Assessing the integration of Asia's equity and bond markets[1]

Laurence Kang-por Fung[2], Chi-sang Tam[3] and Ip-wing Yu[4]

1. Introduction

Ten years after the financial crisis of 1997–98 that devastated 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 financial cooperation and integration in the region.[5] Globalisation in the 1990s made Asia a more integrated region through increased cross-border trades and economic activities. Strong intraregional economic links have resulted in increased cross-border financial activities. Furthermore, economies in the region have made efforts to diversify their sources of funding, diminishing their reliance on the banking sector in favour of other financing instruments such as equities and bonds. Despite these developments, intraregional financial integration appears to lag behind the increase in intraregional trade.[6] Such asymmetric development in economic and financial integration may affect financial stability in the region.

Financial integration would benefit the region through more efficient allocation of capital, greater opportunities for 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. Moreover, financial integration may also promote financial development and hence enhance economic growth in the region.[7] However, intensified financial linkages in a world of high capital mobility may also increase the risk of cross-border financial contagion, in particular when the region's economies become more interdependent. In other words, financial instability in one country could be transmitted to neighbouring countries more rapidly. At times of financial crisis, this contagion might have important consequences for financial stability. Against this background, it is essential to have appropriate measures for monitoring and assessing the progress of

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2 Hong Kong Monetary Authority; Laurence_KP_Fung@hkma.gov.hk.

3 Hong Kong Monetary Authority; Chi-sang_Tam@hkma.gov.hk.

4 Hong Kong Monetary Authority; Ip-wing_Yu@hkma.gov.hk.

5 In addition to these initiatives, an Asian currency basket and Asian currency union for intraregional exchange rate stability have been proposed as medium- and long-term policy objectives (Institute for International Monetary Affairs (2006)).

6 See Danareksa Research Institute (2004).

7 As de Brouwer and Corbett (2005) point out, financial market integration creates powerful internal pressures for financial reform and development by encouraging further financial liberalisation and upgrading of financial capacity.

financial integration in the region.[8] This study provides a discussion of different indicators and measures and addresses the following questions in particular:

- To what extent are equity and bond markets in the region integrated?
- What are the evolution and the current level of integration in the equity and the bond markets? Is integration in either market progressing, at a standstill or even regressing?
- What is the relative importance of regional (within Asia) factors, compared with global factors (proxied by the corresponding asset returns in the United States) in intraregional equity and bond market integration?
- Given the concern about possible contagion effects and their importance for risk management, to what extent are returns in equity and bond markets correlated within and across economies?

Unlike most studies, which focus on the integration of either the equity markets or the bond markets, this study compares the different experiences of the region's equity and government bond markets with integration. In addition, the co-movement of equity and bond returns at the national and regional levels has important implications for contagion and risk management.[9]

The indicators in this study are mostly of high frequency and permit an assessment of the dynamic evolution of financial market integration.[10] Like other integration measures in the literature, the indicators proposed in this study vary in their scope and focus. For example, the return dispersion measure uses the idea of price convergence to assess integration, whereas the correlation analysis uses the extent of asset return co-movement as an indication of the degree of integration. The combined use of these indicators provides information on different dimensions of integration and thus gives policymakers a more balanced picture. That said, the empirical results derived from these indicators should be interpreted with caution as all of the indicators are statistical or model-based measures 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.[11]

The remainder of this paper is organised as follows. In Section 2 we provide a brief review of the current issues related to financial integration in Asia and of the traditional approaches to 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 3. The estimation results from the integration indicators are presented and their behaviours examined in Section 4. Section 5 provides a summary and discussion.

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[8] The informative value of these integration measures or indicators for ongoing efforts to monitor the degree of financial integration in the euro area is highlighted in publications from the European Central Bank (ECB) and the European Commission (EC). See ECB (2005) and EC (2005).

[9] In addition to examining the degree of integration within a specific financial asset market, Cappiello, Engle and Sheppard (2003) and Kim, Moshirian and Wu (2006) also studied the correlations of equity and bond returns in Europe.

[10] 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.

