



ASSESSING FINANCIAL MARKET INTEGRATION IN ASIA – EQUITY MARKETS

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Abstract

Financial integration has strong implications for financial stability. On the one hand, financial integration among economies helps improve their capacity to absorb shocks and foster development. On the other hand, intensified financial linkages in a world of increasing capital mobility may also harbour the risk of cross-border financial contagion. This paper provides a survey of indicators to monitor the development, measure progress and assess the state of equity market integration in Asia. A combined use of these indicators would provide information on different dimensions of integration and thus give regulators a more balanced picture of the general trend of equity market integration in the region. Our empirical results broadly show that a lot of progress has been witnessed between 1994 and 2001 in achieving greater integration among the Asian equity markets. However, the extent of financial integration remains weak and the integration process appears to have stalled since 2002.

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Executive Summary:

- *This study proposes several model-based market integration indicators to assess and monitor the direction of equity market integration among ten economies in Asia: Japan, the Mainland, Hong Kong, Taiwan, Korea, Singapore, Malaysia, Thailand, Indonesia, and the Philippines. These indicators give a timely assessment of the extent of integration.*
- *The indicators show that the equity markets in Asia are weakly integrated. The degree of equity market integration is larger between the mature markets like Japan, Hong Kong, Singapore and Korea than between those in the Asian emerging economies. The equity markets on the Mainland are not well integrated with the other markets in the region.*
- *The results show that the integration process is not complete even if a substantial amount of progress did take place during the 1990s. The indicators suggest that equity market integration has not made any significant improvement since 2002.*
- *Regional and global factors are equally important for Asian equity markets as a whole. Except Japan, the Philippines and the Mainland, all other Asian equity markets show greater integration within the region in terms of their slightly higher sensitivity to the regional factor.*
- *The apparent lack of momentum and different degrees of financial integration since 2002 warrant continuous monitoring. They also pose a challenge to policymakers in removing obstacles and demonstrating stronger political will in achieving financial integration through a co-ordinated strategy for promoting the stability and efficiency of financial intermediation across jurisdictions in the region.*

I. INTRODUCTION

Nine years after the Asian financial crisis of 1997-1998 that devastated the Asian financial markets and economies, several regional initiatives, including the Chiang Mai Initiative and the Asian Bond Markets Initiative, have been put in place to strengthen the financial cooperation and integration in the region.² Globalisation has made Asia a more integrated region through increase in cross-border trades and economic activities in the 1990s. These strong intra-regional economic links have resulted in an increase in cross-border financial activities. Despite recent developments in financial markets in the region, the degree of intra-regional financial integration appears to lag behind the increase in trade.³ Such asymmetric development in economic and financial integration may impact on financial stability in the region.

The issue of financial integration has strong implications on financial stability. On the one hand, financial integration would benefit the region through more efficient allocation of capital, a higher degree of risk diversification, a lower probability of asymmetric shocks and a more robust market framework (Pauer (2005)). These effects would help improve the capacity of the economies to absorb shocks and foster development. On the other hand, intensified financial linkages in a world of high capital mobility may also harbour the risk of cross-border financial contagion, in particular when the region's economies become more inter-dependent. In other words, financial instability in one country could be transmitted to neighbouring countries more rapidly. Against this background, it is essential to have appropriate measures to monitor the development and assess the progress of financial integration in the region.⁴

This study provides a survey of indicators and measures to monitor the development, measure progress and assess the state of equity market integration in the region. In particular, the study attempts to address the following questions:

- To what extent are the equity markets in the region integrated?
- What is the evolution and the current level of equity market integration? Is it progressing, at a standstill, or even regressing?
- What is the relative importance of regional (within Asia) vs. global (mainly the US) factors in intra-regional equity market integration?

² In addition to these initiatives, ideas of an Asian Currency Basket and Asian Currency Union for intra-regional exchange rate stability have been proposed as the mid- and long-term policy objective for the region (Institute for International Monetary Affairs (2006)).

³ See Danareksa Research Institute (2004).

⁴ The informative value of these integration measures or indicators is highlighted by the publications from the European Central Bank (ECB) and the European Commission (EC) as an on-going effort to monitor the degree of financial integration in the Euro area. See ECB (2005) and EC (2005).

In addition to the banking system and the relatively less-developed bond market, the equity market is a major alternative channel of corporate financing in the region. Policymakers are interested in equity market integration because shocks that impact on one equity market may potentially spread to others more rapidly when the markets are more integrated.

For the purpose of assessing and monitoring the progress of equity market integration in the region, the indicators in this study are mostly of high frequency and permit an assessment of the dynamic evolution of equity market integration.⁵ As other measures in the literature, they vary in the scope and focus. For example, the equity return dispersion uses the idea of price convergence to assess integration, whereas the common component approach measures the degree to which excess equity returns in one market are affected by common factors in the region as opposed to idiosyncratic shocks. A combined use of these indicators provides information on different dimensions of integration and thus gives regulators a more balanced picture regarding the general trend of equity market integration in Asia. Having said that, the empirical results from these indicators should be interpreted with caution as all these indicators are statistical or model-based measures and they are subject to technical limitations and modelling assumptions. For monitoring purposes these indicators should, if possible, be supplemented by other integration measures such as the size of capital flows or cross-border holdings of financial assets.⁶

The remainder of this paper is organised as follows. In Section II we provide a brief review on the current issues related to financial integration in Asia and the traditional approaches of assessing the degree of financial integration. The various indicators used in this study are also presented. Data used in the study and some preliminary analyses of the data series are discussed in Section III. The estimation results from the integration indicators are presented and their behaviours are examined in Section IV. Section V provides a summary and discussion.

⁵ Traditional measures of financial market integration such as the savings-investment correlation proposed by Feldstein and Horioka (1980) are not suitable for continuous monitoring on a regular basis.

⁶ These alternative measures may not be as timely and frequent as the indicators proposed in this paper.

II. RECENT STUDIES ON FINANCIAL INTEGRATION AND THEIR MEASURES

The issue of financial market integration in Asia has been examined extensively in the literature using different measures and methodologies. Nonetheless, the degree of financial integration in Asia remains a matter of vigorous debate.

For example, Danareksa Research Institute (2004) finds that financial integration in the region is still far behind that in Europe prior to its unification in the 1990s. Using the size of cross-border assets such as securities and bank claims to estimate the gravity model of bilateral financial asset holdings and the consumption risk sharing model, Kim et al. (2006) conclude that the East Asian financial markets are relatively less integrated with each other than to the global market. They argue that the low financial integration within East Asia is attributed to the low incentives for portfolio diversification within the region, the low degree of development and deregulation of the financial markets, and the instability in the monetary and exchange rate regimes.

On the other hand, Jeon et al. (2006) find that the degree of financial integration in East Asia has increased recently, but it is due to the integration with the global market rather than regional counterparts. Based on the data of intra-regional foreign direct investment (FDI), Kawai (2005) notes that the rise in Asian newly industrialised economies' investment contributes to the integration of the East Asian economies through FDI and FDI-driven trade. Using data from the international bond market and the international syndicated loan market, McCauley et al. (2002) show that East Asian investors and banks have on average allocated half of the funds in bonds underwritten and loans syndicated to borrowers in East Asia. Based on this measure, they assert that the financial markets of East Asia are more integrated than is often suggested.

There is, in general, no universal definition of financial integration. Financial openness, free movement of capital and integration of financial services are part of a broad range of definition frequently cited in literature.⁷ One commonly used definition of financial integration is that financial markets are said to be integrated when the law of one price holds. This implies that assets generating identical cash flows should command the same return, regardless of the domicile of the issuers and the asset holders. Discrepancies in prices or returns on identical (or comparable) assets would tend to be used as evidence to support that financial markets are not integrated. In the literature, there are largely two broad categories of financial integration measures,

⁷ In some studies, regulatory and institutional factors such as the relaxation of capital controls, financial liberalisation, prudential regulations, efficiency of the legal systems and the standardisation of market framework are also cited as measures of financial integration. These measures, however, are less popular than the price- and the quantity-based ones in a regular monitoring framework as they are not available in a timely manner.

price-based measures and quantity-based measures.⁸

a. Price-based measures

Price- or return-based measures of financial integration seek to equate rates of returns of comparable assets across different economies. Most research studies rely on interest rate parity condition, including covered interest rate parity (CIP), uncovered interest rate parity (UIP) and real interest rate parity (RIP), to test for the degree of financial market integration. Yield differentials, co-movement of financial asset returns and return dispersion measures are also used.

b. Quantity-based measures

The traditional quantity-based measure considers the savings-investment correlation such as the Feldstein and Horioka (1980) test of capital mobility. Feldstein and Horioka argue that, with perfect capital mobility, there should be no relation between domestic savings and investment, i.e. if financial markets are well integrated, the correlation between investment and savings should be low.⁹ The net capital flow, which captures cross-border transaction in financial assets, is another measure to assess financial market integration.¹⁰

For monitoring purposes, it is desirable for regulators to have indicators, such as the price-based ones, that are frequently available. In this study, we make use of high frequency data to construct various indicators for measuring different dimensions of equity market integration in Asia. Many of these indicators are model-based and provide high frequency measures for regular monitoring purposes. Some of them are already adopted by the European Central Bank (see ECB (2005)) while the other indicators make use of the recent advances in the literature to measure the time-varying degree of integration. Detailed discussions on the methodologies of constructing these indicators and their interpretation are presented in the Appendix.

⁸ For a survey of the literatures and various indicators, see Adam et al. (2002), Dennis and Yusof (2003), Cavoli et al. (2004) and Baele et al. (2004).

⁹ The Feldstein and Horioka capital mobility test is based on the following cross-country regression equation:

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta \left(\frac{S}{Y}\right)_i$$

where I is investments in country i , Y is the gross domestic product of country i , and S is savings in country i . Theoretically, a very small β coefficient indicates perfect capital mobility. On the other hand, in a closed economy with little capital mobility, the β coefficient will be high and close to one.

¹⁰ See Vo (2005) for a review of the quantity-based integration concept.

It is worth recalling that financial market integration has different dimensions and its definition varies depending on the focus of the study. This paper attempts to give an assessment of equity market integration in different dimensions through the use of various price-based indicators. Some of the indicators look into price convergence; others pay attention to the sensitivity, co-movement, return correlation and cycle synchronisation as evidences of integration. It is, therefore, not surprising to have different results regarding the extent and the speed of equity market integration from these indicators, especially during some sub-sample periods in this study. Given that the construction of these indicators is subject to technical limitations and modelling assumptions, these indicators should be interpreted with caution and taken as indicative but not conclusive evidences on the general trend of the integration process. Table 1 below summarises the integration measures in the study.

