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Abstract

The empirical results provide three interesting findings. First, the results indicate that both the US and the Japanese markets appear to be playing a significant role in transmitting the mean and volatility spillover effects in the Pacific-Basin region. Second, while the US market appeared to be more influential during the pre-crisis period, the Japanese market seems to have gained momentum in the post-crisis period. Lastly, the influence of the US and the Japanese markets on the Malaysian market has somewhat weakened during the post-crisis period, while for Singapore, the magnitude of the mean and spillover effect from these two countries has increased. As for Hong Kong, the US market tends to be more influential than the Japanese market.

The Impact of Asian Financial Crisis and the Spillover Effects on Three Pacific-Basin Stock Markets—Malaysia, Singapore and Hong Kong

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The standardized residuals and the squared standardized residuals of the US and the Japanese markets obtained from ARMA (1,1)-GARCH (1,1) models were used as exogenous variables in the mean and the variance equations of the three Pacific-Basin markets, namely, Malaysia, Singapore, and Hong Kong. The residual series were used to test the presence and the magnitude of the mean and volatility spillover effects from the US and Japan to the three Pacific-Basin markets during the pre- and post-financial crisis periods. The empirical results provide three interesting findings. First, the results indicate that both the US and the Japanese markets appear to be playing a significant role in transmitting the mean and volatility spillover effects in the Pacific-Basin region. Second, while the US market appeared to be more influential during the pre-crisis period, the Japanese market seems to have gained momentum in the post-crisis period. Lastly, the influence of the US and the Japanese markets on the Malaysian market has somewhat weakened during the post-crisis period, while for Singapore, the magnitude of the mean and spillover effect from these two countries has increased. As for Hong Kong, the US market tends to be more influential than the Japanese market.

Introduction

In the era of globalization, there has been a substantial increase in the integration of international financial markets. This has increased the concern of many parties, namely, the investors, bankers, portfolio managers, and academicians at large because the innovations in other stock markets, especially coming from the US and Japan, tend to have a substantial influence on the local stock market returns and performance. Hence, in a highly integrated global financial market, it is vital to investigate the presence of return and volatility spillovers between stock markets of different countries. As stated by Ng (2000), understanding the behavior and sources of volatility is critical, especially for asset allocation decisions, pricing domestic securities, implementing global hedging strategies, and evaluating regulatory proposals to restrict international capital flows.

Volatility modeling has become very important in the financial literature since the introduction of the time varying volatility by Engel in the early 1980s. The time varying volatility models have essentially added a new dimension to the analysis of market co-movements. Volatility is the response to news that comes as a surprise, and information originating in one market is often captured in the volatility of price movement in another

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market. One of the key reasons for the interest in the volatility movement is the association between volatility and risk. The variance of a returns series represents the risk level of the returns, and the larger the response to unexpected news, the larger will be the associated risk with that return series.

Volatility spillover is a process by which volatility in one market is transmitted to another market. The amplitude of the return movement in one market is transmitted to other related market causing the volatility in other markets to change as well. Through these movements, information is being transmitted from one market to another market and Engel calls these movements 'heat wave' and 'meteor shower' effects.

In mid-1997, along with their other East Asian neighbors, Malaysia, Singapore, and Hong Kong experienced the devastating East Asian financial crisis that lashed the region and caused a huge economic and financial turmoil. Prior to the crisis, given the economic prosperity and booming asset markets, the region enjoyed massive capital inflows. Subsequent adverse developments, such as export slowdown, rise in current account deficits, accumulation of external debt, and inadequate risk assessments that began to emerge in several of the regional economies, contributed to the perception of a build-up of vulnerabilities. The ensuing financial market volatility further created a vicious cycle of deteriorating sentiments and confidence and eventually led to a massive reversal of capital flows on the outbreak of the crisis. The changes in investors' confidence level and market sentiments obviously played an important role in intensifying the crisis.