[11] These alternative measures, however, may not be as timely and frequent as the indicators proposed in this paper.

2. Recent studies on financial integration and their measures

The issue of financial market integration in Asia, particularly equity market integration, has been examined extensively in the literature, using different measures and methodologies. However, there are few empirical works on bond market integration in Asia. And the degree of financial integration in Asia remains a matter of vigorous debate.

For example, the Danareksa Research Institute (2004) finds that financial integration in Asia is still far behind that in Europe prior to the latter's unification in the 1990s. Using the 10-year government bond benchmark yield to examine the status of government bond market integration in the ASEAN+3 group of economies, Danareksa Research Institute (2004) finds no significant convergence pattern. It concludes that the underdeveloped state of bond markets in most East Asian countries bears the main responsibility for the slow convergence in bond market yields in the region. 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, Lee and Shin (2006) conclude that the East Asian financial markets are less integrated with each other than they are with the global market. They argue that the low level of financial integration within East Asia is attributable to the lack of incentives for portfolio diversification within the region, the low degree of development and deregulation of the financial markets and the instability of monetary and exchange rate regimes.

On the other hand, Jeon, Oh and Yang (2006) find that the degree of financial integration in East Asia has increased recently, but that this is due to integration with the global market rather than with regional counterparts. Based on the data for intraregional foreign direct investment (FDI), Kawai (2005) notes that the rise in Asia's 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, Fung and Gadanecz (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. The Asian Development Bank (2005) notes that cross-country differentials in bond yields have been declining. Although these differentials remain significant, there are signs of increased co-movement in bond yields, suggesting that bond market integration is making progress.

There is, in general, no universal definition of financial integration. Financial openness, free movement of capital and integration of financial services are mentioned in a broad range of definitions frequently cited in the literature.[12] In one commonly used definition, 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 that financial markets are not integrated. In the literature, there are largely two broad categories of financial integration measures – price-based measures and quantity-based measures.[13]

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

[13] For a survey of the literature and various indicators, see Adam et al (2002), Dennis and Yusof (2003), Cavoli, Rajan and Siregar (2004), Baele et al (2004) and Vo (2005).

a. Price-based measures

Price- or return-based measures of financial integration seek to equate the rates of returns of comparable assets across different economies. Many research studies rely on interest rate parity, 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, as in 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 – ie if financial markets are well integrated, the correlation between investment and savings should be low.[14] The net capital flow, which captures cross-border transactions involving financial assets, is another measure for assessing financial market integration.[15]

For monitoring purposes, it is desirable for policymakers 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 several indicators for measuring different dimensions of equity and bond market integration in Asia, including

1. cross-market return dispersion and differentials;
2. time-varying ß estimated via Haldane and Hall (1991) Kalman filter method;
3. rolling estimates of the standardised trace statistics from dynamic cointegration analysis;
4. rolling concordance index from market cycle synchronisation analysis; and
5. dynamic conditional correlation.

These indicators are mostly model-based and provide high frequency measures for regular monitoring purposes (see Table 1 for a summary of the integration measures in this study).[16] Detailed discussions on the methodologies for constructing these indicators, and on the interpretation of the indicators, are presented in the appendix.

It is worth noting 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 financial 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, cycle synchronisation and return correlation as evidence of integration. It is, therefore, not surprising to have different results regarding the extent and

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[14] The Feldstein and Horioka capital mobility test is based on the following cross-country regression equation: $\left(I/Y\right)_i = \alpha + \beta\left(S/Y\right)_i$,

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

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

[16] ECB (2005) provides a survey of the integration measures it uses in monitoring financial market integration in Europe. Among the integration measures proposed in this study, the return dispersion is adopted from ECB (2005), while the other indicators make use of recent advances in the literature in measuring the time-varying degree of integration.