Table 1. Summary of Integration Measures for Equity Markets

Method	Indicator	Indication of market integration
1. Cross-market return dispersion	Hodrick-Prescott filtered standard deviation of equity returns and 12-month moving average of maximum-minimum return differential	Falling return dispersion and smaller return differential imply higher return convergence
2. Haldane and Hall (1991) Kalman filter method	Time-varying β estimated via Kalman filter	Average β moving towards zero indicates an increasing sensitivity to regional influence
3. Dynamic cointegration analysis	Rolling estimates of the standardised trace statistics	Standardised trace statistics consistently greater than one and on an upward trend indicate the presence of a long-run relationship between equity markets
4. Common component approach	R-square values from rolling OLS regression estimations	Larger R-square values suggest higher market integration
5. Market cycle synchronisation	Rolling concordance index (<i>RCI</i>)	An upward trend in the <i>RCI</i> signals increasing market concordance
6. Dynamic conditional correlation (DCC) model	Time-varying correlation estimated from the DCC model	The higher the time-varying correlation, the larger the co-movement between markets

III. THE DATA AND THEIR TIME SERIES PROPERTIES

Ten economies in the Asian region are covered in this study, namely Japan, the Mainland, Hong Kong, Taiwan, Korea, Singapore, Malaysia, Thailand, Indonesia, and the Philippines. In addition to the aggregate indicator for all these economies, indicators for regional blocs are also constructed. These regional blocs include:

- i. Greater China region: the Mainland, Hong Kong and Taiwan¹¹
- ii. Four-dragon bloc: Hong Kong, Taiwan, Korea and Singapore¹²
- iii. Asian emerging region: Malaysia, Thailand, Indonesia and the Philippines

Table 2 highlights the benchmark equity indices of these economies. The Dow Jones Industrial Average of the US is used as a proxy for the external market, and the MSCI AC Far East Free Index as the regional benchmark.¹³ Data from 16 March 1994 to 6 July 2006 are used in the estimation.¹⁴

Table 2. Benchmark Equity Indices

Equity market	Benchmark index
Asia	
Japan	Nikkei 225 Stock Average
The Mainland	Shanghai A and Shenzhen A
Hong Kong	Hang Seng Index (HSI), Hang Seng China Enterprises Index (H-share)
Taiwan	TSE Composite Index
Korea	KSE Composite Index
Singapore	Straits Times Index
Malaysia	KLSE Composite Index
Thailand	SET Index
Indonesia	JSX Composite Index
The Philippines	PSE Index
World influence	
US	Dow Jones Industrial Average
Regional influence	
MSCI Far East	MSCI AC Far East Free Index

Sources: Bloomberg, CEIC and Datastream.

¹¹ For Hong Kong, the Hang Seng China Enterprises Index (H-share) is included as one of the equity markets in the greater China region along with the benchmark Hang Seng Index.

¹² For Hong Kong, only the benchmark Hang Seng Index is included in the four-dragon bloc.

¹³ The MSCI AC Far East Free Index is a free float-adjusted market capitalisation weighted index consisting of the following ten country indices: the Mainland, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand.

¹⁴ All integration indicators are derived using the benchmark equity index levels expressed in terms of the US dollar. One exception is the indicator from the common component approach in which the index levels are in terms of local currency. The conversion of the benchmark index into US dollar denomination is done by dividing the local currency index level by the local currency per US dollar exchange rate.

To perform cointegration analysis, the non-stationary property of the data series in question must be established. We use the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test to determine the unit root property of the equity indices. Furthermore, the Ljung-Box tests for serial correlation on the weekly equity return series (in the log difference of the equity index level) are performed on the level and the squared level of the equity return series. Table 3 provides the time-series properties of the data series.

Table 3. Stationarity and Serial Correlation Tests of the Data Series

	<u>Stationarity Test</u>			<u>Serial Correlation Test</u>	
	<u>On the level</u>		<u>On the difference</u>	Ljung-Box (Q) test statistics	
	ADF test	PP test	PP test	Q(4)	Q ² (4)
The Mainland					
Shanghai A	-1.47	-1.50	-56.1*	8.61	108.79*
Shenzhen A	-1.50	-1.54	-54.7*	9.56	52.22*
Hong Kong					
HSI	-1.82	-1.88	-54.7*	11.91*	63.48*
H-share	-1.37	-1.55	-48.2*	7.28	78.63*
Taiwan	-1.91	-2.01	-54.9*	3.22	133.28*
Japan	-1.71	-1.69	-61.0*	0.76	35.89*
Korea	-0.95	-0.91	-52.2*	14.24*	250.08*
Singapore	-1.43	-1.37	-50.0*	11.22*	98.94*
Malaysia	-1.38	-1.38	-49.2*	26.08*	218.17*
Thailand	-1.64	-1.79	-50.8*	23.56*	87.31*
Indonesia	-1.49	-1.49	-46.1*	11.00*	262.24*
The Philippines	-1.28	-1.21	-46.5*	19.56*	51.63*
US	-1.72	-1.69	-57.2*	2.45	61.80*
Regional	-1.59	-1.56	-54.7*	2.08	51.80*

Notes: The tests are conducted based on the benchmark indices in US dollar denomination. * indicates significance at the 5% confidence level. The critical value at the 5% level of the ADF test and the PP test is -2.86. Q(4) and Q²(4) are the Ljung-Box statistics based on the level and the squared level of the weekly equity return series (in their log difference) respectively up to the 4th order. Both statistics are asymptotically distributed as $\chi^2(4)$. The critical value of $\chi^2(4)$ at the 5% level is 9.5.

The results of the ADF and PP tests in Table 3 show that all benchmark equity indices are non-stationary in the level (the null hypothesis of the presence of unit root on the level cannot be rejected), but they are stationary in the first difference. Given that these indices possess unit roots, the Johansen (1988) procedure is applied, based on a rolling window with constant sample size, to consider whether the individually non-stationary series are cointegrating. The Ljung-Box tests for serial correlation on the weekly equity return series, as shown by the Q statistics in Table 3,

provide evidence of serial correlation in the level (for some return series) and the squared level of equity return series. Thus, univariate GARCH models are first estimated for each equity return series, and their standardised residuals will then be used in the DCC model to estimate the time-varying conditional correlations between equity returns.

For the common component analysis, monthly data of benchmark equity market indices, exchange rates (per US dollar), dividend yields, forward premia (the log difference between the forward rates and the exchange rates), and 1-month LIBOR are used.¹⁵ The unit root test results in Table 4 show that all the data series for the OLS estimation of Equation (3) in the Appendix are stationary.

Table 4. Unit Root Test of Monthly Data Series

$$(\text{OLS estimation equation: } Y_{i,t} = \sum_{j=c,r,dy,fp} \left(\sum_{n=-p}^p \beta_{j,i} X_{t-n}^j \right) + \varepsilon_{i,t})$$

Data series	Unit root test statistics from	
	ADF test	PP test
Demeaned excess equity return ($Y_{i,t}$) of		
Japan	-11.26*	-11.32*
The Mainland (Shanghai A)	-13.83*	-15.02*
Hong Kong		
HSI	-12.03*	-12.05*
H-share	-11.86*	-11.87*
Taiwan	-11.73*	-11.75*
Korea	-9.99*	-9.90*
Singapore	-11.64*	-11.66*
Malaysia	-10.24*	-10.18*
Thailand	-12.07*	-12.08*
Indonesia	-10.83*	-10.77*
The Philippines	-10.59*	-10.50*
Aggregate series (X_j)		
Excess equity return	-10.09*	-10.06*
Currency return	-10.64*	-10.62*
Dividend yield	-3.04*	-2.79
Forward premia	-2.94*	-3.94*

Notes: Excess equity return of country i is defined as the monthly stock market return (in local currency) less 1-month LIBOR. In the OLS estimation equation, $Y_{i,t}$, the (demeaned) excess equity return, is obtained by dividing the excess equity return series by its average. X_j is a vector of which each element is an aggregate of an unweighted cross-country simple averages of a common component factor over time. The four common component factors are currency return (c), excess equity return (r), dividend yield (dy), and forward premia (fp). See the Appendix for detailed definitions of the data series. * indicates significance at the 5% confidence level. The critical value at the 5% level of the ADF test and the PP test is -2.88.

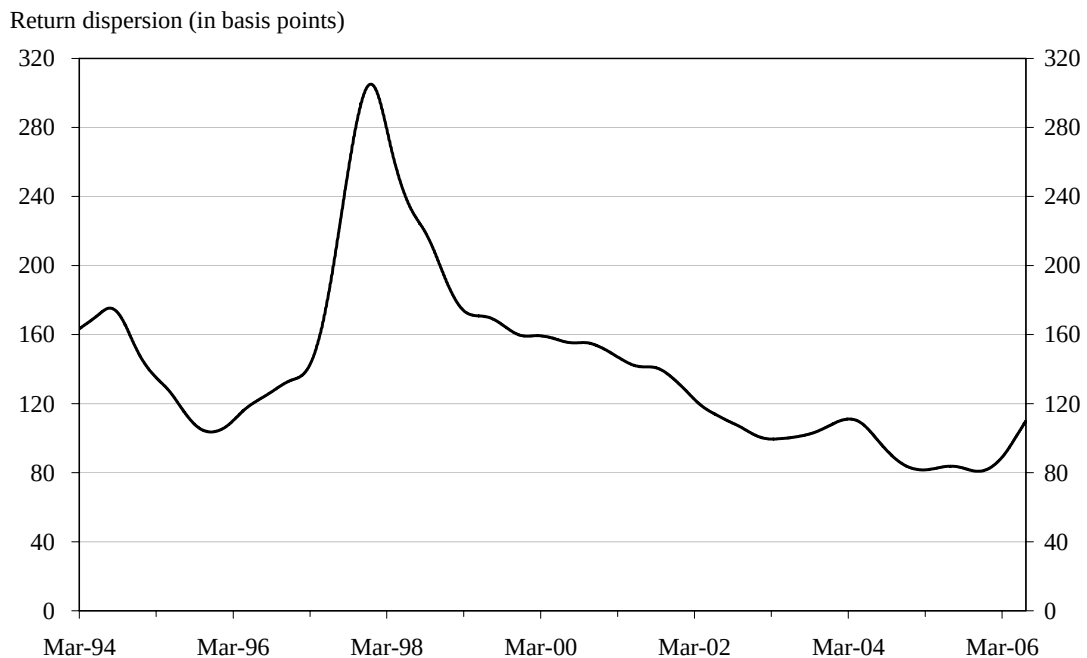
¹⁵ Data are obtained from Bloomberg and CEIC.

IV. RESULTS AND PRESENTATION OF INTEGRATION INDICATORS

i. Cross-market return dispersion

The series of return dispersion is calculated as the cross-market standard deviation of the daily returns of the ten Asian benchmark equity markets. The series is filtered using the Hodrick-Prescott smoothing technique to reveal the long-term trend component of the series.¹⁶ Chart 1 presents the Hodrick-Prescott filtered return dispersion and Chart 2 shows the 250-day moving average of maximum-minimum return differential.

