Intensity of Price and Volatility Spillover Effects in Asia-Pacific Basin Equity Markets

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Abstract:
This paper investigates the intensity of price and volatility spillover effects in five major stock markets within the Asia Pacific basin region with a particular emphasis in the spillover effects between Australia and China. VAR(5) model is used for measuring the return spillover while AR/VAR model with exogenous variables is employed for measuring the effects of same day returns on return spillover. .In modelling the volatility spillover, we employ AR/GARCH model which also incorporates the same day effects. Results of both return and volatility spillover provide evidence that there are significant spillover effects across different markets in the Asia-Pacific region and as well as between Australia and China. This study also provides support to the view that a market is most affected by other markets that opens/closes just before it. The main contribution of this paper is the confirmation of spillover effects between markets in the region, in particular, the interdependence between Australia and China which may have evolved only recently and thus have received relatively little research attention to date.

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1. Introduction

The level of financial market integration has been on increased over the past decade following reformation of national financial systems and liberalisation of capital movements in countries around the world. In addition, the advancement in the information technology has also allowed information to be transmitted more freely across global financial markets than ever before. These developments have reduced the isolation of domestic markets and increased their ability to be affected by news and shocks originating from the rest of the world. As a result, the linkages between different stock markets have grown stronger and this trend is evident first in the developed markets and now in the emerging markets across the globe as well. For emerging markets, international linkages has great implications for domestic economies and for international diversification as strong linkage reduces the insulation of domestic market from any global shock. On the other hand, weak market linkage offers potential gains from international diversifications (Singh, Kumar and Pandey, 2010).

The study of market integration through the analysis of return and volatility spillover has important implications in the modern portfolio theory. Markowitz (1952) was first to report that portfolio efficiency can be optimised by combining assets based on the correlation in their returns, and Grubel (1968) and Solnik (1974) extended the study and reported that portfolio efficiency can be improved with international diversification. However, Kasa (1992) argue that the benefits of international diversification based on low correlations may be overestimated because correlations are time varying and investors need a more accurate measure of international stock market interdependence. Thus, understanding short-run interdependence in returns and volatility across markets can be beneficial for diversification and hedging strategies.

Extent literature provides empirical evidence that supports the view that developed and emerging markets are interdependent and integrated (Bekaert & Harvey, 1997; Ng, 2000; Johansson & Ljungwall, 2009; Diebold & Yilmaz, 2009). Furthermore, developing countries' are forging new economic ties with different countries around the world, thus leading to the formation of new interdependent relationships between those countries. One of the most noteworthy recent emerging trade relationships is between mainland China and Australia. With China's growing appetite for resources (in particular, iron ore), its trade with Australia has increased to a level where China has become the largest trading partner of Australia (Raby, 2010). Therefore, it is timely to focus on the nature of the interactions between the Australian and Chinese equity markets and as well as across the Asia-Pacific basin region where these two countries also play crucial roles. This study investigates the price and volatility spillover effects between Australian and Chinese stock markets and also across other equity markets in the Asia-Pacific basin region. In particular, we consider five major stock markets in the region in our study, namely mainland China, Australia, Japan, Hong Kong and New Zealand.

Our study contributes to the literature in four distinct ways. First, we focus on the important emerging relationship that is developing between Australia and China. As the economic ties between these two countries become stronger, it also increases the level of interdependency between their financial markets. In addition, there are only limited studies that focus on the information spillover arising from the same day effects (Singh et al, 2010). According to Kim (2005), it is important to use the contemporaneous returns (or volatility) when the opening and closing times of different stock markets are different. Based on this view, we incorporate the same day effects in our study by applying AR/VAR model with exogenous variables. Finally, we use data which extends from 2004 to 2010, covering the period leading to, during, and after the recent global financial crisis. The extensive coverage in terms of data adds a nobility factor to our analysis and results.

This paper is organised as follows. First we provide a brief review of the literature relating to the returns and volatility spillover effects across markets. Research data and the descriptive statistics are provided in Section 3. Methodology employed for this study is explained in Section 4. Section 5 presents the main findings, with conclusions and implications drawn at the end.