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 evidence on the general trend of the integration process.[17]

Table 1

Summary of integration measures for equity and bond markets

Method	Indicator	Indication of market integration
Cross-market return dispersion and maximum-minimum return differential	Hodrick-Prescott filtered standard deviation of equity returns and 12-month moving average of maximum-minimum return differentials	Falling return dispersion and smaller return differential imply higher return convergence
Haldane and Hall (1991) Kalman filter method	Time-varying ß estimated via Kalman filter	Average ß moving towards zero indicates an increasing sensitivity to regional influence
Dynamic cointegration analysis	Rolling estimates of the standardised trace statistics	Standardised trace statistics consistently greater than one indicate the presence of a long-run relationship between financial markets
Market cycle synchronisation	Rolling concordance index (*RCI*)	An upward trend in the *RCI* signals increasing market concordance
Dynamic conditional correlation (DCC) model	Time-varying correlation estimated from the DCC model	The higher the correlation, the greater the co-movement between markets is

3. The data and their time series properties

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

[17] It should be noted that most of these aggregate indicators are obtained by taking the simple average of the indicators estimated for individual economies. However, as the starting dates of the bond yield data in this study are different (as are their estimated indicators), the number of individual indicators on bond market integration being averaged will increase over time. For instance, government bond yield data were not available in Indonesia before January 2003. Thus, the estimated bond market integration indicators for Indonesia are not included in the aggregation until January 2003. In this regard, the general trend of these aggregate bond market integration indicators should be interpreted with caution.

1. Greater China region: China, Hong Kong SAR and Taiwan (China);[18]
2. Four-dragon bloc: Hong Kong SAR, Korea, Singapore and Taiwan (China);[19] and
3. Emerging Asia: Indonesia, Malaysia, the Philippines and Thailand.

Table 2a

Benchmark equity indices

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

Sources: IMF; Bloomberg; CEIC; Datastream.

Table 2a highlights the benchmark indices of these economies in the study of equity markets, while Table 2b provides the details of the sovereign (government) bond data used in this paper. Data are examined for bonds with maturities of two years, five years and 10 years issued by these 10 economies. As the empirical results, shown below, indicate that the pattern and extent of integration is very similar for bonds with different maturities, this paper shows only the results for the 10-year bond, for illustration.[20] As government bond issuance varies for the different economies, each bond yield series has a different starting date (see Table 2b). The Dow Jones Industrial Average (DJIA) and the yield on the US 10-year Treasury bond are used as proxies for the external (or world) equity and bond markets, respectively. The MSCI AC Far East Free Index is taken as the regional equity market

[18] For Hong Kong SAR, the Hang Seng China Enterprises Index (H-shares) is included as one of the equity markets in the greater China region along with the benchmark Hang Seng Index. The bond market data for Hong Kong SAR are those of the Exchange Fund Notes (EFN).

[19] For Hong Kong SAR, only the benchmark Hang Seng Index is included in the four-dragon bloc.

[20] Interested readers may refer to Yu, Fung and Tam (2007) for details of the results for the other two maturities.

benchmark.[21] The regional bond market benchmark will be either the unweighted cross-country government bond return average or the JPMorgan EMBIG Asia Sovereign Return Index.[22] Data on benchmark equity indices from 16 March 1994 to October 2007 are used in the estimation.[23]

Table 2b

Government bonds used in this study[1, 2]

	Bond data starting date
Hong Kong SAR[3], Taiwan (China), Japan, Korea, Malaysia, Thailand, the Philippines and the US Treasury bond	Oct–96
China	May–01
Singapore	Jun–98
Indonesia	Jul–03
JPMorgan EMBIG Asia Sovereign yield	Dec–97

[1] Sovereign (government) bonds with a 10-year maturity. [2] All bond data are in terms of yields and the data sample ends at October 2007. [3] Yields are those of Exchange Fund Notes.

Sources: IMF; Bloomberg; CEIC; Datastream.

Most of the indicators derived in this paper, as in other studies, are based on daily returns, except for the estimation of the dynamic conditional correlation indicator, which is based on weekly returns. For equity markets, all integration indicators are derived using the benchmark equity index levels expressed in terms of the US dollar.[24] For bond markets, the derivations of integration indicators are based on the holding period returns (bond returns) in terms of the US dollar.[25, 26]

[21] The MSCI AC Far East Free Index is a free float-adjusted market capitalisation weighted index consisting of indices for the following 10 economies: China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan (China) and Thailand.

