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Price and Volatility Spillover Effects in Selected Asia Pacific Stock Markets

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This paper examines price and volatility spillover across five major Asia Pacific stock markets with a particular interest in the spillover effects between Australia and China. Return spillover is modelled firstly with VAR(5) model, followed with the effects of same day returns on return spillover incorporated using AR/VAR model with exogenous variables. Finally volatility spillover is modelled using AR/GARCH model incorporating same day effects. The results of both return and volatility spillover confirm significant spillover effects across the markets and between Australia and China. A market is most affected by the markets that open/close just before it. The main contribution of this paper is the analysis and confirmation of spillover effects between markets in the region, particularly the interdependence between Australia and China which may have only recently evolved and thus received relatively little research.

Field of Research: Finance

Keywords: finance, volatility, spillover, investment, portfolio

1. Introduction

The past decade witnessed an increasing level of financial market integration, through liberalised capital movements, reforms of national financial systems, and in particular advances in computing and information technologies. Nowadays information transmits across global financial markets more freely than ever. As a result, the linkages between stock markets around the world have grown stronger. This trend is evident first in the developed markets, and increasingly in the emerging markets as well.

The study of market integration through analysing return and volatility spillover has important implications in the modern portfolio theory. Markowitz (1952) has shown that portfolio efficiency can be optimised by combining assets based on the correlation in their returns, and Grubel (1968) shows that portfolio efficiency can be improved with international diversification.

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Abundant empirical literature provides strong evidence of market interdependence and integration among developed markets and emerging markets (Bekaert & Harvey, 1997; Ng, 2000; Johansson & Ljungwall, 2008; Diebold & Yilmaz, 2009). Yet with some developing countries' growing economic ties with other parts of the world, it is reasonable to expect new interdependent relationships forming. One of the most noteworthy recent emerging trading relationships is between mainland China and Australia. With China's huge appetite for resources, its trading with Australia exploded (particularly on iron ore). Now China is the largest trading partner of Australia (Raby, 2010). However, there have been relative few timely studies on the interactions between Australian and Chinese equity markets, and across the western Asian-Pacific region where these two countries play crucial roles.

The purpose of this paper is to fill in this research gap by studying the price and volatility spillover between Australian and Chinese stock markets, and across other equity markets in the western Asian-Pacific region. In specific, five major markets in the region are included in the study, namely mainland China, Australia, Japan, Hong Kong, and New Zealand. In this paper, the return spillover is modelled using Vector Autoregression (VAR) that explains the simultaneous interactions between markets. In addition, I incorporate the same day effect of markets while modelling return spillover, by using a VAR/AR model. Same day effect means incorporating the effect of the markets that open on the same day but ahead of the other markets. For markets that open/close before the market under examination, the same day returns are used; for markets that open/close after the market under examination, the one day lagged returns are used. Finally, volatility spillover is estimated using a two-step AR/GARCH model as Liu and Pan (1997).

This paper contributes to the existing literature in several ways. Firstly, this paper specifically focuses on the important emerging relationship between Australia and China which has not been extensively studied. As the economic ties of the two countries develop, it is reasonable to expect an increasing interdependence between their financial markets. In addition, there have only been limited studies on information spillover that also incorporate the same day effect (Singh et al, 2010). Yet it has been argued that it is important to use contemporaneous returns (or volatility) when their opening and closing time are different (Kim, 2005). This paper incorporates same day effects by applying AR/VAR model with exogenous variables. Finally, the data of this study covers an extended period from 2004 to 2010, which covers the period leading to, during, and after the latest economic crisis. This extensive coverage lends credibility to the results of this analysis.

This paper is organised as follows. Firstly, I will present a brief review of literature on the study of return and volatility spillover 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 has direct implications in the portfolio theory. Despite the early works of Markowitz (1952) and Grubel (1968), both arguing that international diversification improves efficiency, there is evidence of a home bias puzzle that portfolios are found to be dominated by investments in one's proximity, and markets that are geographically and economically close tend to influence one another (Janakiramanan & Lamba, 1998). Johansson and Ljungwall (2009) argue that such integration, or co-movements, is a result of closer political and economic cooperation among countries. They found significant spillover effects among the equity markets of mainland China, Hong Kong, and Taiwan, following their growing economic ties over the past decades.

Much work has been done on the spillover effects in world financial markets. Liu and Pan (1997) studied the return and volatility spillover from US and Japanese equity markets to four Asian markets, and found the US markets more influential at transmitting information. In the European countries' context, there has been increased market integration among European countries following the introduction of Euro, with evidence of strong spillover effects (Melle, 2003; Savva *et al*, 2004).