2. Literature review

The study of financial market integration (the extent to which a certain movement in one market affects subsequent movements in other markets) is important to investors and also has direct implications for the portfolio theory. Substantial changes in volatility of financial markets can have a significant negative effect on the risk averse investors. Although Markowitz (1952) and Grubel (1968) provided evidences that international diversification improves efficiency, there is now a growing evidence that supports the view that portfolios that are dominated by investments in one's proximity, and markets that are geographically and economically close also tend to influence one another (Janakiramanan & Lamba, 1998). Johansson and Ljungwall (2009) argue that integration or co-movements is a result of closer political and economic cooperation among countries. They found significant spillover effects between the equity markets of mainland China, Hong Kong and Taiwan following their growing economic ties over the past decades.

Liu and Pan (1997) studied return and volatility spillover effects from the US and Japanese equity markets to four Asian markets (Hong Kong, Singapore, Taiwan and Thailand), and reported that the US market is more influential than the Japanese market in transmitting returns and volatilities to the other four Asian markets. In the European context, market integration between the European countries following the introduction of Euro has resulted in a stronger spillover effects between these markets (Melle, 2003; Savva *et al*, 2004).

Ghosh *et al* (1999) reported that some stock markets in the Asia-Pacific region co-move with the Japanese market, while others co-move with the US market. Johnson and Soenen (2002) examined the degree of integration of 12 Asia-Pacific equity markets with Japan, and reported that Australia, China, Hong Kong and New Zealand, among others, are highly integrated with the Japanese stock market. Alaganar and Bhar (2002) studied the information spillover effects between Australian stocks that are listed both in Australia and the US, and reported that there is a unidirectional information flow from the US to Australia. A study by Worthington and Higgs (2004) provided evidence of return and volatility spillover across nine Asian stock markets.[4]

Despite the extensive research that has been undertaken relating to the price and volatility spillover effects, only a few have been conducted on China's stock market, and even fewer on its relationship with Australia. With the emergence of important and close Australia-China economic relationship, a detailed study of their financial integration is timely.

3. Data and Methodology

This study uses daily opening and closing prices of the primary stock indices of the five countries under examination. The stock market indices, home countries, trading hours in both local and GMT time (for the purpose of studying the same effects) are reported in Table 1. Table 1 shows that New Zealand is the first market in our sample to open/close, followed by Australia and Japan, which opens/closes simultaneously (see Trading-GMT column), whereas markets in mainland China and Hong Kong opens/closes later in the day. Since Australian and Japanese stock markets simultaneously opens/closes, they are treated in the VAR/AR analysis (step-2) as endogenous variables using VAR model (with exogenous variables), while the other three markets are analysed using AR model.

Table 1
Indices, their home countries, time-zones and trading hours in local and GMT time

Index	**Country**	**Time-zone**	**Trading - local time**		**Trading - GMT**	
			Open	Close	Open	Close
S&P ASX200	Australia	GMT + 10	10:00	16:00	0:00	6:00
NZ50	New Zealand	GMT + 12	10:00	17:00	22:00	5:00
Hang Seng	Hong Kong	GMT + 8	10:00	16:00	2:00	8:00
Nikkei225	Japan	GMT + 9	9:00	15:00	0:00	6:00
SSE Composite	China	GMT + 8	9:30	15:00	1:30	7:00

The data for this study was collated over the period extending 6th May 2004 to 31st August 2010. Only days for which all indices have required data available are considered in our analysis, thus comprising a total of 1,419 trading days of opening and closing price data. The daily close-to-close and open-to-open returns are calculated by taking the logarithm of the

[4] namely, Hong Kong, Japan, Singapore, Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand

ratio of closing/opening price at day *t*, and day *t-1* ($\log(P_t/P_{t-1})$). The descriptive statistics of the close-to-close and open-to-open returns are presented in Table 2. The results for both open and close price returns show that all markets in Table 2 (panel A and B) have positive returns apart from Japan which overall experienced negative returns over the sampling period.

Table 2

Panel A: Descriptive statistics of index closing-price returns

Index	Mean	Std Dev	Minimum	Maximum	Skewness	Kurtosis
ASX200	0.0001823	0.0130478	-0.087043	0.090347	-0.418879	6.66595
NZ50	0.000101	0.0083245	-0.049381	0.0499419	-0.426276	4.4539009
Hang Seng	0.0003823	0.0183219	-0.105963	0.1289184	0.2442699	7.9179489
Nikkei225	-0.000203	0.0173985	-0.127154	0.1323458	-0.616859	9.4874166
SSE	0.0003548	0.0201072	-0.092562	0.0903425	-0.130374	2.3117136

