

# Linkages between the Korea and Asia-Pacific stock markets

Yang Gyu Shin<sup>1</sup>

<sup>1</sup>Department of Asset Management, Daegu Haany University

Received 16 October 2010, revised 3 November 2010, accepted 8 November 2010

## Abstract

The paper investigates linkages between the Korea stock market and each of the major Asia-Pacific stock markets, namely those of the Japan, China, Australia, New-Zealand. We employ the Johansen technique to test for pairwise cointegration between the Korea stock market and each of the major Asia-Pacific stock markets. The major stock indices of the markets are used, from 1 September 2006 to 31 August 2010. The results from the test implies that the Korea market is not cointegrated with any of the major Asia-Pacific markets during the period. Our study implies that there are no long-run linkages between the Korea and any of the major Asia-Pacific stock markets.

*Keywords:* Asia-Pacific stock market, cointegration, johanson technique, stock index.

## 1. Introduction

The Asia-Pacific stock markets have recently received great attention, especially after the financial market crisis in 1997-1998. The market microstructure of Asia-Pacific stock exchanges are reported in Comerton-Forde and Rydger (2006). Chua and Mitchell (2002) found the influence of cultural factors on price clustering from Asia-Pacific stock markets. The issue of linkages among these national stock markets has attracted significant attention. Hung and Chung (1995) studied the interdependence of five major Asian emerging equity markets. Choi (2006) examined the correlation for some East Asia equity markets using daily return series from 1991 to 2005. An empirical studies have conducted in Korea stock market (Choi *et al.*, 2007; Shin, 2006; Shin, 2008; Shin, 2009). Especially, Shin (2009) found the causality of Fluctuation exchange rate and interest rate in the Korea market under global economic crisis.

Interrelations and linkages among the stock markets are studied by estimation and testing for the presence and number of cointegrating vectors. Cointegration relationships allow for the description of stable long-run stationary relationships among integrated variables, and are defined as linear combinations of these non-stationary variables achieving stationarity. When a meaningful interpretation can be attached to this linear combination, it implies that the series do not drift apart and moving together by some long-run equilibrium relationship.

---

<sup>1</sup> Professor, Department of Asset Management, Daegu Haany University, Gyeongsan 712-715, Korea.  
E-mail: yks@dhu.ac.kr

Numerous empirical studies have employed cointegration techniques to explore international stock market linkages. From the first work by Engle and Granger (1987) and including more recent works such as Copeland (1991), Kanas (1998), Syriopoulos (2004) and D'Ecclesia and Costantini (2006), cointegration test is a powerful technique for investigating independence and common trends among international stock markets.

The objective of this paper is to provide evidence on the linkages between the Korea and Asia-Pacific stock markets. We focus on the five major Asia-Pacific stock markets, namely the Korea, Japan, China, Australia and the New Zealand, and investigate the linkages between the Korea and each of these Asia-Pacific markets using pairwise cointegration test. To test for cointegration, we use the Johansen technique (Johansen, 1988). The Johansen technique is preferred to the Dickey-Fuller cointegration test (Engle and Granger, 1987), because of their higher power in comparison to the Dickey-Fuller cointegration test and their property of invariance to different normalizations of the cointegrating regression. The results from the test represent that there are no long-run linkages between the Korean and any of the major Asia-Pacific markets. It implies that the Korea stock market does not exhibit any tendency to move together with any of major Asia-Pacific markets.

The rest of the paper organized as follows. Section 2 provides a description of the data and the applied methodology. Section 3 presents the results from the cointegration tests and discusses the findings. Finally, section 4 provides conclusions.

## 2. Data and methodology

### 2.1. Data

The Asia-Pacific stock markets included in our study are Australia, China (Hong Kong), Japan, Korea, and New Zealand which have a huge growth in the region with a strong track record. We use daily closing values for the stock indices: the All ords for Australia; the Hang Seng Index for Hong Kong; the NIKKEI 225 for Japan; the KOSPI for Korea; the NZ50 for New Zealand. The period under examination extends from 1 September 2006 to 31 August 2010. The data used for the tests are taken from the Informax. The indices are expressed in natural logarithms.