[22] The choice of regional bond market proxy is different in different integration measures. For the Haldane and Hall Kalman filter method, the proxy is the unweighted cross-country government bond return average. For each bond market, this regional benchmark bond return proxy is calculated as the average cross-country bond return, excluding the bond return of that market itself. For instance, when calculating the 10-year regional benchmark bond return for Hong Kong SAR, the 10-year EFN return of Hong Kong SAR is excluded from the cross-country average calculation. On the other hand, the JPMorgan EMBIG Asia Sovereign return is used as the regional bond market proxy for all economies for the estimations of the dynamic conditional correlations. A common regional bond market proxy reduces the number of data series used in the estimations and thus makes the estimation process more efficient.

[23] All integration indicators are derived using the benchmark equity index levels expressed in terms of US dollars. One exception is the indicator from the common component approach, in which the index levels are expressed in terms of local currency. The benchmark index is converted into US dollars by dividing the local currency index level by the local currency per US dollar exchange rate.

[24] The benchmark equity index is converted into US dollars by dividing the local currency index level by the local currency per US dollar exchange rate. Equity market returns are calculated as daily (or weekly) log first differences.

[25] In this study, the bond return is approximated by the daily holding period return for a government bond based on Shiller (1979). For bonds selling at or near par value, Shiller suggests an approximate expression for the n-period holding period return $H_t^{(n)}$. In the approximate expression, the n-period holding period return, $H_t^{(n)}$, is

Table 3a

Stationarity and serial correlation tests of equity return series

	Stationarity test		Serial correlation test Ljung-Box (Q) test statistics	
	On the level	On the difference	Q(4)	$Q^2(4)$
Equity return series				
China				
Shanghai A	7.87	–59.79*	10.34*	109.73*
Shenzhen A	4.41	–56.30*	13.67*	146.58*
Hong Kong SAR				
HSI	1.40	–58.20*	14.34*	75.01*
H-shares	5.54	–53.09*	11.32*	83.89*
Taiwan, China	–1.79	–57.57*	2.93	136.87*
Japan	–1.77	–64.52*	0.09	12.31*
Korea	1.11	–55.36*	14.53*	234.12*
Singapore	1.31	–54.39*	10.97*	89.64*
Malaysia	–1.06	–51.48*	26.81*	210.35*
Thailand	–1.83	–54.19*	25.19*	78.86*
Indonesia	–0.52	–49.16*	10.84*	243.95*
Philippines	–1.13	–49.12*	23.02*	45.93*
United States	–1.05	–60.60*	2.28	58.69*
Regional	–0.88	–57.96*	0.76	50.53*

The tests are conducted based on the benchmark equity return indices expressed in US dollars. * indicates significance at the 5% confidence level. The critical value at the 5% level of the PP test is –2.86. Q(4) and $Q^2(4)$ are the Ljung-Box statistics based on the level and the squared level of the weekly equity return series, 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.

Source: HKMA staff estimates.

approximated as $H_t^{(n)} = (R_t^{(n)} - \gamma_n R_{t+1}^{(n-1)})/(1-\gamma^{n-1})$, $\gamma_n = \gamma(1-\gamma^{n-1})/(1-\gamma^n)$, $\gamma = 1/(1+\overline{R})$, where $R_t^{(n)}$ is the yield to maturity and $\overline{R}$ is the mean value of the yield to maturity. Once the local currency bond return is calculated, it is expressed in terms of the US dollar by dividing the local currency bond return by the daily percentage change in the local currency per US dollar exchange rate. The indicators derived from the cross-country bond return dispersion and differential analysis, and the dynamic conditional correlation model, are based on the bond returns. For the Haldane and Hall Kalman filter method, the indicators are based on the bond indices calculated from the bond return series.

[26] In the integration literature, it is common to express the asset returns in terms of the same currency.

To perform cointegration analysis, the non-stationary property of the data series in question must be established. We use the Phillips-Perron (PP) test to determine the unit root property of the equity and bond return indices. Furthermore, the Ljung-Box tests for serial correlation on the weekly equity return series (in the log difference of the equity index level) and the weekly bond return series (based on the weekly holding period return) are performed on their levels and their squared levels. Tables 3a and 3b provide the time series properties of equity and bond returns, respectively.