Panel B: Descriptive statistics of index opening-price returns

Index	Mean	Std Dev	Minimum	Maximum	Skewness	Kurtosis
ASX200	0.000188515	0.0112985	-0.054987	0.0599686	-0.149216	3.7913335
NZ50	9.86841E-05	0.0083924	-0.056595	0.0581457	-0.354956	5.7142471
Hang Seng	0.000384994	0.0200415	-0.189256	0.1524376	-0.07724	14.082478
Nikkei 225	-0.000194837	0.0157776	-0.160984	0.110522	-0.932934	13.859521
SSE	0.000363319	0.0222031	-0.145002	0.1274083	-0.38383	3.9534638

We use a 3-step approach similar to Singh *et al* (2010) to analyse the price and volatility spillover effects across the markets. First, we examine the simultaneous interactions between markets using a Vector Autoregressive model (VAR). Second, we use a VAR/AR model to examine the same day effects of each market. Finally, volatility spillover was modelled by using a two-step AR/GARCH model.

3.1. Price spillover using *VAR (5)* model

Singh *et al* (2010) state that when studying multiple markets, spillover effects between two markets should be examined with partial effects of other markets. Since new information (shocks/noise) is likely to affect all the indices in a similar way, significant correlations estimated by bivariate VAR model can show significant spillover effects that actually originate from other markets. For example, New Zealand market which opens earliest in our sample may affect both Japanese and Australian stock markets. In addition, a bivariate VAR model between China and Australia or Japan may show significant cross-correlations when the effect actually originates from New Zealand. A VAR(5) model incorporating all five markets is used to consider the dynamic relationship between all five markets. The VAR(5) model of index returns is formulated as follows:

$$r_t = \delta + \sum_{i=1}^{p} \Phi_i r_{t-i} + \varepsilon_t$$

where $r_t = (r_{1t}, r_{2t},...r_{5t})$

3.2. Price spillover using *VAR/AR* model

To incorporate the same day effects, we use a VAR/AR model to analyse the return spillover effects across the markets. Indices with the same opening-closing hours (GMT) are considered to be endogenous and their parameters are estimated using a VAR model. Alternatively, an Autoregressive (AR) model is applied. For indices that open/close before the index under examination, the same day returns are used as explanatory variables while for indices that open/close after the index under examination, the one-day lagged returns are used. In the AR model, we use five lag lengths similar to that used by Singh *et al* (2010), while lag lengths of the VAR model is determined according to the information criterion (IC).

For markets that open/close at the same time, the VAR model with exogenous variables is given below:

$$r_t = \delta + \sum_{i=1}^{p} \varphi_i r_{t-i} + \sum_{1}^{k} \psi_{kt} r_{kt} + \sum_{1}^{l} \chi_{lt} + \varepsilon_t$$

where $r_t = (r_{1t}, r_{2t},\ldots r_{jt})'$, $(1,\ldots j)$ are indices that open simultaneously and treated as endogenous variables. k is the number of indices that open/close before the $(1,\ldots j)$ indices; and l is the number of indices that open/close after the $(1,\ldots j)$ indices. For markets that do not open/close simultaneously with any other market, we use a pure AR model (instead of VAR) with exogenous variables, as follows:

$$r_t = \alpha_i + \sum_{1}^{p} \beta_{it} r_{it-1} + \sum_{1}^{k} \chi_{kt} r_{kt} + \sum_{1}^{l} \chi_{it} r_{it-1} + \varepsilon_{it}$$

where k is the number of indices that open/close before the ith index and l is the number of indices that open/close after the ith index.

The VAR/AR models are applied to estimate the parameters using both close-to-close returns and open-to-open returns.

3.3. Volatility spillover using *AR/GARCH* model

Although it is often argued that information flows across markets through return correlations; volatility has been widely regarded to be a better proxy for the information flows (see Clark, 1973; Ross, 1989, etc). To model volatility spillover across five markets, we have applied the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) by Bollerslev *et al*, (1991). A generalised AR/GARCH model is formulated as follows:

$$r_{jt} = a + b_{j1}r_{jt-1} + \varepsilon_{jt}$$

where $\varepsilon_{jt}|\psi_{jt-1} \sim N(0, \sigma^2_{jt-1})$ and $\sigma^2_{jt} = \alpha_0 + \alpha_{j1}\varepsilon^2_{t-1} + \beta_{j1}\sigma^2_{jt-1}$