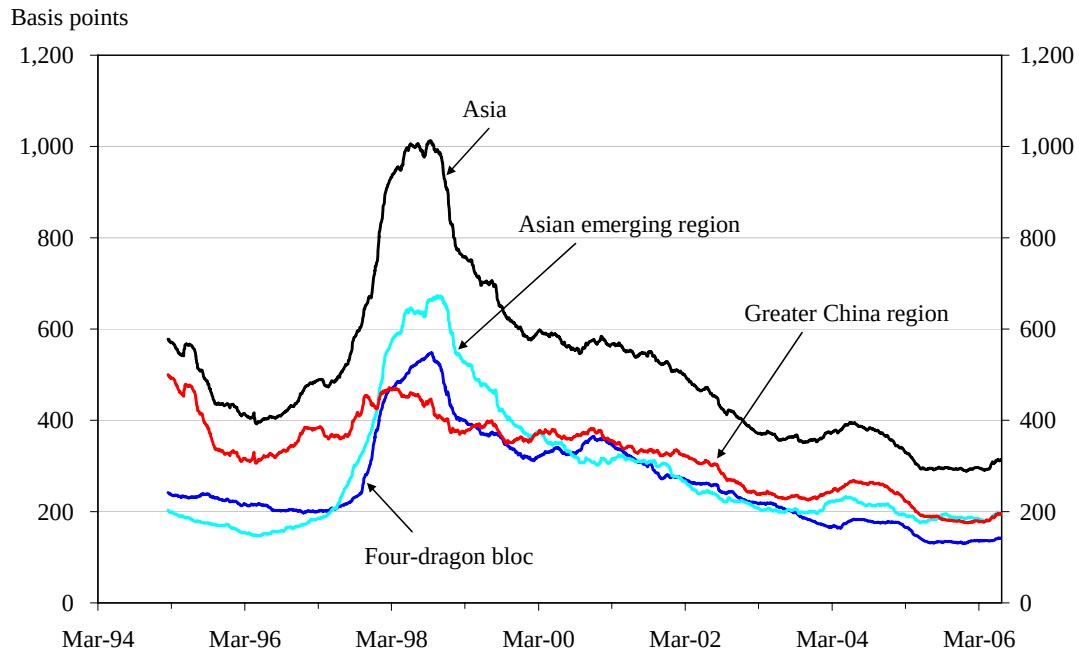
Chart 1. Hodrick-Prescott Filtered Cross-market Return Dispersion of Asian Economies



Source: HKMA staff estimates.

¹⁶ The daily smoothing parameter of the Hodrick-Prescott filter is 6,812,100, which is set following the frequency power rule of Ravn and Uhlig (2002) with a power of 2. While a larger smoothing parameter number results in more smoothing, we find that the general trend of the filtered return dispersion is not affected by the choice of the smoothing parameter.

Chart 2. 12-month Moving Average of Maximum-Minimum Return Differential of Asian Economies



Source: HKMA staff estimates.

Chart 1 indicates a declining return dispersion among the equity markets of the ten Asian economies, from a high of 305 bps during the Asian financial crisis to between 80 and 100 bps in recent year. Similar patterns are also observed for the maximum – minimum return differential indicator in Chart 2 after the Asian financial crisis. For Asia as a whole, the maximum-minimum return differential across markets fell from over 1,000 bps between 1998-1999 to around 300 bps during the past year. The falling return differentials also exhibit for the regional blocs, suggesting that the narrowing of return differentials is common within the Asia region. A similar pattern is also observed in Europe, with the falling return dispersion considered as an indication of return convergence in the region.¹⁷

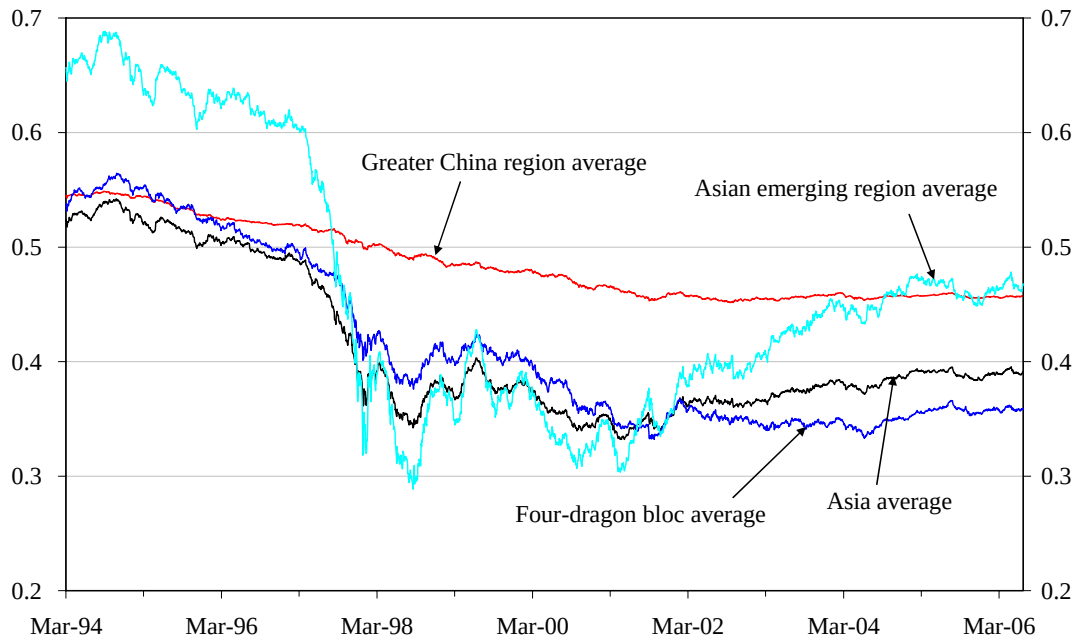
ii. *Haldane and Hall (1991) Kalman filter method*

For this indicator, we take the US equity market as the dominant external market and the MSCI AC Far East Free Index, which is a free float-adjusted market

¹⁷ ECB (2005) shows that the index return dispersion of countries in the Euro area has more than halved, from over 500 bps in 1999 to around 200 bps by the end of 2005.

capitalisation weighted index, as the proxy for the dominant regional market.¹⁸ Based on the signal equation of Equation (1) in the Appendix, the estimated β measures the sensitivity of individual country's equity market index to that in the US relative to the dominant regional market. Equity markets which are more sensitive to the movements of the dominant regional market will show β s of zero, which is interpreted as a sign of price convergence with the dominant regional market. Negative values of β and the tendency for β to move further away from zero indicate price divergence (away from the dominant regional and external US markets). Chart 3 shows the patterns of unweighted average β s.

Chart 3. Haldane and Hall Sensitivity Indicator (β)
(Signal equation: $\ln E_{MSCI,t} - \ln E_{i,t} = \alpha_{i,t} + \beta_{i,t} (\ln E_{MSCI,t} - \ln E_{US,t}) + \varepsilon_{i,t}$)



Source: HKMA staff estimates.

Notes: $E_{i,t}$ is the equity market index level of country i at time t , $E_{MSCI,t}$ is the equity market index level of the MSCI index at time t , which is proxied as the dominant regional market, and $E_{US,t}$ is the dominant external market at time t proxied by the US equity market.

¹⁸ There is no clear-cut finding as to a single dominant equity market in the Asian region. Japan is obviously a natural choice due to the country's economic and financial strength in Asia. Nonetheless, Masih and Masih (2000) find that Hong Kong is the dominant southeast Asian market. For the purpose of examining regional sensitivity as an indication of regional integration, the use of a weighted index to proxy the dominant regional market may be more appropriate than picking a benchmark index of a single equity market. However, it should be noted that the conclusion of whether the equity markets are converging or diverging may well differ, depending on the choices of dominant regional market and dominant external market.

In Chart 3, for the Asia region as a whole, the Asian equity markets appear to be slightly more responsive to the influences from the regional benchmark than that from the US. The Asia average β (black line) fell from 0.55 in 1994 to a low of around 0.34 in 2000, and then edged up slowly again to 0.39 by mid-2006. Among the regional blocs, the sensitivity indicator for the four-dragon equity markets is closer to zero, indicating that they are more affected by the movements of the dominant regional market than the others. However, the sensitivity indicator appears to be stalled at around 0.35 for the past three years. On the other extreme, Asian emerging equity markets appear to be moving away from the dominant regional market since late 2000, as its sensitivity indicator moves closer to one. Compared to their European counterparts, the equity markets in Asia are far from price convergence.¹⁹

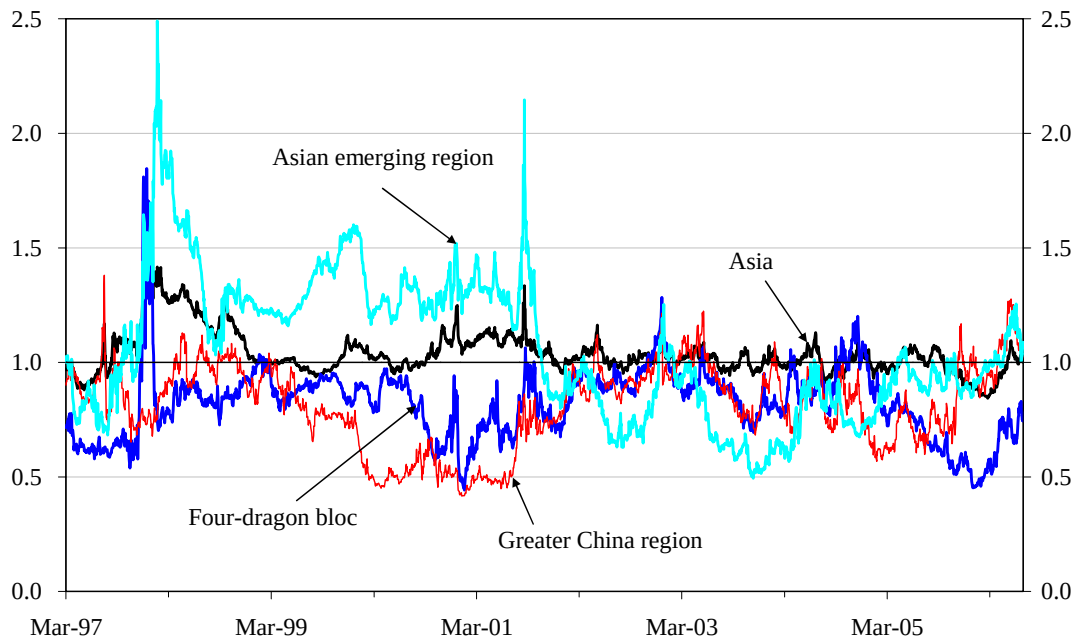
iii. *Dynamic cointegration analysis*

The standardised trace statistic, which is the ratio between the trace statistics obtained from the Johansen (1988) cointegration estimation and the corresponding 95% critical value, is used as a test of the null hypothesis of no cointegration. In this indicator, the presence of a long-term relationship between two markets is interpreted as a sign of market integration.²⁰ If the standardised trace statistic is consistently greater than one, it suggests that the null hypothesis of no cointegration can be rejected. An upward trend for the standardised trace statistics indicates the presence of a long-run relationship between equity markets in the region (or regional blocs). On the other hand, if the standardised trace statistic is less than one and falling, the null hypothesis of no cointegration cannot be rejected. Here we adopt a 3-year rolling cointegration estimation and the standardised trace statistics are plotted over time in Chart 4.