The crisis which involved significant downward adjustments in the regional currencies and equity prices cannot be regarded as negligible given the region's growing integration with the rest of the world. The vulnerability of the domestic economies to the contagion effects however, differed significantly across the region. Therefore, the objective of this paper is to examine the impact of Asian financial crisis on three Pacific-Basin markets, namely, Malaysia, Singapore, and Hong Kong. By considering innovations from the US and the Japanese markets as the world and regional shocks respectively, this study evaluates the magnitude and the changing nature of the mean and volatility spillover effects from these two countries on the Pacific-Basin region during the pre- and post-crisis periods. By analyzing the spillover effects we will be able to enhance our understanding of the amount of information being transmitted (if any) from these two sources of shocks to the Pacific-Basin market under different market conditions.

There has been a vast amount of financial research and empirical studies carried out, primarily examining the spillover effects that may exist among stock markets of different countries.[1] These studies mainly used various ARCH/GARCH models to explore the patterns of mean and volatility spillovers, international correlations, and volatility shock transmission between cross-border financial markets under different market conditions and exchange rate regimes.

[1] See Eun and Shim (1989); Hamao *et al.* (1991); Arshanapalli and Doukas (1993); Koutmos and Booth (1995); Kim and Rogers (1995); Liu and Pan (1997); Cheung and Westermann (2000); Ng (2000); and Worthington and Higgs (2004).

Using the univariate GARCH estimator, Hamao *et al.* (1991) investigated if there is volatility spillovers from the US and the UK markets onto Asia Pacific markets trading in different time zones. They found asymmetric pre-crash (prior to 1987 crash) daily volatility spillovers from New York to London and London to Tokyo but no spillovers in other directions. The report shows that the post-crash volatilities have increased and the effects from Japan were more pronounced after the crash.

Liu and Pan (1997) investigated the mean return and volatility spillover effects from the US and Japan to four Asian stock markets, namely, Hong Kong, Singapore, Taiwan, and Thailand. Using the ARMA (1,1)-GARCH (1,1), the study mainly investigated the role of market contagion in the volatility transmission mechanism. The study covered the period from 1984 to 1991. The empirical findings suggested that the spillover effects from the US and Japan to the Asian markets have increased substantially after the October 1987 stock market crash. Due to the stronger mean and volatility spillover effects after the crash, the authors have concluded that the market contagion has a significant impact on the international transmission in the stock returns and volatility.

Ng (2000) investigated the magnitude and changing nature of the return and volatility spillovers from Japan and the US to the Pacific-Basin (Hong Kong, Korea, Malaysia, Singapore, Taiwan, and Thailand) markets. Both univariate GARCH (1,1) and bivariate GARCH (1,1) models were used to test the spillover effects from Japan and the US market to the Pacific-Basin countries. The study found that both the regional (Japan) and world (US) factors caused significant volatility in the Pacific-Basin region. Interestingly, the world factors appeared to have a stronger spillover effect compared to the regional factor. The study also proved that the impact of the spillover was much more pronounced after the liberalization processes in the Pacific region.

In this study the standardized residuals and squared standardized residuals of the US and the Japanese markets obtained from ARMA (1,1)-GARCH (1,1) models were used as exogenous variables to the mean and the variance equations of the three Pacific-Basin markets respectively. The residual series were mainly used to explore the presence and the magnitude of the mean and volatility spillover effects from the US and Japan to the three Pacific-Basin markets during the pre- and post-1998 Asian financial crisis periods. The Japanese and US markets were selected as both are well-developed markets and thus assumed to have greater influence on the other three markets.

The study covers the period from January 3, 1994 to December 31, 2003 (a total of 2,578 observations). In order to test the impact of market contagion on return and volatility spillover effects, the sample period was divided into two sub-periods with the 1998 financial crisis as the cut-off point. While the pre-crisis period covers from January 3, 1993 to December 31, 1998 (a total of 1,286 observations), the post-crisis period covers from January 4, 1999 to December 31, 2003 (a total of 1,292 observations).

Description of the Data

The data employed in this study is the daily adjusted closing market indices of the US (the Standard and Poor's 500 Index), Japan (the Nikkei Index), Malaysia (the KLSE Index), Singapore (the STI Index), and Hong Kong (the Hang Seng Index). The data was obtained from 'Yahoo.finance'.