To account for the same day effects, residual terms from the AR process of other indices are incorporated back into the GARCH equation for the index under examination. As such, the AR/GARCH equation used in this study is as follows:

$$r_{jt} = a + b_{j1}r_{jt-1} + \varepsilon_{jt}$$

where $\varepsilon_{jt}|\psi_{jt-1} \sim N(0, \sigma^2_{jt-1})$ and $\sigma^2_{jt} = \alpha_0 + \alpha_{j1}\varepsilon^2_{t-1} + \beta_{j1}\sigma^2_{jt-1} + \sum_{k=1}^{k} \chi_{kt}\varepsilon^2_{kt} + \sum_{i=1}^{l} \chi_{it}\varepsilon^2_{it-1}$

where $\alpha_0>0$, α_{j1}, $\beta_{j1}\geq 0$, $\alpha_{j1}+\beta_{j1}\leq 1$, k is the number of indices that open/close before the jth index, and l is the number of indices that open/close after the jth index. For example, when modelling SSE Composite's (China) volatility, we incorporate the same day residuals of NZX50, S&P ASX200, and Nikkei200 (which open/close before SSE Composite), and one-day lagged residuals of Hang Seng index (Hong Kong index open/close after SSE Composite) in the GARCH model.

4. Findings and Discussions

4.1 Estimating return spillover using *VAR* model

Before applying VAR model, we checked the time-series data for stationarity. We conducted two tests, Johansen's (1988) rank test and Engle and Granger (1987) test on cointegrating relationships between the ten index returns (5 open-to-open return series and 5 close-to-close return series). Although Johansen's (1991) rank test detected some cointegrating relationships, a closer examination of the return series (a pair at a time) using the Engle and Granger (1987) test revealed that no cointegrating relationships existed and it is safe to proceed with the VAR analysis. We have also used similar method to that used by Singh *et al* (2010) to determine lag lengths in the VAR system using Akaike Information Criterion (AIC). The test revealed that lag lengths was 1 in this study.

Table 3 (panels A and B) report the results of VAR analysis on close-to-close and open-to-open returns of the five indices under examination. On a 5% significant level, the one-day lagged return of SSE Composite index (China) significantly affects the current stock returns of S&P ASX200 index (Australia). However, the one-day lagged returns of ASX200 (t-1) do not show any significant spillover effects on returns of the SSE Composite. The result suggests that information incorporated in the SSE Composite returns affect the next day returns of S&P ASX200 index but not vice versa. This can be due to the underlying economic reality, that is, greater dependency of Australia on the Chinese market, but not vice versa. Alternatively, the same day effects could be omitted in the VAR system as S&P ASX200 open/close before SSE Composite, therefore the information from S&P ASX200's returns are likely to flow to SSE Composite during the same day. A noticeable finding is that the one-day lagged returns of Nikkei225 index did not significantly affect the current S&P ASX200 returns nor does lagged S&P ASX200 returns affect the current Nikkei225 returns. This result suggests that there is a lack of information transmission from the Japanese market to the Australian market.

The lagged returns of Nikkei225 index and Hang Seng index have a relatively stronger spillover effects on most of the markets across the region. It is also worth noting that there are significant bilateral interactions between Nikkei225, Hang Seng and SSE Composite returns, which suggest the existence of a higher level of interdependence between the three East Asian markets. The significant but mixed results from VAR analysis indicate that a more comprehensive examination of the relationships with VAR/AR analysis incorporating the same day effects need to be undertaken.

Table 3

Panel A: Parameter estimates of VAR(5) model of *close-to-close* returns.

Variable	NZ50	ASX200	Nikkei 225	SSEC	Hang Seng
NZ 50(-1)	0.019432	0.066497	0.123555	0.185806**	0.188247**
ASX 200(-1)	0.024188	-0.106402**	-0.026514	-0.042004	-0.045215
Nikkei 225(-1)	-0.041544**	-0.075392**	-0.189753**	-0.12915**	-0.060223
SSEC(-1)	-0.015965	-0.051224**	-0.083293**	-0.03691	-0.076251**
Hang Seng(-1)	0.09275**	0.145103**	0.199757**	0.161609**	0.018935

Panel B: Parameter estimates of VAR(5) model of *open-to-open* returns

Variable	NZ50	ASX200	Nikkei 225	SSEC	Hang Seng
NZ 50(-1)	-0.016647	0.057745	0.147788**	0.322118**	0.179152**
ASX 200(-1)	0.079868**	-0.125848**	-0.003066	-0.148316**	0.000867
Nikkei 225(-1)	0.020867	0.022824	-0.186734**	-0.055566	-0.121375**
SSEC(-1)	-0.011596	-0.068337**	-0.094672**	-0.133814**	-0.070513
Hang Seng(-1)	0.190043**	0.27335**	0.354676**	0.104656**	-0.043037**