Amongst Asian-Pacific markets, Ghosh *et al* (1999) found some stock markets co-move with the Japanese market, while some others with the US market. A more recent paper by Johnson and Soenen (2002) examined the degree of integration of 12 Asian-Pacific equity markets with Japan, and found that Australia, China, Hong Kong and New Zealand, among others, are highly integrated with the stock market in Japan. In addition, Alaganar and Bhar (2002) studied the information spillover between dually listed Australian stocks' trades in Australia and US, and found a unidirectional information flow from the US to Australia. Worthington and Higgs (2004) found evidence of return and volatility spillover across nine Asian stock markets.

Despite the extensive research in the field, relatively few researches have been conducted on mainland China's stock market, and fewer on its relationship with Australia. Yet with the emergence of important and close China-Australia economic relationship, a detailed study of their financial integration is warranted.

3. Data and Methodology

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 ASX 200	Australia	GMT + 10	10:00	16:00	0:00	6:00
NZX50	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
Nikkei 225	Japan	GMT + 9	9:00	15:00	0:00	6:00
SSE Composite	China	GMT + 8	9:30	15:00	1:30	7:00

This study uses the daily opening and closing prices of the primary stock indices of the five countries under examination. The stock indices and their home countries are presented in Table 1. Also presented are their trading hours in both local and GMT time, for the purpose of studying the same effects. As can be seen from the table (Trading-GMT column), New Zealand is the first market in the sample to open/close, followed by Australia and Japan which open/close simultaneously. Mainland China market and Hong Kong markets open/close later in the day. Thus Australia and Japan, with simultaneous open/close, 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.

The data included in this study covers a period from 6th May 2004 (06/05/2004) to 31st August 2010 (31/08/2010). Only days for which all indices have available data are taken for analysis, which results in a total of 1419 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 ratio of closing/opening price at day *t*, and price at day *t-1*. The descriptive statistics of the close-to-close and open-to-open returns are presented in Table 2a and Table 2b. All index open/close price data are obtained from *Yahoo Finance* website: www.finance.yahoo.com.

Table 2a:
Descriptive statistics of index closing-price returns

Index	Mean	Std Dev	Minimum	Maximum	Skewness	Kurtosis
ASX 200	0.0001823	0.0130478	-0.087043	0.090347	-0.418879	6.66595
NZX50	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
Nikkei 225	-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

Table 2b:
Descriptive statistics of index opening-price returns

Index	Mean	Std Dev	Minimum	Maximum	Skewness	Kurtosis
ASX 200	0.000188515	0.0112985	-0.054987	0.0599686	-0.149216	3.7913335
NZX50	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

As can be seen from the table, the Shanghai Composite and Hang Seng indices enjoy the highest mean returns over the sampled period, while the Australian and New Zealand indices performed relatively poorly. However, Shanghai Composite and Hang Seng indices also have the highest standard deviation, traditionally an indicator of risk. Australasian index returns show much more centralised distribution. The Japanese Nikkei 225 index has both high and low extremes in daily returns. On another parameter of return distribution, all indices show negative skewness in their open-to-open returns, and with the exception of Hang Seng index, in the close-to-close returns. Kurtosis appears more varied among the sampled indices. While most index returns appear leptokurtic (peaky), Shanghai Composite is platykurtic in both open-to-open and close-to-close returns, and ASX 200 index is platykurtic in its open-to-open returns.

Following Singh *et al* (2010), this paper uses a 3-step approach to analysing the price and volatility spillover across the markets. First of all, to examine the simultaneous interactions between markets, a Vector Autoregressive model (VAR) is employed. Second, a VAR/AR model is used to incorporate the same day effects of markets. Finally, volatility spillover is modelled using a two-step AR/GARCH model.

3.1 Price Spillover Using *VAR(5)* Model

Vector autoregression (VAR) is a popular econometric model used to capture the evolution and the interdependencies between multiple time series. Singh *et al* (2010) argued that when studying multiple markets, any spillover effect between two markets should be examined with partial effects of other markets considered. Since new information (shocks) is likely to affect all the indices in a similar way, significant correlations estimated by *bi-variate* VAR can show misleadingly significant spillover that actually originate from other markets. For example, New Zealand market which opens earliest in our sample may affect both Japan and Australia, and then a *bi-variate* VAR of China and Australia or Japan may show significant cross-correlations while the effects actually originate from New Zealand. Thus a VAR(5) model incorporating all five markets are used to consider the dynamic relationship between all five markets. The VAR(5) model of index returns is as follows:

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

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

The results of VAR analysis on close-to-close and open-to-open returns are presented in Table 3a and Table 3b.

3.2. Price Spillover Using *VAR/AR* Model

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

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

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

where $r_t = (r_{1t}, r_{2t},\ldots r_{jt})'$, (*1,…j*) are indices that open simultaneously and treated as endogenous variables. *k* is the number of indices that open/close before the (*1,…j*) indices; *l* is the number of indices that open/close after the (*1,…j*) indices.