### 2.2. Methodology

We consider the pairwise cointegrating regression

$$y_t = a + bx_t + z_t$$

where  $z_t$  is the residual series of the cointegrating regression, and  $y_t$  and  $x_t$  are the two variables to be tested for integration. The multivariate technique for cointegration and vector error correction are developed by Johansen (1988). Our technique is based on the vector autoregressive (VAR) system of  $n \times 1$  vector of I (1) variables  $X_t$  :

$$X_t = \mu + \Gamma_1 X_{t-1} + \cdots + \Gamma_p X_{t-p} + \epsilon_t$$

where  $\Gamma_1, \cdots, \Gamma_p$  are  $n \times n$  matrices of coefficients,  $p$  is the lag length, and  $\epsilon_t$  is assumed to be an i.i.d Gaussian process. Utilizing maximum likelihood estimation, Johansen developed

two statistics to test for the null hypothesis of no cointegration:

$$\lambda_{trace}(r) = -N \sum_{i=r+1}^n \ln(1 - \lambda_i)$$

$$\lambda_{LR}(r, r + 1) = -N \ln(1 - \lambda_{r+1})$$

where  $N$  is the sample size,  $r$  is the number of distinct cointegrating vectors, and  $\lambda_1, \dots, \lambda_n$  are the  $n$  squared canonical correlations between the  $X_{t-p}$  and  $\Delta X_t$  series, which arranged in descending order, so that  $\lambda_i > \lambda_j$  for  $i > j$ . These statistics are called Johansen's Trace Statistic and Johansen's Likelihood Ratio Statistic. This method is invariant to different normalizations (Wei, 2006).

### 3. Empirical results

#### 3.1. Unit roots tests

Prior to testing for cointegration, unit root tests are performed for each of the national stock indices involved in order to determine the order of integration of each of these indices. The Augmented Dickey-Fuller (ADF) test with a deterministic trend was used, and performed on both the levels and first differences of the equity indices. The statistics,  $\tau_t$ , are based on the Dickey-Fuller regression

$$\Delta x_t = c_0 + c_1 t + c_2 x_{t-1} + w_t$$

where  $t$  denotes the time trend,  $x_t$  denotes the stock market index,  $\Delta$  denotes the first differences of series  $x_t$ , and  $w_t$  is the white noise error term. If the error term is not a white noise, lags of  $\Delta x_t$  were added to the above regression. The results of the ADF test are presented in Table 3.1.

**Table 3.1** Unit Root Tests

levels					
	Korea	Japan	Hong-Kong	Australia	New-Zealand
lag	0	1	1	0	0
$\tau_t$	-2.47	-1.67	-1.83	-1.45	-1.27
differences					
	Korea	Japan	Hong-Kong	Australia	New-Zealand
lag	0	1	1	0	0
$\tau_t$	-38.62	-42.54	-35.36	-45.32	-35.58

notes) The critical value at the 5% level is -3.41 (Wei, 2006, p593, Table G)

Each stock index is non-stationary in levels and stationary in first differences, suggesting that the stock indices are individually integrated of order 1,  $I(1)$ .

#### 3.2. Cointegration test

On the basis of the result presented in Table 3.1, we proceed to test whether the Korean stock market is pairwise cointegrated with each of the stock market in the Japan, Hong Kong, Australia and the New Zealand. Table 3.2 reports the results of tests of the stock

indices for the period by EViews 6. EViews 6 implements VAR-based cointegration tests using the methodology developed in Johanson. The lag length for each VAR is established by likelihood ratio tests of alternative lag lengths. We started with an upper limit of 25 lags, and then we chose 20 for Korea-Japan and Korea-Hong Kong, and 25 for Korea-Australia and Korea-New Zealand. The number of cointegrating vectors is denoted by  $r$ .