*(**) denotes rejection significance at the 10 (5%) level

4.2 Estimating return spillover using *VAR/AR* model

Table 4 (panels A and B) reports the parameter estimates for all five indices and for both, close-to-close and open-to-open returns. Results of the VAR and AR analyses show strong evidence of same day effects. The results indicate that the current day returns of those markets that open/close earlier significantly affect the same day returns of those markets that open/close later in the day. Particularly, the VAR/AR analysis (reported in Table 4) supports the earlier VAR results (reported in Table 3) that one-day lagged returns of SSE Composite strongly affect the current day S&P ASX200 returns. The VAR/AR analysis further show that the current S&P ASX200 returns significantly affect the same day SSE Composite returns which open/close later in the day. These results confirm that there is a significant price spillover effect between the Australian and Chinese equity markets, thus indicating a strong interdependent relationship.

Our results for VAR/AR analysis provides evidence that a stock market is more strongly affected by the stock market(s) that open/close immediately before it during the day. The Japanese stock market show relatively strong strength in transmitting information across the region. A plausible reason could be that the Tokyo Stock Exchange is the second largest stock exchange in the world by market capitalisation (The Economic Times, 2010). Despite having strong same day effects, both the Japanese market and the Australian market show consistently weak spillover effects.

It can be concluded that information flows quickly from one market to another as they open/close during the day. Sampled markets across the Asia-Pacific basin region show strong evidence of information transmission through price spillover.

In summary, larger stock markets, such as the Japanese market and the Hong Kong market, are more influential than other markets. China and Australia show strong spillover effects bilaterally. The stock markets in the East Asian region in our sample also show strong interdependence as well.

Table 4 Panel A: VAR/AR model with exogenous variables for close-to-close returns

Parameters	NZ 50	ASX 200	Nikkei 225	SSEC	Hang Seng
Const.	0.0000698	0.0000873	-0.000343	0.000261	0.000386
AR1	0.017306			-0.007751	-0.091353**
AR2	0.006616			0.007327	0.008737
AR3	0.036696			0.06416**	-0.051055**
AR4	-0.011407			0.026936	-0.004248
AR5	0.006392			-0.023609	-0.037179**
NZ 50(t-1)					
ASX 200(t-1)	0.026565	-0.114608**	-0.020582		
Nikkei 225(t-1)	-0.042163**	-0.031513	-0.136138**		
SSEC(t-1)	-0.015557	-0.034348**	-0.06266**		
Hang Seng(t-1)	0.091497**	0.054759**	0.096383**	0.050944	
NZ 50		0.962308**	1.089374**	0.219924**	-0.027328
ASX 200				0.217814**	0.467229**
Nikkei 225				0.117046**	0.417695**
SSEC					0.220968**

Table 4 Panel B: VAR/AR model with exogenous variables for open-to-open returns

Parameters	NZ 50	ASX 200	Nikkei 225	SSEC	Hang Seng
Const.	0.0000255	0.000116	-0.000342	0.000364	0.000472
AR1	-0.017831			-0.09296**	-0.294756**
AR2	-0.000956			-0.007436	0.014125
AR3	0.040396			0.083353**	-0.027386
AR4	0.009752			0.059461	-0.046224**
AR5	0.011583			-0.007339	-0.041187**
NZ 50(t-1)					
ASX 200(t-1)	0.079533**	-0.14519**	0.017297		
Nikkei 225(t-1)	0.021241	0.017184	-0.182777**		
SSEC(t-1)	-0.011704	-0.061185**	-0.087536**		
Hang Seng(t-1)	0.190771**	0.158311**	0.242761**	-0.081193**	
NZ 50		0.562745**	0.489935**	-0.090604	-0.295917**
ASX 200				0.358233**	0.548677**
Nikkei 225				0.207117**	0.488076**
SSEC					0.25299**

*(**) denotes rejection significance at the 10 (5%) level

4.3 Volatility spillover using AR/GARCH model

Singh et al (2010) argue that volatility spillover is a better proxy for information transmission. Therefore, we use AR/GARCH model with partial effects and same day effects of indices (similar to Singh *et al* (2010)) to model the volatility spillover across the sampled indices. The results are reported in Table 5, panels A and B.