¹⁹ Based on a similar methodology, Lucey et al. (2004) show that the twelve European equity markets are highly sensitive to both the equity markets in Frankfurt and London, with their estimated indicators tending towards zero over the period from 1989 to 2002. These results are interpreted as an indication of price convergence among the twelve European equity markets.

²⁰ One of the first to use the cointegration technique for stock indices to assess integration is Kasa (1992). Kasa notes that in a system with n indices, a condition for complete integration is that there be $n-1$ cointegrating vectors. In our study where eleven Asian equity markets (or indices) are involved, if ten cointegrating vectors are found between the equity markets, then convergence has occurred and these markets are said to be completely integrated. For the various regional blocs with four equity markets (or indices) involved, if three cointegrating vectors are found, equity markets in these regional blocs are said to be completely integrated.

Chart 4. 3-year Rolling Standardised Trace Statistics



Source: HKMA staff estimates.

The standardised trace statistics for Asia as a whole (black line) show weak cointegration (the statistics are slightly larger than one occasionally). Over the study period, there is no sign of increased cointegration as the indicator does not change. Tests of the null hypothesis of more than one cointegrating vector are rejected for Asia as a whole.²¹ The same applies to other regional blocs as well and their respective standardised trace statistics fluctuate widely. Significant indication of cointegration was found during the period of Asian financial crisis (from 1997 to 1998) when the standardised trace statistics of the four-dragon markets and the Asian emerging markets surged and were consistently greater than one, indicating these Asian equity markets are more likely cointegrated.²² After the crisis, the indicator for the Asian emerging markets remained significantly greater than one until mid-2001, while that for the four-dragon markets dropped below one. In other times of the study period, the statistics are not consistently greater than one, suggesting no cointegration between equity markets of the regional blocs.

²¹ In our rolling analysis, no more than one cointegrating vector is found for Asia as a whole as well as the three regional blocs. This result is similar to Click and Plummer (2005), who employ the Johansen VAR modelling to examine the cointegration between the ASEAN 5 equity markets over the full sample period from July 1998 to December 2002, and find only one cointegrating vector.

²² However, one should be cautious in interpreting the cointegration results as a sign of market integration during the Asian financial crisis period. Market contagion and volatility spillover may also attribute to their strong cointegration during that period.

Our results are in line with the findings from Manning (2002) and Click and Plummer (2005), which show that the Asian equity markets only partially converge and the integration process is not complete. Similar results are also found in the European markets. Using the same rolling approach, Pascual (2003) and Lucey et al. (2004) find no evidence of increasing cointegration among different European equity markets.

iv. Common component approach

In this approach, the adjusted R-square values obtained from 3-year rolling OLS estimations of Equation (3) in the Appendix are used as an indicator of time-varying degree of capital market integration.²³ The larger the adjusted R-square value is, the higher is the degree of integration.²⁴ Table 5 presents the adjusted R-square values from the full sample estimations of Equation (3), as well as their average adjusted R-square values based on the 3-year rolling estimations of Equation (3). The unweighted average adjusted R-square values for the regional blocs based on the rolling estimations are presented in Chart 5.

Table 5. Adjusted R-square of Common Component Approach from Full Sample and Rolling Estimations

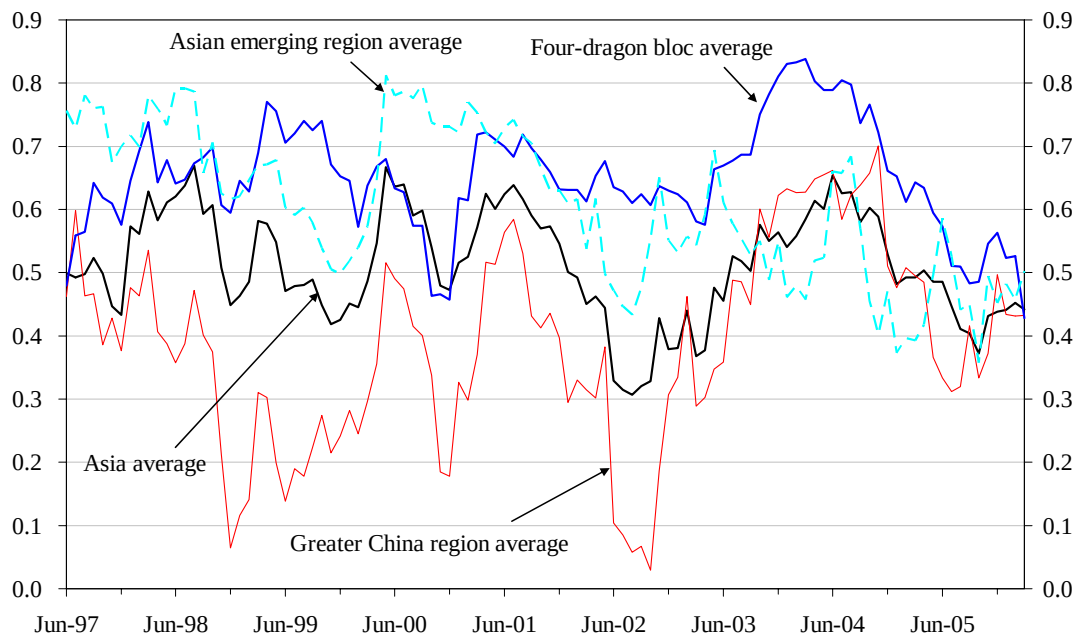
	Adj. R ² obtained from full sample estimation	Average Adj. R ² obtained from 3-year rolling estimations
Japan	0.33	0.24
The Mainland	0.09	0.00
Hong Kong		
HSI	0.64	0.68
H-share	0.51	0.35
Taiwan	0.37	0.52
Korea	0.61	0.71
Singapore	0.70	0.69
Malaysia	0.64	0.51
Thailand	0.66	0.72
Indonesia	0.54	0.69
The Philippines	0.60	0.50

Source: HKMA staff estimates.

²³ The cross-country averages of currency return, excess equity return, dividend yield and forward premia are used as the four common component factors in the estimations.

²⁴ The adjusted R-square measures how well the excess return of an equity market can be explained by common factors. Thus, the concept of integration here is based on whether the markets are affected by common factors rather than the price convergence.

Chart 5. Rolling Unweighted Average R-square of Common Component Approach



Source: HKMA staff estimates.

Chart 5 shows that the Asian equity markets used to be highly integrated, but the momentum appears to be losing stream in recent years. The average R-square value for Asia as a whole (black line) fell from 0.65 in June 2004 to 0.44 recently, suggesting a decline in equity market integration in the region. There were also notable declines in integration for the three regional blocs since late 2004, especially in the greater China and four-dragon regions. The indicator for the greater China region fluctuates widely, as compared to other regional blocs. This mainly reflects the highly unstable association between equity markets on the Mainland and the four common component factors of currency return, excess equity return, dividend yield and forward premia. A similar method is also applied to Europe and it is shown that the eight European equity markets under study are at least partially integrated.²⁵

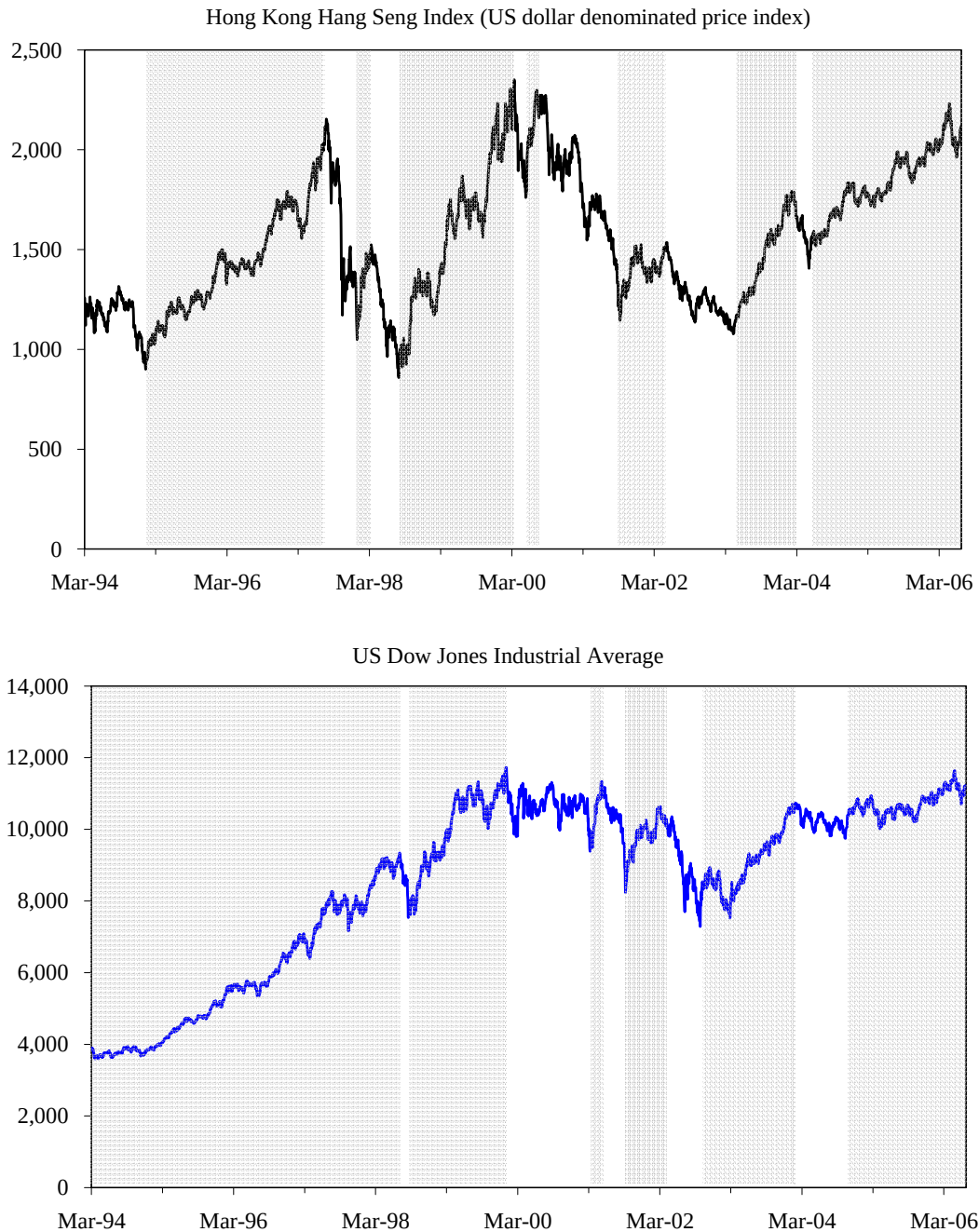
v. *Market cycle synchronisation*

The extent of integration between different markets can be measured by whether the market cycles of different economies are synchronised or not. As demonstrated in Edwards et al. (2003), the construction of the synchronisation indicator, the concordance index, depends on how financial market cycles are identified. In Chart 6, we show the evolution of the equity indices (in US dollar denomination) for Hong

²⁵ Using this dynamic factor analytical model, Emiris (2002) studies eight European equity markets (Belgium, France, Germany, Italy, the Netherlands, Spain, Finland and the United Kingdom) and finds that these markets are at least partially integrated.