The results of the PP tests in Tables 3a and 3b show that all benchmark equity indices and bond return indices are non-stationary on their levels (the null hypothesis of the presence of a unit root on the level cannot be rejected), but they are stationary on the first differences. Given that these indices possess unit roots, the Johansen (1988) procedure is applied, based on a rolling window with a 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 and bond return series, as shown by the Q statistics in Tables 3a and 3b, provide evidence of serial correlation in their levels (for most return series) as well as the squared levels (except the bond return series of Japan). Thus, univariate GARCH models are first estimated for each return series, and their standardised residuals will then be used in the DCC model to estimate the time-varying conditional correlations between asset returns.

Table 3b

Stationarity and serial correlation tests of bond return series

	Stationarity test		**Serial correlation test Ljung-Box (Q) test statistics**	
	On the level	**On the difference**	**Q(4)**	**Q^2(4)**
Bond return series				
China	–1.70	–40.93*	5.36	11.25*
Hong Kong SAR	–0.77	–52.00*	20.56*	41.22*
Taiwan, China	–0.63	–55.30*	64.42*	25.51*
Japan	–2.30	–53.33*	1.40	4.77
Korea	–0.01	–49.93*	189.33*	241.83*
Singapore	–0.21	–47.37*	3.46	38.36*
Malaysia	0.69	–46.66*	28.42*	113.58*
Thailand	0.08	–55.67*	18.60*	146.00*
Indonesia	–0.12	–35.77*	31.12*	18.99*
Philippines	1.32	–53.45*	14.78*	37.40*
United States	–1.33	–52.03*	1.65	14.11*
Regional	–0.70	–54.93*	25.95*	106.51*

The tests are conducted based on the benchmark bond return indices expressed in US dollars. * indicates significance at the 5% confidence level. The critical value at the 5% level of the PP test is –2.86. Q(4) and Q^2(4) are the Ljung-Box statistics based on the level and the squared level of the weekly bond return series, respectively, up to the 4th order. Both statistics are asymptotically distributed as χ^2 (4). The critical value of χ^2 (4) at the 5% level is 9.5.

Source: HKMA staff estimates.