Results of AR/GARCH model show a strong evidence of volatility spillover across Asia-Pacific basin markets. Our results also provide stronger evidence compared to previous studies that stock markets are affected by the stock markets that open/close earlier during the day. In addition, our findings also provide support to the view that volatility spillover is indeed a better proxy for information transmission across different markets compared to the returns spillover, as we provide stronger results for information flows across markets as they open/close. Although our AR/GARCH analysis results do not show evidence of strong interdependence between Australian and Chinese markets that was reported earlier in Table 3, it does provide support for a relatively closer interdependence between the three East Asian markets. Notably, the residual term of the AR process on NZX50 returns is significant across GARCH models for all other four markets, suggest that as New Zealand is the first market to open/close, the information flows from New Zealand to other markets through volatility spillover.

Table 5
Panel A: Volatility spillover estimates of AR(1)-GARCH(1) model on Close-to-Close returns

	NZ 50	ASX 200	Nikkei 225	SSEC	Hang Seng
Intercept	0.000433**	0.000958**	0.00053	0.000722	0.001136**
AR1	0.107604**	-0.060086	-0.045612	0.016408	-0.04369
ARCH1	0.062411**	0.122602**	0.07071**	0.048052**	0.028519
GARCH1	0.808975**	0.594602**	0.85732**	0.929464**	0.146102**
NZ 50(t-1)					
ASX 200(t-1)	0.023105**		-0.017192		
Nikkei 225(t-1)	0.003546	0.009794			
SSEC(t-1)	0.002844**	0.001398	-0.00112		
Hang Seng(t-1)	0.002801	0.016176	0.006568	0.006402	
NZ 50		0.47684**	0.257074**	0.097091**	0.304005**
ASX 200				0.020091	0.528253**
Nikkei 225				-0.024234**	0.271709**
SSEC					0.060601**

Panel B: Volatility spillover estimates of AR(1)-GARCH(1) model on Open-to-Open returns

	NZ 50	ASX 200	Nikkei 225	SSEC	Hang Seng
Intercept	0.000447**	0.000824**	0.000292	0.000448	0.000905**
AR1	0.094745**	0.041457	0.032083	-0.079291**	-0.101222**
ARCH1	0.072562**	0.065324**	0.052604**	0.069456**	0.096381**
GARCH1	0.771188**	0.849935**	0.858415**	0.911909**	0.652047**
NZ 50(t-1)					
ASX 200(t-1)	0.023337**		0.009966		
Nikkei 225(t-1)	0.004786	-0.014182**			
SSEC(t-1)	0.00238**	-0.00048	-0.002555**		
Hang Seng(t-1)	0.009031**	0.016774**	0.018188**	0.001004	
NZ 50		0.104873**	0.113912**	0.10235**	0.015243
ASX 200				0.027876	0.272742**
Nikkei 225				-0.020177**	0.131054**
SSEC					0.032283**

*(**) denotes rejection significance at the 10 (5%) level

5. Conclusion

This study examines price and volatility spillover effects among five stock markets across the Asia-Pacific basin region over the period from May 2004 to August 2010, thus covering the period leading to, during, and after the recent global financial crisis. Our prime focus is on the emerging relationship between Australia and China given their strong economic ties that also increased the level of interdependency between their financial markets. Contemporaneous returns (or volatility) are used in the analysis for information spillover arising from the same day effects. We incorporate the same day effect by applying the AR/VAR model with exogenous variables. In addition, we also use AR/GARCH model with partial effects and same day effects to model the volatility spillover across the sampled indices. The data and the method employed make our study noble.

Our results for price spillover effects show that information flows quickly from one market to another market as they open/close during the day. The results provide strong evidence of information transmission through price spillover. We also found that larger stock markets are more influential than the smaller stock markets. In addition, China and Australia consistently show strong spillover effects bilaterally, which is a testimony to their close economic ties. The other East Asian markets within the sample (Japan, Hong Kong, and New Zealand) also show strong interdependence.

Our results also provide evidences of volatility spillover effects across the Asia-Pacific markets in the study. Our results show that markets are more affected by those markets that open/close earlier. Although our results regarding volatility spillover do not provide a strong evidence of interdependence between Australian and Chinese markets, our results do show that there is a closer interdependence between the other three East Asia markets which is consistent with that reported by Miyakoshi's (2003) that there are greater regional influences among Asian markets. Interestingly, the residual term of the AR process on New Zealand stock market returns is significant across GARCH models of all the other four markets. Given that New Zealand stock market is the first to open/close compared to the other four stock markets, it suggests that information flows from New Zealand to other stock markets through volatility spillover.

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