Kong and the US, with their bull periods shaded for visual inspection using the method suggested by Edwards et al. (2003).²⁶

Chart 6. Equity Indices and Market Cycles



Note: Shaded areas represent bull phases.

²⁶ Please refer to the Appendix for the rules of identifying peaks and troughs.

Pairwise concordance indices (*RCI*) derived from Equation (4), as shown in the Appendix, over the full sample period are presented in Table 6.

Table 6. Concordance Indices of Asian Equity Markets

	SHA	SZA	H-share	HK	TW	SG	KR	ID	MY	TH	PH	JP	MSFE	US(lagged)
SHA	1	1.00	0.55	0.48	0.56	0.40	0.49	0.39	0.42	0.37	0.56	0.50	0.46	0.38
SZA		1	0.55	0.47	0.56	0.39	0.35	0.38	0.42	0.37	0.56	0.50	0.46	0.38
H-share			1	0.67	0.71	0.55	0.52	0.80	0.65	0.67	0.68	0.58	0.52	0.60
HK				1	0.79	0.77	0.65	0.74	0.78	0.48	0.64	0.74	0.73	0.76
TW					1	0.65	0.57	0.77	0.74	0.56	0.66	0.72	0.64	0.74
SG						1	0.81	0.69	0.78	0.64	0.70	0.86	0.93	0.62
KR							1	0.66	0.72	0.67	0.60	0.75	0.74	0.60
ID								1	0.82	0.66	0.73	0.67	0.66	0.69
MY									1	0.60	0.67	0.72	0.75	0.71
TH										1	0.57	0.59	0.57	0.53
PH											1	0.74	0.75	0.51
JP												1	0.91	0.54
MSFE													1	0.59
US(lagged)														1

Notes: The concordance indices of Hong Kong are highlighted. The equity market abbreviations in the table are as follows: SHA for Shanghai, SZA for Shenzhen, H-share for Hong Kong's Hang Seng China Enterprises Index, HK for Hong Kong's Hang Seng Index, TW for Taiwan, SG for Singapore, KR for Korea, ID for Indonesia, MY for Malaysia, TH for Thailand, PH for the Philippines, JP for Japan, MSFE for MSCI AC Far East Free Index.

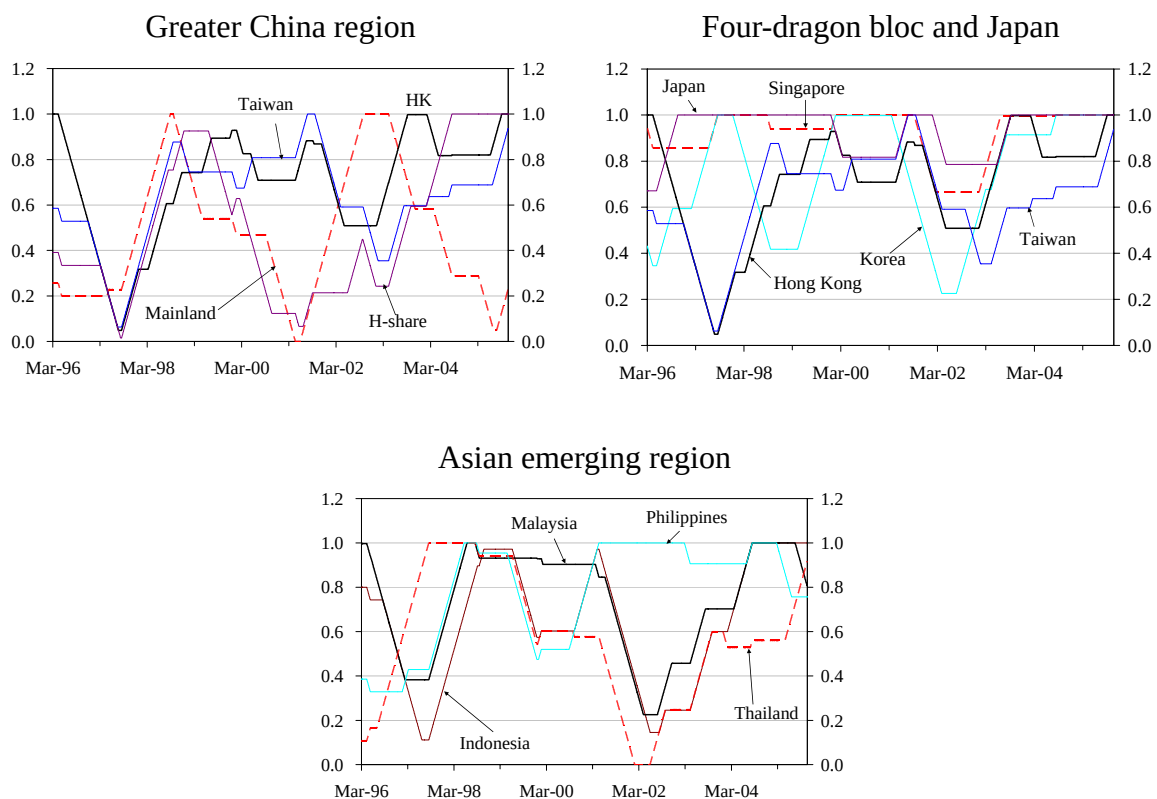
Source: HKMA staff estimates.

Except with the equity markets on the Mainland and Thailand, the concordance indices of Hong Kong are quite high, averaging about 0.65 and above. This implies that for the whole period, over 65% of the time the Hong Kong equity market cycles are aligned with most other equity market cycles in the region. The concordance indices of other mature equity markets like Singapore, Korea and Japan are similar to Hong Kong's, while those of the Asian emerging equity markets are slightly lower. The two equity markets on the Mainland have the lowest concordance indices among all markets in the region, with only about 50% of the time that the equity market cycles on the Mainland are aligned with other Asian markets. In terms of regional blocs, if we take the MSCI Far East Free Index as the representative of the whole Asia region, then the four-dragon bloc has an average *RCI* of 0.76 with the MSCI Index, which is higher than those of the greater China region (0.59) and the Asian emerging region (0.68). These results suggest that the equity market cycles in the four-dragon bloc are more aligned with the region than the others.²⁷

²⁷ The results may be different depending on the choice of the regional benchmark index or the composition (and the weights) of the equity markets in calculating a specific index as a proxy for the regional benchmark. An example is to take the average *RCI* of a country's equity market with other markets as an intra-regional cycle synchronisation measure. Based on this calculation, from Table 6, the average *RCI* of the four-dragon bloc with other equity markets is 0.66, which is slightly higher than that of the greater China region (0.60) and the Asian emerging region (0.64). While the average *RCI* of the four-dragon bloc is less than the one calculated with the MSCI Index as the regional benchmark, it is still higher than the other two regional blocs.

A rolling *RCI* derived from Equation (4), using a window of 350 days (16 months, which is equivalent to the length of one complete market cycle), is constructed for equity markets *i* and *j*. The value of the *RCI* ranges from zero (perfect misalignment of phases) to one (perfect alignment). An upward (downward) trend in the *RCI* signals increased (decreased) stock market concordance, implying greater (or less) market integration. Plotting the *RCI* over time thus provides a picture of evolution of how an equity market cycle coincides with other markets. Taking the MSCI Far East Index as the regional market proxy, Chart 7 shows the *RCIs* between the proxy and individual Asian equity markets.²⁸

Chart 7. *RCIs* of Asian Equity Markets vs. Regional Market Proxy



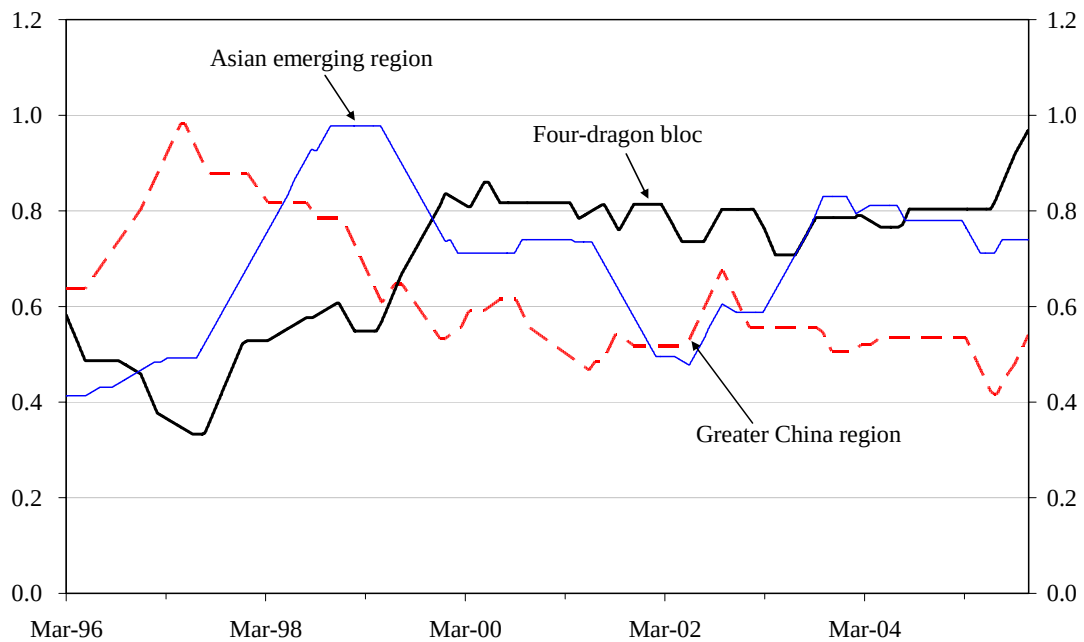
Source: HKMA staff estimates.

