** 0	-16.0960*** 9	-16.1156*** 9

Table 3-2. Unit Root Tests (Japan)

	ADF test		PP test	
	With trend and constant	With constant	With trend and constant	With constant
VJ Lag	-6.5731*** 2	-6.5821*** 2	-7.4919*** 5	-7.4997*** 5
ΔVJ Lag	-16.5994*** 1	-16.6285*** 1	-40.9654*** 65	-40.7466*** 65
YJ Lag	-3.5451** 13	-3.5334*** 13	-4.6312*** 7	-4.6271*** 7
ΔYJ Lag	-9.0267*** 12	-9.0440*** 12	-17.2567*** 4	-17.2828*** 4
PJ Lag	-1.9660 12	-2.4603 12	-2.8566 4	-3.2297** 5
ΔPJ Lag	-6.8869*** 11	-6.7000*** 11	-15.3553*** 2	-15.2867*** 1
MJ Lag	-4.6211*** 0	-4.7276*** 0	-4.9666*** 9	-4.8861*** 9
ΔMJ Lag	-15.9770*** 0	-15.9368*** 0	-15.9759*** 4	-15.9353*** 4
IJ Lag	-5.1715*** 4	-6.1000*** 4	-4.4814*** 10	-7.3677*** 10
ΔIJ Lag	-4.3509*** 5	-3.1865** 5	-7.0926*** 6	-5.8083*** 8

Table 3-3. Unit Root Tests (US)

	ADF test		PP test	
	With trend and constant	With constant	With trend and constant	With constant
VU	-4.8530***	-4.7804***	-5.3979***	-5.3279***
Lag	2	2	1	1
ΔVU	-14.2829***	-14.3080***	-16.0500***	-16.0876***
Lag	1	1	14	14
YU	-2.8319	-2.6653*	-2.9819	-2.9184**
Lag	12	12	9	9
ΔYU	-6.3711***	-6.3856***	-16.7765***	-16.7993***
Lag	11	11	9	9
PU	-2.6677	-2.4181	-4.2690***	-3.9990***
Lag	12	12	2	1
ΔPU	-9.9369***	-9.9675***	-10.9316***	-10.9586***
Lag	11	11	11	11
MU	-2.2295	-2.0899	-2.8183	-2.5097
Lag	12	12	6	6
ΔMU	-7.0027***	-7.0002***	-12.5793***	-12.6001***
Lag	11	11	1	1
IU	-2.7957	-1.6846	-2.3417	-1.7626
Lag	3	2	12	12
ΔIU	-6.1316***	-6.1435***	-8.7147***	-8.7345***
Lag	1	1	6	6

4.3 *Granger Causality Tests*

In order to view the effects of macroeconomic variables on stock price volatility (*V*), Granger causality tests are conducted. Granger causality tests verify whether or not there exists causality between each of the variables. Tables 4 to 6 show whether there exist Granger causality between stock price volatility and each real-economy variable, and between stock price volatility and each monetary-policy variable, in China, Japan, and the United States, respectively. As mentioned before, here, the rate of increase in industrial production (*Y*) and the rate of increase in the consumer price index (*P*) are used as real-economy variables, and the rate of increase in M2 (*M*) and the one-year lending rate (*I*) are used as monetary-policy variables.

Table 4. Granger Causality Tests (China)

Table 4-1. Granger Causality Tests (China, Janaury1991-December 2014)

Null Hypothesis:	F-Statistic	Prob.
ΔYC does not Granger Cause ΔVC	0.2294	0.6324
ΔVC does not Granger Cause ΔYC	2.6275	0.1061
ΔPC does not Granger Cause ΔVC	1.3265	0.2504
ΔVC does not Granger Cause ΔPC	4.1014	0.0438**
ΔMC does not Granger Cause ΔVC	0.5220	0.4706
ΔVC does not Granger Cause ΔMC	1.0093	0.3159
ΔIC does not Granger Cause ΔVC	0.0713	0.7897
ΔVC does not Granger Cause ΔIC	0.0136	0.9072

Table 4-2. Granger Causality Tests (China, Janaury1991-August 2007)