For markets that do not open/close simultaneously with any other market, I 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 *i*th index and *l* is the number of indices that open/close after the *i*th index. The VAR/AR models are applied to estimate the parameters using both close-to-close returns and open-to-open returns. The results are presented in Table 4a and Table 4b.

3.3. Volatility Spillover Using *AR/GARCH* Model

Though it is often argued that information flow across markets through return correlations, volatility has been widely regarded as a better proxy of information (see Clark, 1973; Ross, 1989, etc). To model volatility spillover across the five markets under examination, this study applies the Generalised Autoregressive Conditional Heterokedasticity (GARCH) by Bollerslev (1982). A generalised AR/GARCH model is set out 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 into the GARCH equation of the index under examination. So the AR/GARCH equation used in this study is:

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

where $\varepsilon_{jt} | \psi_{jt-1} \sim N(0, \sigma^2_{jt-1})$ and

$$\sigma^2_{jt} = \alpha_0 + \alpha_{j1} \varepsilon^2_{t-1} + \beta_{j1} \sigma^2_{jt-1} + \sum_1^k \chi_{kt} \varepsilon^2_{kt} + \sum_1^l \chi_{it} \varepsilon^2_{it-1}$$

where $\alpha_0 > 0$, $\alpha_{j1}, \beta_{j1} \geq 0$, $\alpha_{j1} + \beta_{j1} \leq 1$, *k* is the number of indices that open/close before the *j*th index, *l* is the number of indices that open/close after the *j*th index. For example, when modelling SSE Composite (China) volatility, I incorporate the same day residuals of NZX 50, S&P ASX 200, and Nikkei 200 (which open/close before SSE Composite), and one-day lagged residuals of Hang Seng index (the Hong Kong index open/close after SSE Composite) in the GARCH model. The results of AR/GARCH analysis are presented in tables 5a and 5b.

4. Findings and Discussions

4.1 Estimating Return Spillover Using *VAR* Model

The results of *VAR* analysis, as explained in Section 5.1, are presented here. Before the application of VAR model, it is required that the time-series be checked for stationarity (Watson, 1994). We conducted two well known tests on cointegrating relationships between the ten index returns (5 open-to-open return series and 5 close-to-close return series): Johansen's (1988) rank test, and Engle and Granger (1987) test. Due to the limited scope of this paper, the results of the cointegration tests are not presented in tables. Though Johansen's (1991) rank test detects some cointegrating relationships, a closer examination of the return series (a pair at a time) using the Engle and Granger (1987) test reveal no cointegrating relationships. Thus, we find it safe to proceed with the VAR analysis. In addition, following Singh *et al* (2010), lag lengths in the VAR system is determined by Akaike Information Criterion (AIC), to be 1 in this study.

Table 5a and 5b presents the results of VAR analysis on close-to-close and open-to-open returns of the five indices under examination. As can be seen, on a 5% significant level, the one-day lagged return of SSE Composite index (China) significantly affects the current stock return of ASX 200 index (Australia). But the one-day lagged returns of ASX200 do not show significant spillover effects on returns of the SSE Composite. The result suggests that information incorporated in the SSE Composite returns affects the next day returns of ASX200 index but not vice versa. This can be interpreted as either due to underlying economic reality (greater dependency of Australia on the Chinese market, but not vice versa), or the same day effects being omitted in the VAR system (as ASX open/close before SSE, information from ASX returns likely flows to SSE during the same day). Also noticeable is the finding that one-day lagged returns of Nikkei225 index do not significantly affect the current ASX 200 returns, nor do lagged ASX 200 returns affect current Nikkei 225 returns. This result shows a lack of information transmission from the Japanese market to the Australian market.

The lagged returns of Nikkei 225 index and Hang Seng index seem to have relatively strong spillover effects on most of the markets across the region. Also noteworthy is the significant bilateral interactions between Nikkei 225, Hang Seng, and SSE Composite returns, indicating a high level of interdependence between the three East Asian markets.

The significant but mixed results from VAR analysis warrant more comprehensive examination of the relationships with VAR/AR analysis incorporating the same day effects.

Table 3a:
Parameter estimates of VAR(5) model of *close-to-close* returns.

Variable	NZX50	ASX200	Nikkei 225	SSEC	Hang Seng
NZX 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

Table 3b:
Parameter estimates of VAR(5) model of *open-to-open* returns

Variable	NZX50	ASX200	Nikkei 225	SSEC	Hang Seng
NZX 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**

4.2 Estimating Return Spillover Using *VAR/AR* Model

This section presents the findings of VAR/AR analysis incorporating the same day effects. The parameters are estimated for all 5 indices and for both close-to-close and open-to-open returns, as shown in Table 4a and 4b.