The graphs in Chart 7 show that equity markets in the four-dragon bloc and Japan have consistently higher *RCIs* of over 0.5, while the *RCIs* of equity markets on the Mainland vary a lot. These suggest that the equity market cycles on the Mainland are not synchronised with the regional proxy very much. The *RCIs* of Asian emerging equity markets also fluctuate widely but they show signs of increased synchronisation with the region over the past year, with the *RCIs* reaching a level between 0.7 and 1.

²⁸ During the location of peaks and troughs, multiple peaks (troughs) could be identified but only the highest (lowest) of consecutive peaks (troughs) will be taken as the peak (trough) of the cycle. Hence, for a complete cycle, there is only one peak and one trough.

In summary, the equity market cycles in the four-dragon bloc and Japan are highly coincident with the regional market proxy. Those in the Asian emerging region are less aligned in general, but they show signs of increased synchronisation over the past year. Equity markets on the Mainland are completely misaligned with the regional market cycle over the past few years. Chart 8 takes a closer look on the average rolling *RCIs* for the three regional blocs respectively.

Chart 8. Average RCI of Regional Blocs



Source: HKMA staff estimates.

In Chart 8, it is shown that equity market cycles in the greater China region are less synchronised with each other compared to the other two regional blocs. Since 2001, the average *RCI* of the greater China region varies between 0.42 and 0.67, and it does not show any sign of increased synchronisation. Before 2000, the equity market cycles in the Asian emerging region were more aligned than the cycles in the four-dragon bloc. However, cycle synchronisation within the four-dragon bloc has surpassed that in the Asian emerging region and it maintains at a high level of 0.7 and above for the past three years. On the other hand, the market cycles in the Asian emerging region are getting slightly misaligned over the past years, with the *RCI* falling from 0.83 in late 2003 to just above 0.7 in mid-2006.

vi. Dynamic conditional correlation (DCC)

The GARCH(1,1)-DCC model using a two-step estimation procedure is estimated with weekly equity returns. The extent of market integration is given by the correlation estimated from this model. Table 7 highlights the average pair-wise dynamic conditional correlation over the study period.

Table 7. Average Conditional Correlations

	SHA	SZA	HK	H-share	TW	SG	KR	TH	MY	PH	ID	JP	US	MSFE
SHA	1	0.94	0.12	0.20	0.06	0.06	0.04	0.06	0.09	0.04	0.08	0.07	0.00	0.09
SZA		1	0.11	0.18	0.05	0.05	0.03	0.03	0.10	0.02	0.07	0.07	0.00	0.09
HK			1	0.57	0.35	0.62	0.45	0.41	0.38	0.30	0.34	0.37	0.46	0.52
H-share				1	0.21	0.41	0.30	0.31	0.26	0.22	0.26	0.19	0.23	0.30
TW					1	0.38	0.36	0.30	0.29	0.29	0.23	0.25	0.29	0.35
SG						1	0.42	0.53	0.50	0.43	0.47	0.39	0.38	0.54
KR							1	0.38	0.22	0.29	0.25	0.37	0.32	0.48
TH								1	0.42	0.43	0.48	0.28	0.26	0.39
MY									1	0.34	0.44	0.26	0.25	0.37
PH										1	0.44	0.24	0.23	0.31
ID											1	0.21	0.19	0.31
JP												1	0.30	0.93
US													1	0.37
MSFE														1

Notes: The DCCs of Hong Kong are highlighted. The equity market abbreviations in the table are as follows: SHA for Shanghai, SZA for Shenzhen, H-share for Hong Kong's Hang Seng China Enterprises Index, HK for Hong Kong's Hang Seng Index, TW for Taiwan, SG for Singapore, KR for Korea, ID for Indonesia, MY for Malaysia, TH for Thailand, PH for the Philippines, JP for Japan, MSFE for MSCI AC Far East Free Index.

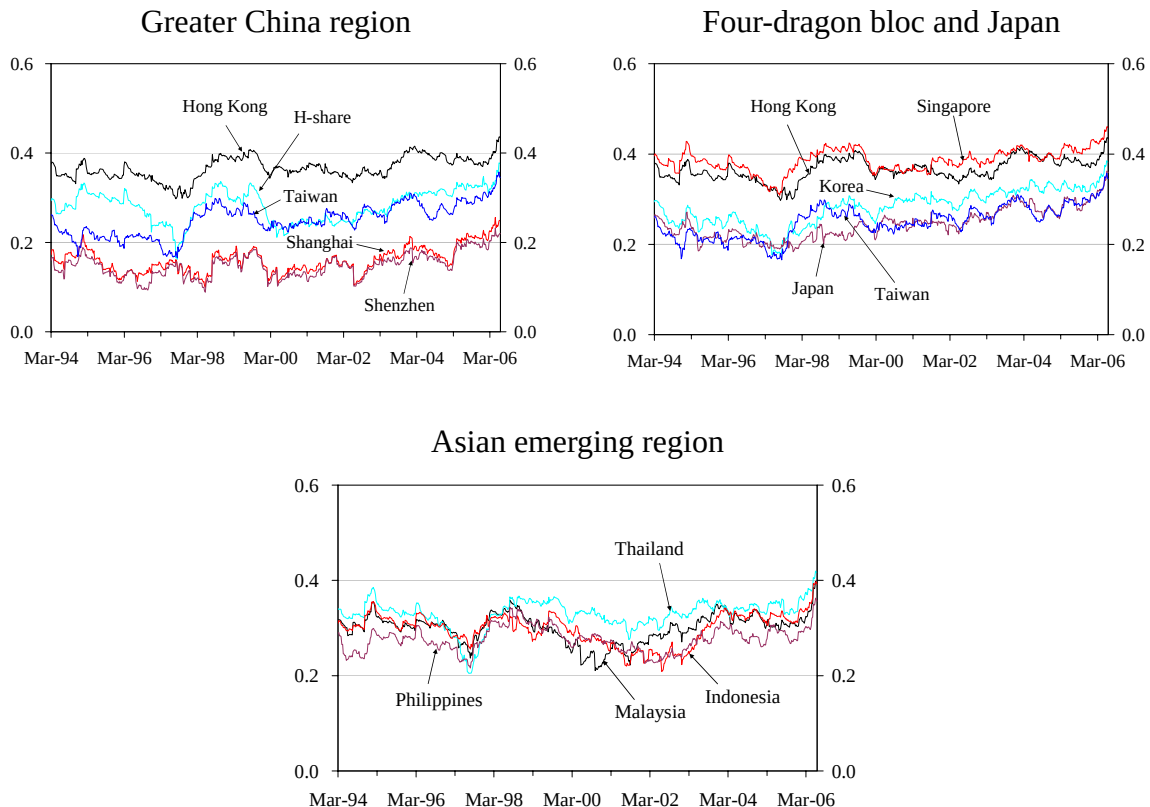
Source: HKMA staff estimates.

The table shows that the equity markets on the Mainland are far less correlated with the rest of the equity markets in the region. Their average conditional correlations with the other Asian equity markets are mostly less than 0.1. For Hong Kong, its DCCs range from 0.12 (with the Mainland) to 0.62 (with Singapore). In terms of regional blocs, if we take the MSCI Far East Free Index as the representative of the whole region, then the four-dragon bloc has an average DCC of 0.47 with the MSCI Index, which is higher than that of the greater China region (0.30) and the Asian emerging region (0.35).²⁹ Since the MSCI Index is a market capitalisation weighted

²⁹ The results may be different depending on the choice of the regional benchmark index or the composition (and weights) of the equity markets in calculating a specific index as a proxy for the regional benchmark. An example is to take the average conditional correlation of a country's equity market return with other markets' as an intra-regional return correlation measure. Based on this calculation, from Table 7, the average DCC of the four-dragon bloc with other equity markets is 0.32, which is just slightly higher than that of the greater China region (0.27) and the Asian emerging region (0.30). While the average DCC of the four-dragon bloc is less than the one calculated with the MSCI Index as the regional benchmark, it is still higher than the other two regional blocs.

index, it is not surprising to note that the equity markets in Japan, Hong Kong, Singapore and Korea have higher DCCs with the MSCI index than the rest of the Asian equity markets. To have a better picture of intra-regional equity return correlation, Chart 9 depicts the average conditional correlations between individual equity markets and other equity markets in the region.

Chart 9. DCCs of Individual Asian Equity Market with Other Equity Markets



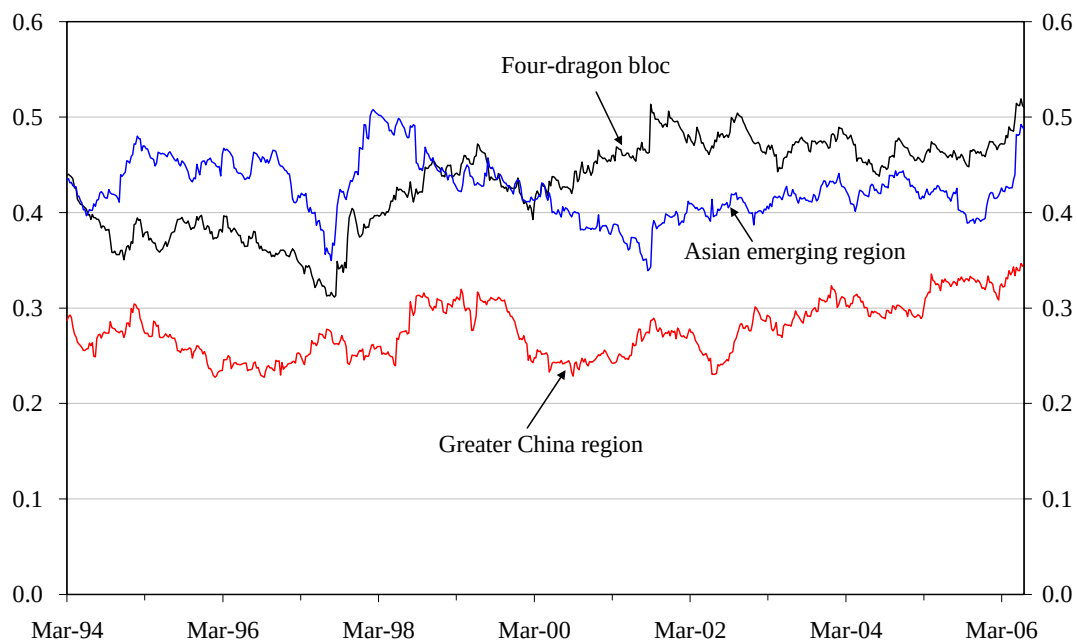
Source: HKMA staff estimates.