The daily stock return for four countries is computed as:

$$R_t = \ln P_t - \ln P_{t-1} \quad ...(1)$$

where R is the daily stock return, while lnP is the natural logarithm of the stock price index, and t is time.

As for missing data due to public holidays in one market while other markets are open, the previous day's closing price is used. The time differential problem between the US and the Pacific-Basin countries requires an appropriate pairing of time. Since, a shock in the US market during day 't' will only be reflected in the Pacific-Basin stock markets on day '$t+1$', an appropriate pairing of time between these two regions would be, 't–1' for the US and 't' for the other four countries.

The five return series exhibited 'volatility clustering', i.e., small fluctuations followed by small fluctuation and large fluctuations, followed by large fluctuations. Unexpected events like the financial crisis appeared to be causing more volatility in the Pacific-Basin markets during that period. These features are interpreted as evidence that the volatility of financial asset prices are not randomly scattered but there appears to be some kind of pattern in their movement. As pointed out by Engle (1982) and Bollerslev (1986), the volatility process has innovations with slow rate of decay, indicating that the shocks are 'persistent' and thus takes a longer time to revert back to the unconditional situation. As such, the volatility process appears to have predictive power for many periods into the future and thus there is a degree of autocorrelation in the volatility of the return series. So far, the GARCH models appear to be performing reasonably well in capturing the dynamic behavior of the stock return.[2]

Methodology

In this study, a two-stage univariate mean return and volatility spillover model was employed to examine the impact of the local and the world factors on stock return and volatility.[3] Unexpected returns on any particular stock market are not only influenced by news originating from home but also from foreign shocks. As stated by Ng (2000) the foreign shocks can be categorized into two, namely, the regional shock originating from Japan and the global shock originating from the US.

In the first stage, each stock return series is modeled using the ARMA (1,1)-GARCH (1,1).[4] The mean and variance equation for market 'i' are specified as:

$$R_{i,t} = \mu_i + \varphi_i R_{i,t-1} + \theta_i \varepsilon_{i,t-1} + \varepsilon_{i,t} \quad ...(2)$$

[2] Engle (1982) introduced a new class of stochastic processes called Autoregressive Conditional Heteroscedastic (ARCH) processes and later by Bollerslev (1986), the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) processes to model the time varying volatility.

[3] A similar approach as Liu and Pan (1997) were employed in this study, whereby a two-stage GARCH model is used to examine the international transmission of stock return and volatility.

[4] Each stock return series is modeled as an ARMA (1,1) or MA (1) process in the mean equation to adjust for possible serial correlation in the data.

$$\varepsilon_{i,t} = Z_{i,t}\sigma_{i,t}$$

where $Z_{i,t} \sim N(0,1)$[5]

$$\sigma^2_{i,t} = \varpi_i + \alpha_i \varepsilon^2_{i,t-1} + \beta_i \sigma^2_{i,t-1} \quad \text{where } \varepsilon_{i,t} / \Omega_{t-1} \sim N(0, \sigma^2_{i,t}) \qquad ...(3)$$

Referring to the above-mentioned ARMA(1,1)-GARCH(1,1) model, there are six parameters (μ, φ, θ, ϖ, α, β) to be estimated. Maximum likelihood techniques are used to estimate the conditional mean and variance equations jointly. This technique chooses a set of parameter values that are most likely to have produced the observed data. By assuming the stock return series to be normally distributed, the likelihood function, i.e., the joint density of T observation is derived. Taking logs of the derived function provides the following log likelihood function:[6]

$$LL = \frac{-T}{2} log(2\pi) - \frac{1}{2}\sum_{t=1}^{T} log(\sigma^2_t) - \frac{1}{2}\sum_{t=1}^{T} \frac{\varepsilon^2_t}{\sigma^2_t} \qquad ...(4)$$

The standardized residual series and its squares from the first stage for the US and the Japanese markets are saved to be used in the second stage to model the mean return and volatility spillover effects from these two markets to the other three markets.