Null Hypothesis:	F-Statistic	Prob.
ΔYC does not Granger cause ΔVC	0.1767	0.6747
ΔVC does not Granger cause ΔYC	1.4508	0.2299
ΔPC does not Granger cause ΔVC	0.9999	0.3186
ΔVC does not Granger cause ΔPC	4.3238	0.0389**
ΔMC does not Granger cause ΔVC	1.0342	0.3104
ΔVC does not Granger cause ΔMC	1.0587	0.3048
ΔIC does not Granger cause ΔVC	0.0678	0.7949
ΔVC does not Granger cause ΔIC	0.0000	0.9989

Table 4-3. Granger Causality Tests (China, September 2007-December 2014)

Null Hypothesis:	F-Statistic	Prob.
ΔYC does not Granger cause ΔVC	0.3149	0.5762
ΔVC does not Granger cause ΔYC	2.4488	0.1214
ΔPC does not Granger cause ΔVC	0.8428	0.3613
ΔVC does not Granger cause ΔPC	2.3473	0.1293
ΔMC does not Granger cause ΔVC	2.7571	0.1006
ΔVC does not Granger cause ΔMC	0.0910	0.7637
ΔIC does not Granger cause ΔVC	0.6547	0.4207
ΔVC does not Granger cause ΔIC	0.1264	0.7231

Table 4-1 shows the results of the Granger causality tests in China from January 1991 to December 2014. As to the real-economy variables, the rate of increase in industrial production and the rate of increase in the consumer price index do not Granger cause stock price volatility, while stock price volatility Granger causes the rate of increase in the consumer price index at the significance level of 5%. As to the monetary-policy variables, the rate of increase in M2 and the one-year lending rate do not Granger cause stock price volatility, and stock price volatility also does not Granger cause them.

Moreover, Table 4-2 shows the results of the Granger causality tests in China before the global financial crisis, from January 1991 to August 2007, and Table 4-3 shows the results of the Granger causality tests in China after the global financial crisis, from September 2007 to December 2014.

For the period of January 1991 to August 2007, all the macroeconomic variables (real-economy variables and monetary-policy variables) do not Granger cause stock price volatility. Moreover, stock price volatility Granger causes the rate of increase in the consumer price index at the significance level of 5%, while does not Granger cause the rate of increase in industrial production and the monetary-policy variables.

For the period of September 2007 to December 2014, all the macroeconomic variables do not Granger cause stock price volatility, and stock price volatility also does not Granger cause all the macroeconomic variables.

Table 5. Granger Causality Tests (Japan)

Table 5-1. Granger Causality Tests (Japan, Janaury1991-December 2014)

Null Hypothesis	F-Statistic	Probability
ΔYJ does not Granger cause ΔVJ	13.3256	0.0003***
ΔVJ does not Granger cause ΔYJ	0.0403	0.8410
ΔPJ does not Granger cause ΔVJ	2.4666	0.1174
ΔVJ does not Granger cause ΔPJ	1.6514	0.1998
ΔMJ does not Granger cause ΔVJ	0.0562	0.8129
ΔVJ does not Granger cause ΔMJ	1.3131	0.2528
ΔIJ does not Granger cause ΔVJ	0.1765	0.6748
ΔVJ does not Granger cause ΔIJ	0.9887	0.3209

Table 5-2. Granger Causality Tests (Japan, Janaury1991-August 2007)

Null Hypothesis:	F-Statistic	Probability
ΔYJ does not Granger cause *ΔVJ*	0.1217	0.7275
ΔVJ does not Granger cause *ΔYJ*	0.0235	0.8782
ΔPJ does not Granger cause *ΔVJ*	0.6252	0.4301
ΔVJ does not Granger cause *ΔPJ*	0.4942	0.4829
ΔMJ does not Granger cause *ΔVJ*	0.6579	0.4183
ΔVJ does not Granger cause *ΔMJ*	0.9662	0.3268
ΔIJ does not Granger cause *ΔVJ*	0.0153	0.9017
ΔVJ does not Granger cause *ΔIJ*	2.1497	0.1442

Table 5-3. Granger Causality Tests (Japan, September 2007-December 2014)