The graphs in Chart 9 show that among the equity markets in the Greater China region, those on the Mainland have the lowest correlations with the other Asian markets. Even though there are signs of increasing correlations with the region in the past two years, their correlations are just slightly more than 0.2 as compared to those in Taiwan and Hong Kong's H-share (between 0.26 and 0.38) as well as Hong Kong (between 0.37 and 0.44). Among the equity markets in the four-dragon bloc, the correlations of Hong Kong and Singapore with the other Asian equity markets are quite similar and range from 0.30 to 0.46. The correlations of Taiwan, Korea and Japan are slightly lower and between 0.17 and 0.38. The DCCs of the Asian emerging equity markets are similar to those in the four-dragon bloc with their correlations ranging between 0.21 and 0.42. Overall, the equity markets in Asia are showing increased correlation with each other in the past year, but the correlations remain at a low level of

around 0.45 for most of the equity markets over the whole sample period. Compared to the European Monetary Union (EMU), the return correlation given by the DCC in Asia is much smaller.³⁰

Chart 10 focuses on the pattern of the average DCCs of the three regional blocs. In the chart, the equity markets in the greater China region are less integrated with each others when compared to that in the four-dragon bloc or even the Asian emerging region. It is noted that the average DCC of the Asian emerging equity markets was higher than that of the four-dragon bloc before 2000. After 2000, the DCC of the four-dragon bloc surpassed that of the Asian emerging region, suggesting that the equity markets integration in the four-dragon bloc is higher than in the other two regional blocs.

Chart 10. Average DCCs of Regional Blocs



Source: HKMA staff estimates.

³⁰ In their investigation of correlations of global equity returns, Cappiello et al. (2003) show that the equity return correlations both within and outside the EMU increase after 1999, with the average DCCs rising from 0.5 to 0.7.

V. SUMMARY AND DISCUSSION

Table 8 provides a summary on the current status of equity market integration by the various indicators.

Table 8. Summary of Current Equity Market Integration in Asia

Method	Indication of market integration	Current status of market integration
1. Cross-market return dispersion	Lower return dispersion and smaller return differential imply higher return convergence	Return dispersion and differential have been falling steadily
2. Haldane and Hall (1991) Kalman filter method	Unweighted average β moves towards zero indicates an increasing sensitivity to regional influence	Big progress during 1990s but no significant improvement since 2002
3. Dynamic cointegration analysis	Standardised trace statistics consistently greater than one indicates the presence of a long-run relationship between equity markets	Only weak cointegration and no indication of further improvement
4. Common component approach	Increasing R-square values suggest higher market integration	High level of R-square values but they have been falling lately
5. Market cycle synchronisation	An upward trend in the <i>RCI</i> signals increased market concordance	Higher <i>RCI</i> between mature equity markets than Asian emerging equity markets
6. Dynamic conditional correlation (DCC) model	The higher the time-varying correlation, the larger the co-movement between markets	Higher conditional correlation between mature equity markets than Asian emerging equity markets, but it is at a low level of 0.45.

Given the different focus of each of these indicators, the picture that emerges from the empirical results is not completely uniform. Nevertheless, most indicators suggest that the equity markets in Asia are only weakly integrated and the integration process is not complete. The return dispersions or differentials have been falling, suggesting that there is an increased equity return convergence within Asia. On

the other hand, the results from the Haldane and Hall approach indicate that the integration process, as illustrated by the sensitivity indicator, is far from complete as individual equity market indices are equally responsive to both global and regional influences. The results from the dynamic cointegration method also indicate weak integration. A common finding among these indicators is that the price convergence process appears to be more complete within the mature markets like Japan, Hong Kong, Singapore and Korea (as suggested by the indicators from the Haldane and Hall approach, common component approach, market cycle synchronisation and dynamic conditional correlation), than those in the Asian emerging markets. The equity markets on the Mainland are only weakly integrated with the region (as shown by results from the common component approach, market cycle synchronisation and dynamic conditional correlation).

On the evolution and status of integration, it is noted that a lot of progress took place within the region during the 1990s with respect to greater price convergence. However, the convergence process appeared to be at a standstill since 2002. Notable declines in integration are observed from the common component factor approach. While there are signs of increased synchronisation of equity market cycles and higher correlations in the region, indicators from the Kalman filter method and dynamic cointegration analysis suggest that the price convergence process has not made any progress since 2002.

On the question of the relative importance of regional vs global factors, this study shows that both factors are important to the Asian equity markets as a whole. However, the impacts on the equity markets in different economies are not the same. Except Japan, the Philippines and the Mainland, all other Asian economies in this study show greater integration within the region in terms of their slightly higher sensitivity to the regional factors.³¹ Furthermore, among the three regional blocs studied, it is noted that the equity markets in the four-dragon bloc are more integrated with each other with

³¹ The following table shows the average β_i over the whole study period estimated using the Haldane and Hall approach for individual equity market i . The closer the estimated β approaches zero, the greater is the equity market sensitivity with the region. On the contrary, the closer the value approaches one, the greater is the equity market sensitivity with the external (global) market.

Equity market	Average β	Equity market	Average β
A. Four-dragon markets and Japan		B. Emerging markets and the Mainland	
Hong Kong	0.42	Malaysia	0.48
Singapore	0.42	Thailand	0.42
Korea	0.34	Indonesia	0.42
Taiwan	0.48	The Philippines	0.53
Japan	-0.10	The Mainland	
		Shanghai	0.59
		Shenzhen	0.58

higher return correlations, more synchronised market cycles and greater price convergence than those in the greater China or Asian emerging regions.

In summary, the empirical results from these indicators provide a general picture regarding the trend of equity market integration but the results differ somewhat as to the extent and the speed of equity market integration in the region. The evidence presented broadly supports the observation that a lot of progress has been witnessed over the years in the region in achieving greater regional financial integration in the equity markets. However, the extent of integration still seems to be weak. The process appears to have stalled in recent years and the two major regional blocs, mature and emerging equity markets, seem to have different degrees of integration. Quantity-based measures presented by Chu et al. (2006) in terms of the share of Asia's total overseas portfolio investment and Asian investors' holding in Asian assets also indicate a lower degree of regional integration in Asian capital markets. Compared to their Asian counterparts, the European equity markets appear to be more integrated as (a) the equity return dispersions in Europe have dropped by more than half from over 500 bps in 1999 to about 200 bps by the end of 2005, (b) their index movements are more sensitive to the regional benchmark index and (c) their return correlations are much higher.

The divergence and the lack of progress in integration may be attributed to the absence of several aspects across jurisdictions in Asia. The first is the establishment of links between jurisdictions across the whole spectrum of financial infrastructure – the trading, payment, clearing, settlement and custodian systems which would facilitate movements of capital and savings across jurisdictions, leading to more financial intermediation. The second aspect concerns the harmonisation of standards in the capital markets, for example the adoption of minimum acceptable international standards, which would improve investor confidence and enrich the flow of capital within the region. The third relates to the strengthening of co-operative efforts in financial system development that will increase the diversity of financial intermediation channels in individual jurisdictions. Last but not least is the need for the relaxation of non-supervisory restrictions against access of foreign financial intermediaries to the domestic financial markets. Greater competition through financial services liberalisation enhances efficiency.³² As pointed out by Jeon et al. (2006), the lack of success in policy coordination may also hamper the progress of financial integration.

³² There are discussions regarding the extent of currency cooperation, in terms of regional exchange rate arrangement, in reducing the risk of uncertainties of exchange rate movement, in providing stability of regional currencies and facilitating cross-border financial transactions. However, due to differences in economic structure and development across jurisdictions, even if there is the political will to move towards monetary integration, it will take years. See also Park (2004) on the challenges and prospects.

Financial market integration is important to the region's economic development. The apparent lack of momentum and the diverged degrees of equity market integration between regional blocs since 2002 warrant continuous monitoring. They also pose a challenge to policymakers, despite the fact that Asian countries have shown their political support towards greater financial cooperation and integration. Obstacles in areas such as differences in economic structure and development, maturity level of individual equity market and infrastructure, needed to be addressed. To clear these obstacles, a coordinated strategy for promoting the stability and efficiency of financial intermediation across jurisdictions in Asia is required to facilitate the integration process.

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Appendix

Methodology and Interpretation: Indicators of Financial Market Integration

This Appendix provides in details the methodologies of constructing the different indicators for assessing equity market integration in Asia and their interpretation. All integration indicators are derived using the benchmark equity index levels expressed in terms of the US dollar. One exception is the indicator from the common component approach in which the index levels are in terms of local currency. The conversion of the benchmark index into US dollar denomination is done by dividing the local currency index level by the local currency per US dollar exchange rate.

i. Cross-market return dispersion

The idea behind the cross-market return dispersion approach introduced by Solnik and Roulet (2000) is rather simple and intuitive. This can be used as an alternative to the time-series approach to estimating the level of correlation of equity markets. Following the law of one price, identical or comparable assets across different countries should generate the same return. If there is a large discrepancy in equity market returns across countries, as measured by the cross-market return dispersion, it will imply that the equity markets are not fully integrated in the sense of return convergence. In this measure, low return dispersion implies higher market integration and vice versa.³³ Based on Solnik and Roulet (2000), Adjaoute and Danthine (2003) and Baele et al. (2004) use the negative relationship between dispersion and integration to assess the equity market integration in Europe.

The cross-market dispersion is calculated as the standard deviation of the log differences of the benchmark equity indices of various countries and economies. Once a time series of standard deviations is obtained, it is filtered using the Hodrick-Prescott smoothing technique to estimate the long-term trend component of the series. In addition, a 12-month moving average of the cross-market maximum-minimum return differential, which also captures the dispersion of returns across equity markets, is also used to assess the equity market integration process among regional blocs. The smaller the maximum-minimum return differential between equity markets, the greater their return convergence is.

ii. Haldane and Hall (1991) Kalman filter method

The notion of convergence or integration is that the difference between two (or more) series should become arbitrarily small or they converge to some constant c

³³ It should be noted that equity markets in different countries are not homogenous in the sense that their returns may no be absolutely equal even though these markets are fully integrated.

as time elapses, such that $\lim_{k \rightarrow \infty} E(X_{t+k} - Y_{t+k}) = 0$ or c , where X and Y are the two series.