In the second stage, the mean and volatility spillover effects from the US and Japan to the Pacific-Basin markets are estimated. The univariate mean and volatility spillover model for market '*i*' are specified as:

$$R_{i,t} = \mu_i + \varphi_i R_{i,t-1} + \theta_i \varepsilon_{i,t-1} + \lambda_{i,1} e_{t-1,US} + \lambda_{i,2} e_{t,JP} + \varepsilon_{i,t} \qquad ...(5)$$

$$\sigma^2_{i,t} = \varpi_i + \alpha_i \varepsilon^2_{i,t-1} + \beta_i \sigma^2_{i,t-1} + \gamma_{i,1} e^2_{t-1,US} + \gamma_{i,2} e^2_{t,JP} \qquad ...(6)$$

where $e_{t-1,US}$ and $e_{t,JP}$ are the standardized residual series for the US and the Japanese markets respectively. To reflect the time difference between the US and the Pacific region, the residual series for the US is taken at 't–1'. The residuals are substituted into the mean equation to capture the mean return spillover effect from these two markets to the three Pacific-Basin markets. The mean spillover effect is present when the innovations in the US and the Japanese markets have persistent effects on the Pacific-Basin market returns. The following hypotheses were carried out to test for the presence of mean return spillover effect from these two markets to the three Pacific-Basin markets:

Hypothesis 1

H_0: $\lambda_{i,1} = 0$ (No mean return spillover effect from the US to market 'i')

H_1: $\lambda_{i,1} \neq 0$ (Mean return spillover effect is present)

[5] $Z_{i,t}$ is assumed to be normally distributed.

[6] EViews uses Marquardt algorithm to search for the global maximum, i.e., a set of parameter values that maximizes the log likelihood function.

Hypothesis 2

H_0: $\lambda_{i,2} = 0$ *(No mean return spillover effect from Japan to market 'i')*

H_1: $\lambda_{i,2} \neq 0$ *(Mean return spillover effect is present)*

To examine the presence of volatility spillover, the squared standardized residual series, i.e., $e^2_{t-1,US}$ and $e^2_{t,JP}$ are included as exogenous variables in the conditional volatility equation. The volatility spillover parameters, $\gamma_{i,1}$ and $\gamma_{i,2}$ represent the dependences of local shock on the US and Japanese shocks. The following hypotheses were carried out to test for the presence of volatility dependence from these two markets to the three Pacific-Basin markets:

Hypothesis 3

H_0: $\gamma_{i,1} = 0$ *(No volatility spillover effect from US to market 'i')*

H_1: $\gamma_{i,1} \neq 0$ *(Volatility spillover effect is present)*

Hypothesis 4

H_0: $\gamma_{i,2} = 0$ *(No volatility spillover effect from Japan. to market 'i')*

H_1: $\gamma_{i,2} \neq 0$ *(Volatility spillover effect is present)*

The above univariate mean and volatility spillover model allows us to differentiate between the relative influences of the US and Japanese markets on the three Pacific-Basin markets.[7]

Empirical Results

A preliminary data analysis revealed a high kurtosis value for all the five return series suggesting that the daily return series have fat-tailed distribution and they are leptokurtic with respect to normal distribution. The Q-statistics of the return series are highly significant at 5% level in the pre-crisis period than the post-crisis period. This implies that there were stronger linear dependencies on returns series in the pre-crisis period than in the post-crisis period. The Q-statistics for squared returns in all markets are highly significant in both periods showing a clear evidence of non-linear dependency caused by a time-varying volatility.[8]

Stage 1—ARMA (1,1)-GARCH (1,1) Model

A preliminary analysis of the data suggests the use of ARMA (1,1) to capture the linear dependency in the return series and GARCH (1,1) to capture the fat-tails and time

[7] At this stage, the mean and volatility spillover effects are assumed to be constant overtime within each sub-period.

[8] The results can be obtained from the author upon request.

varying volatility in all the five stock return series.[9] The GARCH (1,1) was used to model the conditional variance (σ_t^2) as it tends to provide a parsimonious model.[10] Tables 1 and 2 summarize the estimation results of modeling each stock return series as an ARMA (1,1)-GARCH (1,1) process for the pre- and post-crisis periods respectively. The parameter estimates are obtained by maximizing the log-likelihood function of the model using the Marquardt algorithm.