Null Hypothesis	F-Statistic	Probability
ΔYJ does not Granger cause *ΔVJ*	9.8191	0.0024***
ΔVJ does not Granger cause *ΔYJ*	0.0190	0.8906
ΔPJ does not Granger cause *ΔVJ*	1.5844	0.2116
ΔVJ does not Granger cause *ΔPJ*	1.3903	0.2417
ΔMJ does not Granger cause *ΔVJ*	0.1050	0.7467
ΔVJ does not Granger cause *ΔMJ*	0.8719	0.3531
ΔIJ does not Granger cause *ΔVJ*	3.7251	0.0570*
ΔVJ does not Granger cause *ΔIJ*	1.4345	0.2344

Table 5-1 shows the results of the Granger causality tests in Japan from January 1991 to December 2014. As to the real-economy variables, the rate of increase in industrial production Granger causes stock price volatility at the significance level of 1%, while the rate of increase in the consumer price index does not Granger cause stock price volatility. As to the monetary-policy variables, the rate of increase in M2 and the one-year lending rate do not Granger cause stock price volatility. Moreover, stock price volatility does not Granger cause all the macroeconomic variables (real-economy variables and monetary-policy variables).

Moreover, Table 5-2 shows the results of the Granger causality tests in Japan before the global financial crisis, from January 1991 to August 2007, and Table 5-3 shows the results of the Granger causality tests in Japan after the global financial crisis, from September 2007 to December 2014.

For the period of January 1991 to August 2007, all the macroeconomic variables do not Granger cause stock price volatility, and stock price volatility also does not Granger cause all the macroeconomic variables.

For the period of September 2007 to December 2014, as to the real-economy variables, the rate of increase in industrial production Granger causes stock price volatility at the significance level of 1%, while the rate of increase in the consumer price index does not Granger cause stock price volatility. As to the monetary-policy variables, the one-year lending rate Granger causes stock price volatility at the significance level of 10%, while the rate of increase in M2 does not Granger cause stock price volatility. Moreover, stock price volatility does not Granger cause all the macroeconomic variables.

Table 6. Granger Causality Tests (US)

Table 6-1. Granger Causality Tests (US, Janaury1991-December 2014)

Null Hypothesis:	F-Statistic	Prob.
ΔYU does not Granger Cause ΔVU	1.8825	0.1711
ΔVU does not Granger Cause ΔYU	0.0760	0.7830
ΔPU does not Granger Cause ΔVU	4.6477	0.0319**
ΔVU does not Granger Cause ΔPU	21.4745	0.0000***
ΔMU does not Granger Cause ΔVU	0.8808	0.3488
ΔVU does not Granger Cause ΔMU	0.1845	0.6679
ΔIU does not Granger Cause ΔVU	1.9520	0.1635
ΔVU does not Granger Cause ΔIU	12.4463	0.0005***

Table 6-2. Granger Causality Tests (US, Janaury1991-August 2007)

Null Hypothesis:	F-Statistic	Prob.
ΔYU does not Granger Cause ΔVU	5.3427	0.0219**
ΔVU does not Granger Cause ΔYU	0.8336	0.3624
ΔPU does not Granger Cause ΔVU	0.0021	0.9635
ΔVU does not Granger Cause ΔPU	1.0714	0.3019
ΔMU does not Granger Cause ΔVU	3.2688	0.0721*
ΔVU does not Granger Cause ΔMU	0.4706	0.4935
ΔIU does not Granger Cause ΔVU	0.8198	0.3663
ΔVU does not Granger Cause ΔIU	3.4227	0.0658*

Table 6-3. Granger Causality Tests (US, September 2007-December 2014)

Null Hypothesis:	F-Statistic	Prob.
ΔYU does not Granger Cause ΔVU	4.9683	0.0285**
ΔVU does not Granger Cause ΔYU	0.8255	0.3662
ΔPU does not Granger Cause ΔVU	3.3471	0.0709*
ΔVU does not Granger Cause ΔPU	24.6055	0.0000***
ΔMU does not Granger Cause ΔVU	0.0276	0.8684
ΔVU does not Granger Cause ΔMU	0.2786	0.5990
ΔIU does not Granger Cause ΔVU	2.6056	0.1103
ΔVU does not Granger Cause ΔIU	13.0507	0.0005***