4. Results and presentation of integration indicators

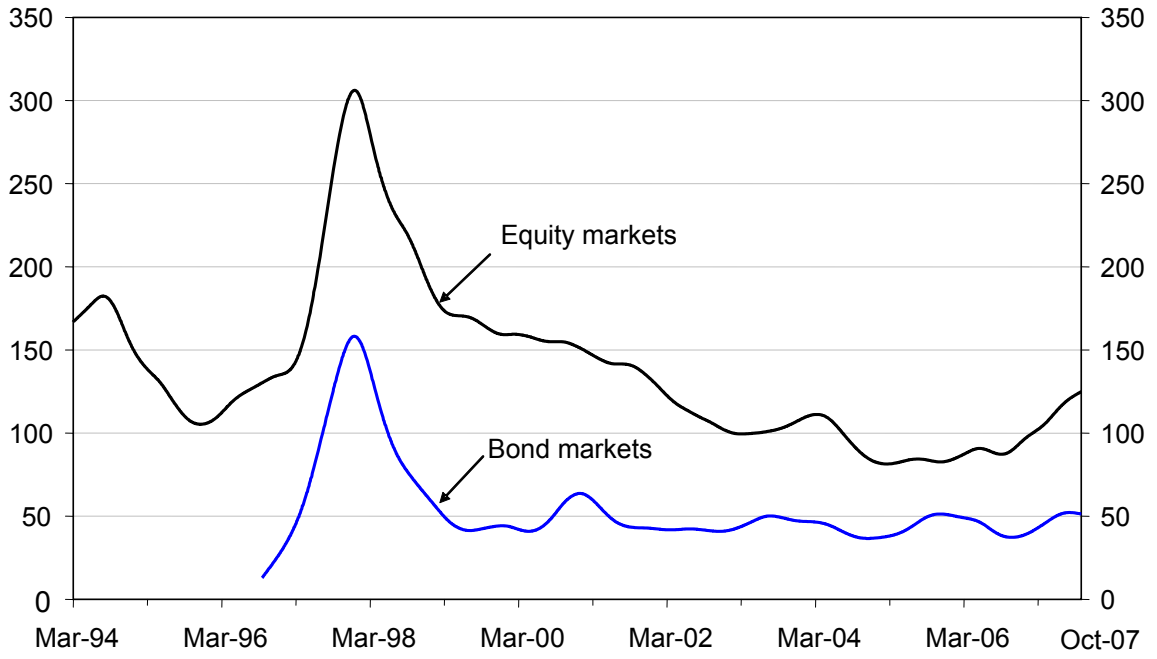
4.1 Cross-market return dispersion

The series of return dispersion is calculated as the cross-market standard deviation of the daily returns of the 10 Asian benchmark equity markets. The series is filtered using the Hodrick-Prescott smoothing technique to reveal the long-term trend component of the series.[27] Figure 1 presents the Hodrick-Prescott filtered equity and bond return dispersions.

Figure 1

Hodrick-Prescott filtered return dispersion in Asian economies

In basis points



Source: HKMA staff estimates.

Figure 1 shows that the return dispersion is larger in equity markets than in bond markets, suggesting that the return divergence is larger for equities than for bonds. The two return dispersion series depict a rapid decline after the Asian financial crisis. For equity markets, the return dispersion dropped from a high of 305 basis points (bps) during the Asian financial crisis to a low of 82 bps at the end of February 2005. The decline in return dispersion during this period implies greater equity market integration. However, the dispersion has been trending upward, widening to 125 bps at end-October 2007. For bond markets, the return dispersion dropped from its peak of 160 bps in early 1998 to fluctuate between 40 and 50 bps beginning in mid-2001. Given that the perceived credit risk or liquidity of the relevant government bonds could be different even in a fully integrated market, the bond return

[27] 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.

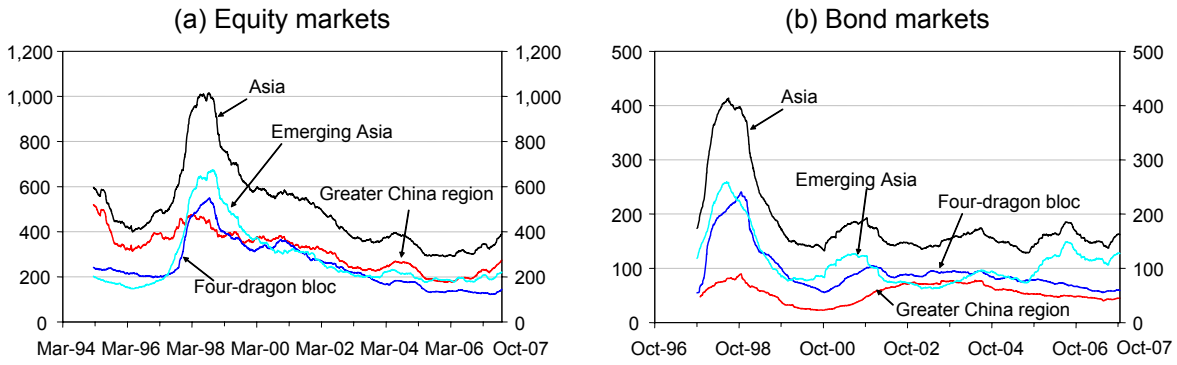
dispersion indicator may not fall further even when there is increased integration in the bond markets.

Figures 2a and 2b illustrate the 250-day moving average of maximum-minimum equity and bond return differentials, respectively.

Figure 2

Twelve-month moving average of maximum-minimum return differentials in Asian economies

In basis points



Source: HKMA staff estimates.