The convergence may be a gradual and on-going process over time. If we expect the convergence process to take place over time from a lower to a higher level, we need a measure which would allow for such dynamic structural change. This measure will be useful in describing the process of structural change in terms of both degree and timing. The Kalman filter approach suggested by Haldane and Hall (1991) is a method that can be used to measure the time-varying convergence dynamic.³⁴

The Haldane and Hall method estimates a simple equation via Kalman filter estimation with the signal equation as

$$\ln E_{B,t} - \ln E_{i,t} = \alpha_{i,t} + \beta_{i,t} (\ln E_{B,t} - \ln E_{US,t}) + \varepsilon_{i,t}, \quad \varepsilon_{i,t} \sim N(0, V) \quad (1)$$

and the state equations as

$$\begin{aligned} \alpha_{i,t} &= \alpha_{i,t-1} + \xi_t, & \xi_t &\sim N(0, U) \\ \beta_{i,t} &= \beta_{i,t-1} + \mu_t, & \mu_t &\sim N(0, W) \end{aligned} \quad (2)$$

where $E_{i,t}$ is the equity market index level of country i at time t , $E_{B,t}$ is the equity market index level of a dominant regional market (i.e. a regional equity index or a major market index) at time t and $E_{US,t}$ is the dominant external market at time t proxied by the US equity market. We obtain the estimated parameter β_i over time via Kalman filter. From Equation (1), it is easy to show that if E_i and E_B converge (the equity market of country i converges to the dominant regional market), we would expect β_i to approach zero. Conversely, if E_i and E_{US} converge (the equity market of country i converges to the dominant external US market instead of the regional market), we would find β_i to approach one.³⁵ In this measure, a tendency for β_i moving towards zero indicates an increasing sensitivity of individual equity market to the influence of regional

³⁴ Serletis and King (1997) and Manning (2002) use the Haldane and Hall approach to measure convergence of European Union and South East Asian equity markets respectively.

³⁵ By re-arranging Equation (1), we obtain the following equation:

$$(1 - \beta_{i,t}) \ln E_{B,t} + \beta_{i,t} \ln E_{US,t} - \alpha_{i,t} - \varepsilon_{i,t} = \ln E_{i,t} \quad (A1)$$

It can be seen from Equation (A1) that when β_i approaches zero, the movement in $E_{i,t}$ would be increasingly influenced by that in $E_{B,t}$, suggesting that the two series are converging. On the other hand, when β_i approaches one, the influence from $E_{B,t}$ is reducing while that from $E_{US,t}$ is increasing, which suggests $E_{i,t}$ and $E_{US,t}$ are converging. The situation when β_i is greater than one or becomes negative suggests that $E_{i,t}$ is diverging away from $E_{B,t}$ and $E_{US,t}$.

market, suggesting a higher degree of price convergence with the regional market.³⁶

iii. Dynamic cointegration analysis

In the literature, cointegration analysis is among a number of traditional methods to estimate the nature and extent of financial market integration. The essence of cointegration is that the series that are cointegrated cannot deviate too far away from each other, implying that there exists a long-run relationship between them. Kasa (1992) is one of the first to use the cointegration technique for stock indices to assess equity market integration. In a system with n equity market indices, a condition for complete integration is that there be $n-1$ cointegrating vectors (Kasa (1992)). Using the Johansen (1988) cointegration technique, Manning (2002) analyses nine Asian equity markets and finds a minimum of two common trends in these indices, indicating only partial convergence in these equity markets. Click and Plummer (2005) also apply the Johansen (1988) technique to five equity markets in the ASEAN countries and find only one cointegrating vector among the five equity indices. Click and Plummer thus conclude that the five ASEAN equity markets are integrated in the economic sense, but that the integration is not complete.

A major issue regarding the use of cointegration technique in examining market integration in these studies is that it says little about the dynamics of convergence as it fails to take into account the fact that convergence is a gradual and on-going process. To examine the time-varying nature of convergence, a procedure of recursive cointegration test can be used. In particular, the Johansen approach generates a statistic that can be used for this purpose. The trace statistic is a test of the general question of whether there exist one or more cointegrating vectors. In a recursive cointegration approach of Hansen and Johansen (1992) with an expanding sample size, the trace statistics can be plotted over time to examine the time varying nature of market integration. If markets are cointegrating (i.e. converging), the standardised trace statistics, which is the ratio between the trace statistics and the corresponding 95% critical values, should be consistently greater than one, suggesting that the null hypothesis of no cointegration can be rejected. If markets are diverging or not even in any sense of cointegrated, the standardised trace statistics will be less than one.

Rangvid (2001) uses this recursive approach to examine the convergence among European equity markets and observes the upward trend for the trace statistics, indicating an increasing convergence among European equity markets. However, as the conclusion of increasing convergence does not distinguish whether it is due to the reduction of the number of underlying stochastic trends over time as the equity markets

³⁶ One caveat of the Haldane and Hall approach is that the conclusion of whether the equity markets are converging or diverging may well differ according to the choices of dominant regional market and dominant external market.

become more integrated, or because the sample size has increased over time (also known as the “the power of the test” effect), Pascual (2003) proposes to conduct rolling cointegration test with a constant sample size as the estimation rolls over to the next period. Under this circumstance, an upward trend in the estimated trace statistics can then be interpreted as evidence of more cointegration. Based on this rolling estimation approach, Pascual finds no evidence of increasing cointegration among the same group of European equity markets in Rangvid (2001). In this study, we adopt Pascual’s rolling estimation approach to eliminate the effect of increasing sample size.

iv. *Common component approach*

Bekaert and Hodrick (1992) and Campbell and Hamao (1992) have shown that the dividend yields and forward premia, together with currency returns, are common component factors which are able to capture the dynamics of the excess asset returns. For each country i , the common component approach estimates the following equation:

$$Y_{i,t} = \sum_{j=c,r,dy,fp} \left(\sum_{n=-p}^p \beta_{j,i} X_{t-n}^j \right) + \varepsilon_{i,t} \quad (3)$$

where $Y_{i,t}$ is the (demeaned) excess equity return of country i , obtained from monthly stock market return expressed in local currency less 1-month LIBOR, X^j is a vector of which each element is an aggregate of an unweighted cross-country averages of a common component factor over time. The four common component factors are currency return (c), excess equity return (r), dividend yield (dy), and forward premia (fp).³⁷ The regression is estimated on the past, present and future of these four aggregates. The adjusted R-square value obtained from the above regression equation is regarded as a measure of equity market integration of country i , in the sense that it represents the contribution of the common component to the total variance for the excess equity return in country i . Following Emiris (2002), Equation (3) is estimated using a 3-year rolling window to examine the dynamic of integration.³⁸ Emiris (2002) uses this dynamic factor analytical model on eight European equity markets and finds that these European capital markets are at least partially integrated.

³⁷ For each country i , the currency return (c_i) is constructed using the country’s exchange rate (per US dollar) in excess of its forward rate for the previous month. The excess equity return (r_i) is the monthly stock market return of country i less 1-month LIBOR. The dividend yield (dy_i) of country i is the dividend yield of its benchmark stock index. The forward premia (fp_i) of country i is the log difference of the forward rate and exchange rate. The X has four vectors, each vector containing the cross-country simple average of a common component factor over time.

³⁸ Using monthly data we apply a 3-year rolling window to estimate Equation (3), and we will restrict the number of leads and lags of each component factor to three in Equation (3).

v. ***Synchronisation of financial market cycle approach***

Another indication of market integration is whether market phases “coincide” in time across the region. That is, we try to identify whether, at a given moment in time, financial markets in the region are in the same phase of the financial market cycle. If financial market cycles in the region are more or less “synchronised”, it may provide another indication (or evidence) of financial market integration.

Following Pagan and Sossounov (2003) and Edwards et al. (2003), the first step in the analysis of the cycle phases is the determination of the turning points – the peaks and the troughs that signal the change in the trend of the market. This requires some rules in defining the turning points. Following the rules from Edwards et al. (2003), we identify the peaks and the troughs of equity market cycle as follows:

1. local peak (trough) is located by comparing the natural log of equity index at time t with equity index levels throughout $t + 174$ days and $t - 174$ days (approximately eight months before and after time t)³⁹
2. Once the peaks and troughs are identified, censoring rules are applied to ensure that we do not identify spurious phases:
 - i. turning points within eight months of the beginning / end of the series are eliminated
 - ii. peak or trough next to the endpoint of the series is eliminated if it is lower / higher than the endpoint
 - iii. cycles of less than 16 months of duration are eliminated
 - iv. phases of less than four months are eliminated, unless the rise / fall exceeds 25%
 - v. enforced alternation so that a peak is always followed by a trough and vice versa
 - vi. if consecutive peaks (troughs) occur, take the highest (lowest) one
3. For periods which are identified as bull phase (S_t), then $S_t = 1$. For periods which are identified as bear phase (B_t), then $B_t = 1$. A rolling concordance index (RCD), using a window of width 16 months (approximately 350 days, which is equivalent to the length of one complete market cycle), is constructed for equity markets i and j , as follows:⁴⁰

³⁹ Edwards et al. (2003) note that the results of locating peaks and troughs may be sensitive to the choice of the window width. In this study, as in Edwards et al., a total cycle length of 16 months is chosen, as suggested by Pagan and Sossounov (2003).

⁴⁰ A rolling window width of 16 months is used as this length represents one complete cycle.

$$RCI_{ij} = \frac{1}{350} \sum_{\tau=1}^{350} [S_{i,t-\tau} S_{j,t-\tau} + B_{i,t-\tau} B_{j,t-\tau}] \quad (4)$$

The value of the concordance index ranges from zero (perfect misalignment of phases) to one (perfect alignment).⁴¹ An upward (downward) trend in the *RCI* signals increasing (decreasing) market concordance, implying the markets are more (less) integrated.

vi. *Correlation using dynamic conditional correlation (DCC) model*

Simple (or rolling) correlation analysis is among the simplest method for examining the co-movement of equity markets. Basically, higher correlation between equity markets implies higher co-movement and greater integration between the markets. The DCC model, proposed by Engle and Sheppard (2001) and Engle (2002), is a new class of multivariate model which is particularly well suited to examine correlation dynamics among assets. The DCC approach has the flexibility of univariate GARCH. As the parameters to be estimated in the correlation process are independent of the number of series to be correlated, a large number of series can be considered in a single estimation. Furthermore, Wong and Vlaar (2003) show that the DCC model outperforms other alternatives in modelling time-varying correlations.

To measure equity market correlations, a two-step estimation procedure of the DCC model is used. Univariate GARCH models are first estimated for each equity market return series. The standardised residuals from the first step are then used to estimate the dynamic conditional correlations between equity market returns. Specifically, let $z_{i,t}$ and $z_{j,t}$ be the standardised residuals of equity market returns of country i and j at time t respectively, $i \neq j$. The GARCH process, as suggested in Engle (2002), is as follows:

$$q_{ij,t} = \bar{\rho}_{ij} + \alpha(z_{i,t-1}z_{j,t-1} - \bar{\rho}_{ij}) + \beta(q_{ij,t-1} - \bar{\rho}_{ij}) \quad (5)$$

and

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}} \quad (6)$$

where q_{ij} is the off diagonal elements of the variance-covariance matrix, $\bar{\rho}_{ij}$ is the unconditional expectation of the cross product $z_{i,t}z_{j,t}$ and $\rho_{ij,t}$ is the conditional correlation between the equity market returns of country i and j at time t .⁴²

⁴¹ The concordance index is used in Harding and Pagan (2000, 2002).

⁴² See Engle (2002) for a detailed description of the simple DCC model and the estimation procedure.