The results provided in Tables 1 and 2 show that a MA (1)-GARCH (1,1) model fits most of the stock return series well with the exception of Hong Kong in the pre-crisis

Table 1: ARMA (1,1)-GARCH (1,1) Model Estimation on Daily Stock Index Returns for the Period 1994 to 1998

	US	Japan	Malaysia	Singapore	Hong Kong
Mean Equation					
μ	0.000882 (4.066757)	3.85E-05 (0.118887)	2.43E-05 (0.071774)	–0.000196 (–0.621114)	0.000687 (1.520029)
ϕ	–	–	–	–	0.484153 (2.003891)
θ	0.048078 (1.516310)	–0.043776 (–1.420170)	0.129303 (4.169481)	0.164011 (5.379012)	–0.398514 (–1.552207)
Variance Equation					
ω	1.18E-06 (4.018648)	4.38E-06 (6.162295)	1.65E-06 (6.011682)	3.16E-06 (6.760317)	4.24E-06 (4.828539)
α	0.091540 (9.816054)	0.078481 (6.727409)	0.106167 (11.04563)	0.141872 (10.41229)	0.108276 (9.136867)
β	0.898651 (78.34601)	0.899553 (65.40330)	0.895881 (143.5379)	0.842762 (83.14364)	0.880995 (81.58799)
LB (10)	9.13290	10.74300	7.86030	11.0530	12.14500
LB (15)	11.7570	16.49500	15.4790	20.9620	22.29200
Squared Standardized Residuals					
LB (10)	5.02690	3.25670	1.72290	6.04240	2.71550
LB (15)	8.03370	4.70300	3.81770	9.47290	2.92450

Note: Total number of observations is 1,285. LB(k) is the Ljung-Box Q-statistics for k order serial correlation of the returns and squared returns. The *z*-statistics of the coefficients are provided in the brackets.

[9] The mean equation was modeled using the AR (1), MA (1) or ARMA (1,1). The model that yields insignificant serial correlation in the residuals series is then selected.

[10] Given that some of the return series exhibit slightly negatively skewed distribution, it might be more appropriate to use EGARCH or TGARCH to model the conditional variance. However, in this study the GARCH (1,1) model was used because the research objective is mainly to test the presence of mean and volatility spillover effects from the US and Japan to the Pacific-Basin markets. Therefore, at this point of time, little attention was given to the presence of asymmetries in the distribution of the return series.

Table 2: ARMA (1,1)-GARCH (1,1) Model Estimation on Daily Stock Index Returns for the Period 1999 to 2003					
	US	Japan	Malaysia	Singapore	Hong Kong
Mean Equation					
μ	0.000152 (0.459499)	–5.05E-05 (–0.125066)	0.000530 (1.436351)	0.000249 (0.649496)	0.000319 (0.798718)
ϕ	–	–	0.399650 3.050952	–	–
θ	–0.030830 (–0.992664)	–0.003769 (–0.111389)	–0.222071 (–1.591621)	0.070941 (2.364573)	0.046896 (1.457999)
Variance Equation					
ω	3.67E-06 (2.638247)	1.22E-05 (2.906609)	4.59E-06 (5.769743)	1.14E-05 (6.362725)	2.35E-06 (2.606106)
α	0.064072 (5.085105)	0.058220 (3.882113)	0.103676 (9.340707)	0.076734 (4.967555)	0.041177 (5.790485)
β	0.914519 (50.73281)	0.888189 (29.76817)	0.864611 (77.02245)	0.860047 (42.88603)	0.948346 (104.0234)
LB (10)	9.35840	4.72870	12.7620	8.45300	3.22500
LB (15)	17.4540	7.22820	20.1220	9.87950	11.7380
Squared Standardized Residuals					
LB (10)	9.13420	22.0740	10.3260	4.39260	5.63300
LB (15)	11.4360	30.5650	13.1890	7.14290	10.9010

Note: Total number of observations is 1,292. LB(k) is the Ljung-Box Q-statistics for k order serial correlation of the returns and squared returns. The *z*-statistics of the coefficients are provided in the brackets.

period and Malaysia in the post-crisis period. In both the return series, an additional AR term was included in the mean equation in order to obtain insignificant serial correlation in the residual series. Both the estimated GARCH parameters are highly significant for all the five return series. The $(\alpha + \beta)$ appears to be very close to 1 for all the return series, thus exhibiting high degrees of volatility persistence.