Results of the VAR and AR analyses show strong evidence of same day effects, in 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, VAR/AR analysis supports the earlier VAR results that one-day lagged returns of SSE Composite strongly affects the current day ASX 200 returns. The VAR/AR analysis further shows that the current ASX 200 returns significantly affects the same day SSE Composite returns which open/close later during the day. This result confirms significant price spillover between Australia and Chinese equity markets, indicating a strong interdependent relationship.

VAR/AR analysis provides evidence that markets are most strongly affected by the markets that open/close immediately before them during the day, though the

Japanese stock market show relatively strong strengths in transmitting information across the region. This may be due to the position of the Tokyo Stock Exchange in the financial world, as the second largest stock exchange in the world by market capitalisation (The Economic Times, 2010). However, despite incorporating the same day effect into the analysis, the Japanese market and the Australian market show consistent weak spillover effects as found in the VAR analysis.

It can be concluded from the above two analysis on price spillover that information flows quickly from one market to another as they open/close during the day. Sampled markets across the western Asian-Pacific region show strong evidence of information transmission through price spillover. Larger stock markets, such as the Japan market and the Hong Kong market, are more influential than other markets. China and Australia show consistent strong spillover effects bilaterally, perhaps a testimony to their close economic ties. East Asia markets within the sample also show strong interdependence

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

Parameters	NZX 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**
NZX 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	
NZX 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 4b:
VAR/AR model with exogenous variables for open-to-open returns

Parameters	NZX 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**
NZX 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**	
NZX 50		0.562745**	0.489935**	-0.090604	-0.295917**
ASX 200				0.358233**	0.548677**
Nikkei 225				0.207117**	0.488076**
SSEC					0.25299**

4.3 Volatility Spillover Using AR/GARCH Model

Volatility spillover has been argued by many to be a better proxy of information transmission. I use an AR/GARCH model with partial effects and same day effects of indices as suggested by Singh *et al* (2010) to model the volatility spillover across the sampled indices. The results are presented in Table 5a and 5b.

The results of AR/GARCH model show strong evidence of volatility spillover across western Asian-Pacific markets. The results also provide stronger evidence than in previous analysis that markets are more affected by the markets that open/close earlier during the day. If volatility spillover is indeed a better proxy than return spillover for information, this result further supports the point that information flows across markets as they open/close.

The AR/GARCH analysis does not show evidence of strong interdependence between Australian and Chinese markets found earlier, though the result further supports the relatively closer interdependence between the three East Asia markets. Notably, the residual term of the AR process on NZX 50 returns is significant across

GARCH models of all other four markets. This suggests that as the first market to open/close, information flows from New Zealand to other markets through volatility spillover.

Table 5a:
Volatility spillover estimates of AR(1)-GARCH(1) model on *close-to-close* returns

	NZX 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**
NZX 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	
NZX 50		0.47684**	0.257074**	0.097091**	0.304005**
ASX 200				0.020091	0.528253**
Nikkei 225				-0.024234**	0.271709**
SSEC					0.060601**

Table 5b:
Volatility spillover estimates of AR(1)-GARCH(1) model on *open-to-open* returns

	NZX 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**
NZX 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	
NZX 50		0.104873**	0.113912**	0.10235**	0.015243
ASX 200				0.027876	0.272742**
Nikkei 225				-0.020177**	0.131054**
SSEC					0.032283**

5. Conclusions

This paper analyses the price and volatility spillover among five stock markets across the western Asian-Pacific region over the period from 6th may 2004 to 31st August 2010. This paper contributes to the literature by analysing the integration and interdependence between Australian and Chinese stock markets, and markets across the wider western Asian-Pacific region. This paper finds strong spillover effects across the sampled stock markets in the region, particularly between Australia and China, with their growing economic ties. This paper also finds a close relationship between the three East Asian markets, consistent with Miyakoshi's (2003) finding of greater regional influence among Asian markets.

This study has important implications. The close relationships between Australian and Chinese stock markets, and between markets of the Eastern Asian countries, are confirmed. The results show that market participants should pay close attention to the co-movements of the markets of the Asian Pacific region. Particularly, the results show that with the growing economic ties between Australia and China, now the equity markets of both economies are strongly interconnected. Market participants of the two countries now should pay more attention to each other.

In addition to the results, this study can be further expanded in a number of ways. First of all, this study only confirms the strong relationships between sampled markets, but does not uncover how the relationships evolve over time. It can be very meaningful if the evolution of the relationships can be described. This study can also be extended by employing high frequency data of the indices into the analysis, which should provide a finer picture of the price and volatility spillover. In addition, this study analyses overall indices, and more detailed analysis into sectors may provide better insights into which sectors/industries are more closely related to among markets.

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