Table 6-1 shows the results of the Granger causality tests in the United States from January 1991 to December 2014. The rate of increase in the consumer price index Granger causes stock price volatility at the significance level of 5%. Moreover, stock price volatility Granger causes both the rate of increase in the consumer price index and the one-year lending rate at the significance level of 1%. However, there is no Granger causality between stock price volatility and the rate of increase in industrial production or the rate of increase in M2.

Moreover, Table 6-2 shows the results of the Granger causality tests in the United States before the global financial crisis, from January 1991 to August 2007, and Table 6-3 shows the results of the Granger causality tests in the United States after the global financial crisis, from September 2007 to December 2014.

For the period of January 1991 to August 2007, the rate of increase in industrial production and the rate of increase in M2 Granger cause stock price volatility at the significance level of 5% and 10%, respectively. Moreover, stock price volatility Granger causes the one-year lending rate at the significance level of 10%.

For the period of September 2007 to December 2014, the rate of increase in industrial production and the rate of increase in the consumer price index Granger cause stock price volatility at the significance level of 5% and 10%, respectively. Moreover, stock price volatility Granger causes the rate of increase in the consumer price index and the one-year lending rate at the significance level of 1%.

Finally, the results of the Granger causality tests are as follows. Japan's rate of increase in industrial production Granger causes Japan's stock price volatility, and the US's rate of increase in the consumer price index Granger causes the US's stock price volatility in the whole sample period (January 1991 to December 2014). In addition, China's real-economy variables and monetary-policy variables do not Granger cause China's stock price volatility in any analysis period.

V Summary and Concluding Remarks

In this paper, while focusing on the impact that the global financial crisis had on the stock markets of China, Japan, and the United States, the stock-price volatilities and linkage between these three countries are analyzed, as well as the relationships between macroeconomic variables (real-economy variables and monetary-policy variables) and stock price volatility in each country.

The estimation results of the EGARCH model revealed that although China's stock price volatility was far greater than those of Japanese and US stock prices, China was less affected by the global financial crisis in 2007 than Japan and the United States. Conversely, Japanese and US stock prices became rather volatile in the wake of the global financial crisis in 2007, which suggests that the Japanese and US stock markets were hugely affected by the global crisis. For China, stock price volatility was greater in the early 1990s, shortly after the stock market had been established, than in 2007 when the global financial crisis occurred. In addition, the covariance of Chinese, Japanese, and US stock prices became fairly greater in the aftermath of the global financial crisis in 2007, which suggests that the linkage of Chinese, Japanese, and US stock prices increased in this period.

Moreover, Granger causality testing revealed the following results. Japan's industrial output affects stock price volatility, while US's consumer prices affect the US's stock price volatility. In addition, China's real-economy variables and monetary-policy variables do not Granger cause China's stock price volatility.

The reasons why the linkage of the Chinese, Japanese, and US stock markets has increased after the global financial crisis in 2007 can be considered as follows. After 2000, particularly after its accession to the WTO in December 2001, China implemented a succession of economic reforms and facilitated the globalization of the stock market. Consequently, the Chinese market has become more likely to be affected than before by asset price movements in other countries. In addition, with the widespread use of the Internet and the progress of communication technology, stock price movements of a certain country can be known rapidly by investors all over the world and influence their investment behaviors. Furthermore, amidst the situation in which trades are expanding and global corporations are tapping new overseas markets, the world economy is being increasingly integrated and events of a certain country quickly ripple through other countries in the field of finance as well. Therefore, with the increasing presence of the Chinese economy, the movement of China’s stock prices has a growing effect on the investment behaviors of overseas investors. In addition, Hong Kong, which was returned to China in 1997, has a free stock market and is believed that international investors are adjusting their portfolio well. However, the Hong Kong economy is greatly affected by China’s policies and economic conditions. In this situation, the Hong Kong market has increasingly reflected China’s economic conditions and the Chinese mainland stock markets. All these factors seem to make the linkage between the stock markets of China and other countries increase.