In Tables 1 and 2, the Ljung-Box Q-statistics are insignificant at 5% level at 10^{th} lag and the 15^{th} lag suggesting that both the standardized and squared standardized residuals for all the return series do not suffer from serial correlation problem. Based on the above results, the MA (1)-GARCH (1,1) or ARMA (1,1)-GARCH (1,1) models appeared to be performing reasonably well in capturing any dynamics that maybe present in the mean and variance equations. The standardized residual series of the US and the Japanese markets were saved and used in the second stage to model the univariate mean and volatility spillover effects.

Stage 2—Mean and Volatility Spillover Effects

The mean and return volatility spillover effects from the US and Japan to the three Pacific-Basin markets are examined using Equations 5 and 6. Tables 3 and 4 present the estimates of the mean and volatility spillover effects of the pre- and post-crisis period respectively.

Table 3: Mean and Volatility Spillover on Daily Stock Index Returns for the Period 1994 to 1998

	Malaysia	Singapore	Hong Kong
Mean Equation			
μ	0.000509 (1.091534)	–0.000104 (–0.362855)	0.001594 (2.835709)
ϕ	–	–	0.008617 (0.005112)
θ	0.156345 (4.235074)	0.151687 (4.899741)	0.008503 (0.005036)
λ_1	0.002184 (4.379374)	0.002004 (7.830342)	0.004580 (8.195199)
λ_2	0.001790 (4.499225)	0.001260 (5.249410)	0.004326 (8.677809)
Variance Equation			
ω	–6.82E-06 (–11.07822)	–1.69E-07 (–0.210837)	7.82E-05 (18.55782)
α	0.157682 (9.700562)	0.126234 (8.344531)	0.177458 (8.333902)
β	0.790730 (73.26635)	0.855815 (78.13143)	0.596658 (42.51502)
γ_1	2.82E-05 (9.185542)	1.85E-06 (2.474602)	2.84E-06 (0.910413)
γ_2	3.25E-06 (1.674313)	1.28E-06 (1.924616)	–6.21E-06 (–2.395392)
LB (10)	10.102000	12.290000	13.378000
LB (15)	18.753000	20.749000	18.021000
Squared Standardized Residuals			
LB (10)	1.101200	6.011300	10.880000
LB (15)	3.312100	11.952000	22.403000

Note: Total number of observations is 1,285. LB(k) is the Ljung-Box Q-statistics for k order serial correlation of the returns and squared returns. The *z*-statistics of the coefficients are provided in the brackets.

Table 4: ARMA (1,1)-GARCH (1,1) Model Estimation on Daily Stock Index Returns for the Period 1999 to 2003			
	Malaysia	Singapore	Hong Kong
Mean Equation			
μ	0.000568 (1.612274)	0.000451 (1.401846)	0.000333 (1.049372)
ϕ	0.359467 (2.812145)	–	–
θ	–0.168461 (–1.270510)	0.016463 (0.534091)	–0.025351 (–0.829686)
λ_1	0.001663 (6.561951)	0.002679 (7.373292)	0.004211 (12.67884)
λ_2	0.001631 (6.487763)	0.003931 (11.89120)	0.004904 (14.57851)
Variance Equation			
ω	1.04E-06 (1.446986)	3.24E-06 (1.327341)	–1.35E-06 (–1.011836)
α	0.102306 (8.679346)	0.080140 (4.310372)	0.047216 (5.698695)
β	0.871443 (75.17484)	0.820957 (25.23645)	0.932414 (84.32582)
γ_1	–1.30E-06 (–1.551701)	4.89E-06 (2.447768)	2.42E-06 (2.018298)
γ_2	3.73E-06 (5.229702)	5.49E-06 (5.383601)	2.10E-06 (2.874853)
LB (10)	18.173000	5.546500	7.442300
LB (15)	22.295000	7.159100	10.57000
Squared Standardized Residuals			
LB (10)	12.292000	15.676000	9.410500
LB (15)	16.287000	18.310000	17.966000

Note: Total number of observations is 1,292. LB (k) is the Ljung-Box Q-statistics for k order serial correlation of the returns and squared returns. The z-statistics of the coefficients are provided in the brackets.