**Table 3.2** Cointegration Tests

$H_0$	$H_A$	5% Critical value	Korea -Japan	Korea -Hong Kong	Korea -Australia	Korea -New Zealand
LR statistic						
$r = 0$	$r = 1$	14.50	11.65	12.74	10.73	5.87
$r \leq 1$	$r = 2$	8.08	0.65	2.36	1.10	0.56
Trace statistic						
$r = 0$	$r \geq 1$	17.97	11.66	12.82	10.78	5.90
$r \leq 1$	$r \geq 2$	8.08	0.65	2.36	1.10	0.56

notes) Critical values are from Wei, 2006, pp440-441, Table 17.2, 17.3.

For the period, in all cases the values of both statistics are below the corresponding critical values, suggesting that the null hypothesis of no cointegration can not be rejected in any case. From the result, we can suggest that the Korea stock market is not pairwise cointegrated with any of the major Asia-Pacific stock markets during period.

#### 4. Conclusion

The linkages between the Korea and the four major Asia-Pacific stock markets, those of the Japan, Hong Kong, Australia and the New Zealand has been examined using cointegration methods. The period under examination extends from 1 september 2006 to 31 August 2010. From the analysis, it is found that the Korean stock index, KOSPI, is not pairwise cointegrated with NIKKEI 225, Hang Seng Index, All ords, and NZ50. The result implies that there are no long-run linkages between the Korea and the major Asia-Pacific stock markets. The finding of no linkages between these stock markets can be interpreted from a portfolio diversification perspective. Therefore, this result can be valuable to investors and financial institutions holding long-run investment portfolios.

#### 5. Acknowledgements

This paper was written while the author was visiting the Waikato University in New Zealand. I would like to thanks Professor Stuart Locke, Chairperson, Department of Finance.

#### References

- Angelos Kanas (1998). Linkages between the us and european equity markets: Further evidence from cointegration tests. *Applied Financial Economics*, **8**, 607-614.
- Bill Wan-Sing and Yan-Leung Cheung (1995). Interdependence of asian emerging equity markets. *Journal of Business Finance & Accounting*, **22**, 281-288.
- Carole Comerton-Forde and james Rydge (2006). The current state of Asia-Pacific stock exchanges: A critical review of market design. *Pacific-Basin Financial Journal*, **14**, 1-32.

- Choi M. S., Hwang S. Y. and Park J. A. (2007). Analysis of multivariate financial time series using cointegration: Case Study. *Journal of Korean Data & Information Science Society*, **18**, 73-80.
- Choi Wan-Soo (2006). Dynamic nature of conditional correlation in East-Asia equity market. *Korean Journal of Finance*, **19**, 155-187.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and control*, **12**, 231-254.
- Laurence S. Copeland (1991). Cointegration tests with daily exchange rate data. *Oxford Bulletin of Economics and Statistics*, **53**, 185-198.
- Philip Brown, Angeline Chua and Jason Mitchell (2002). The influence of cultural factors on price clustering: Evidence from Asia-Pacific stock markets. *Pacific-Basin Financial Journal*, **10**, 307-332.
- Rita L. D'Ecclesia and Mauro Costantini (2006). Comovements and correlations in International stock markets. *The European Journal of Finance*, **12**, 567-582.
- Robert F. Engle and C. W. J. Granger (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica*, **55**, 251-276.
- Shin Y. K. (2006). An empirical study on stock trading value of each investor type in the Korean stock market. *Journal of Korean Data & Information Science Society*, **17**, 1099-1106.
- Shin Y. K. (2008). Empirical analysis on profit and stability of Korean reverse convertible funds. *Journal of Korean Data & Information Science Society*, **19**, 1073-1080.
- Shin Y. K. (2009). Study on the causality between call rate and exchange rate under global economic crisis. *Journal of Korean Data & Information Science Society*, **20**, 655-660.
- William W. S. Wei (2006). *Time series analysis: Univariate and multivariate method*, Pearson Addison Wesley, New York.