However, the Chinese stock market is different from the Japanese and US stock markets because it is not completely internationalized and liberalized yet. Although the Chinese stock market was affected by the global financial crisis in 2007, the effect was relatively small. Moreover, currently, although China is the world’s second largest economic power, its stock market has not completely developed yet and its financial system is fragile. Learning the lesson that the flight of investment capital triggered the Asian currency crisis in 1997, the Chinese government regulates its capital dealings to secure the stability of domestic financial markets, which prevents overseas investors to freely invest in the Chinese stock market. The rate of domestic investors to investments in the stock market of the Chinese mainland is more than 90%. Basically, the Chinese stock market is speculative and major institutional investors that make investment decisions on the basis of economic fundamentals, such as corporate performance, have not completely grown to a full-fledged level. Market participants are dominated by capital gain-oriented individual investors. They cause unstable stock price fluctuations and make the market more speculative. In addition, many listed companies are state-owned and their management reflects the intentions of the central government, which holds their shares. Therefore, corporate governance does not function properly. Furthermore, listed companies’ shares include nontradable shares that cannot be publicly traded in the stock market.[18] Such special type of stock causes wild stock price fluctuations, and makes the Chinese stock market become obscure.

Moreover, China’s monetary policies do not affect stock price volatility. The reason for this is that in China, indirect finance dominates direct finance and it cannot yet be said

[18] Nontradable shares were created shortly after the stock market was established to retain government’s control over listed companies. Nontradable shares comprise national shares, corporate shares, and employees’ shares, and are held mainly by government and state-owned companies.

that the arbitrage and adjustment functions of the financial markets are sufficient. Because the degree of enterprises' dependence on bank loans remains high, it is necessary to make efforts to develop the stock markets more in China, to diversify the financing of enterprises and the choice of investments, and to use risk analysis to exchange information more widely in the future. However, currently, China still regulates capital dealings. The regulation of capital dealings is likely to make it impossible to adequately cope with the growing globalization of the securities market. China should liberalize capital dealings in a steady and deliberate manner in the future.

In recent years, the Abe administration of Japan has been implementing economic measures that have come to be termed "Abenomics"; these measures include an emergency economic stimulus package and quantitative easing of the monetary policy to tackle deflation in an effort to create a resilient economy. The yen's depreciation is expected to improve the performance of export industries, accelerate corporate activities, and stimulate domestic demands. In addition, more capital is invested in the stock market and the Japan's stock prices are recovering. Amidst the economic slowdown triggered by the shocking failure of Lehman Brothers in September 2008, the US government has been implementing the quantitative monetary easing policy to support the economy and prevent deflation. The policy is now functioning in favor of the real economy. It is stimulating investment and consumption, and the economy is recovering. This has resulted in the economic recovery pushing up stock prices and providing vitality to the stock market. However, if Japan and the United States continue to adopt a bold accommodative monetary policy in step with each other, it could "heat up" the global financial market beyond the real economy and eventually lead to global financial bubbles.

For China, "shadow banking"—lending money through a different route from ordinary bank loans—is spreading rapidly. This has caused a temporary confusion in the Chinese financial market due to a sharp rise in short-term interest and a decline in stock prices. The Chinese government has begun to control the spread of money far beyond the real economy. However, if those brakes work too hard, investment and consumer spending will go down, which will place a downward pressure on the real economy. Conversely, if loans through shadow banking continue to increase, it will cause the gaps between the real economy and finance to widen, which will lead to the formation of credit bubbles. Thus, shadow banking could threaten to shake the Chinese economy.

Learning a lesson from the global financial crisis in 2007, many countries have accumulated foreign reserves and have enhanced their financial systems. These efforts have brought about a gradual recovery of the real economy. To prevent another global financial crisis in the future, China, Japan, and the United States should not only strengthen their economic fundamentals and implement structural reform, but also adopt closer collaborative measures in the field of finance to respond jointly to financial risk. If they do so, we can expect the financial liberalization and unification of the world economy to advance smoothly, and the financial system to be strengthened further.

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