Mean Spillover Effect in the Pre- and Post-Crisis Periods

The results indicate that there is a significant positive mean spillover effect in the pre-crisis period from the US and Japan to all the three Pacific-Basin markets. Since the magnitude of $|\lambda_{i,1}| > |\lambda_{i,2}|$, it clearly shows that before the crisis, the Pacific Basin markets were more influenced by the world factors (US) than by the regional factors (Japan).

There is also a significant positive mean spillover effect in the post-crisis period from the US and Japan to the Pacific-Basin region. However, it is interesting to note that the magnitude of the mean spillover from Japan appears to be larger in the post-crisis period for Singapore and Hong Kong highlighting the importance of the Japanese market in the Pacific-Basin region after the crisis period.

Another point worth noting is that for Malaysia, both the regional factors and the world factors relatively appear to be less influential on the conditional mean returns in the post-crisis period than the pre-crisis period. One possible reason for the decline in the mean spillover effect could be due to the capital and exchange control measures undertaken by the Malaysian Central Bank in late 1998. On the other hand, the regional and world factors tend to have greater influence on Singaporean market in the post-crisis period.

Volatility Spillover Effect in the Pre- and Post-Crisis Periods

In the pre-crisis period, there is a strong evidence of volatility spillover from the US to the Malaysian and Singaporean markets, but no clear evidence of volatility spillover from the US to Hong Kong. As for the regional factors, there are no significant volatility spillovers from Japan to Malaysia and Singapore. As for Hong Kong, there is a significant negative spillover effect from the Japanese market. This supports the presence of the US influence in the Pacific-Basin region during the pre-crisis period.

However, in the post-crisis period, there is a strong evidence of significant volatility spillover from the Japanese market to all the three Pacific-Basin markets. It is also interesting to note that there is no significant volatility spillover effect from the US to Malaysia while the US influence on the Hong Kong market appears to be gaining momentum.

On the whole, it can be concluded that in the pre-crisis period, the US market appears to be more influential than the Japanese market in transmitting return and volatility to the three Pacific-Basin markets. This indicates that in the pre-crisis period, the world factors tends to have stronger influence in the Pacific-Basin region than the regional factors. After the 1998 financial crisis, the Japanese market appears to be more influential in the region than the US market. The regional factors appear to be playing significant role in the region. The instability in the mean return and volatility spillover effects between the pre- and post-crisis periods suggests that the market contagion do have significant impact on the international transmission of mean and volatility.

Conclusion

This study uses the ARMA (1,1)-GARCH (1,1) models to examine the mean and volatility spillover effects from the US and Japan to the three Pacific-Basin markets, namely, Malaysia, Singapore, and Hong Kong. The main objective is to investigate the magnitude and changing nature of the return and volatility spillovers from the US and Japan to the Pacific-Basin region during the pre- and post-1998 financial crisis.

Three findings were discovered from this study. First, both the world and regional factors appear to be playing a significant role in the Pacific-Basin region during the pre- and post-crisis period. Second, the world factors tend to be more influential in the pre-crisis period, while the regional factors appear to have gained momentum in the post-crisis period. Lastly, the magnitude of the mean and volatility spillover effects tend to have declined in the Malaysian market in the post-crisis period while for Singapore both the regional and world factors tend to be more influential during this period. As for Hong Kong, the US market tends to have more influence in the post-crisis period than the pre-crisis period. Overall, market contagion appears to be playing a significant role in affecting the magnitude and the changing nature of the return and volatility spillovers. Thus, understanding the behavior and sources of this volatility are important especially for asset allocation decisions, pricing domestic securities, and implementing global hedging securities.

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