Similar patterns are also observed for the maximum-minimum return differential indicator in Figure 2 after the Asian financial crisis. For Asia as a whole, the maximum-minimum return differential across equity markets fell from over 1,000 bps between 1998 and 1999 to around 300 to 400 bps during 2007. The falling return differentials also exhibit for the regional blocs, suggesting that the narrowing of return differentials is common within equity markets in the Asia region. A similar pattern is observed in Europe, with the falling return dispersion considered to be an indication of return convergence.[28] Among the regional blocs, equity markets in the four-dragon bloc showed a relatively smaller return differential, and thus a higher degree of integration, than the other two blocs. The return differentials in the greater China region and emerging Asia have increased slightly since late 2005, suggesting a tendency towards return divergence. For bond markets, the greater China region has a relatively smaller return differential than the others. Bond return differentials in the four-dragon bloc and emerging Asia used to have similar patterns and magnitudes, but, since late 2005, the return differentials between bond markets in emerging Asia have been trending upwards, while those in the other two regional blocs have remained steady.

4.2 Haldane and Hall (1991) Kalman filter method

When examining equity market integration, 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 capitalisation weighted index, as the proxy for the dominant regional market.[29] For bond

[28] ECB (2005) shows that the equity 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.

[29] There is no clear-cut finding as to a single dominant equity market in Asia. Japan is a natural choice because of its economic and financial strength in Asia. Nonetheless, Masih and Masih (1999) find that Hong Kong SAR is the dominant Southeast Asian market. For the purpose of examining regional sensitivity as an indicator of regional integration, the use of a weighted index to proxy the dominant regional market may be more

market integration, the bond return index of the 10-year US Treasury bond is taken as the dominant external factor, while the bond indices of dominant regional benchmarks are proxied by the average cross-country bond indices.[30] Based on the signal equation of equation (1) in the appendix, the estimated ß measures the sensitivity of individual countries' equity (bond) market index to the corresponding index in the United States, relative to the dominant regional market. Equity (bond) markets that are more sensitive to the movements of the dominant regional market will show ß trending close to zero, which is interpreted as a sign of price convergence with the dominant regional market. Any tendency for ß to move further away from zero indicates return divergence. Negative values for ß suggest that the equity (bond) market diverges from the regional and US markets. Figures 3a and 3b show the patterns of unweighted average ß for equity and bond markets, respectively.

Figure 3 shows that the sensitivity indicators for equity markets are less volatile than those for bond markets. Nonetheless, the patterns seem to be very similar. As shown in Figure 3, both the equity and the bond markets in Asia appear to be slightly more responsive to the regional benchmark than to the US benchmark. Average ß for Asian equity markets fell from 0.53 in 1994 to a low of around 0.35 in mid-2001, and then edged up slowly again to 0.45 by end-October 2007. For bond markets, average ß for Asia as a whole also dropped to a low of 0.16 by mid-September 2001 and then rose to 0.46 by the end of October 2007. Hence, the sensitivity to regional equity and bond influences, though still significant, appears to have declined in recent years. Among the regional blocs, the sensitivity indicator for the four-dragon equity markets is closer to zero, indicating that these markets are more affected by the movements of the dominant regional market than markets in the other blocs. However, the sensitivity indicator appears to have been moving upwards, at around 0.41, during the past three years. At the other extreme, equity markets in emerging Asia appear to have moved away from the dominant regional market since late 2000, as the sensitivity indicator moves closer to one. Compared with their European counterparts, the equity markets in Asia are far from price convergence.[31] A notable difference is observed between the equity and bond markets in the greater China region. While average ß for equity markets in the greater China region declined steadily throughout the study period, suggesting that the regional benchmark has greater influence than the US benchmark, average ß for bond markets has been on a rising trend since late 2001, reaching 0.65 at end-October 2007. This suggests that the region's sensitivity to the US Treasury bond is greater than its sensitivity to the regional benchmark.

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appropriate than picking a benchmark index of a single equity market. However, it should be noted that conclusions as to whether the equity markets are converging or diverging may well differ, depending on the choice of dominant regional external markets.

[30] The regional benchmark bond return index for each economy is calculated as the average cross-country bond index of the corresponding maturity, excluding the bond return index of that market itself. For instance, when calculating the 10-year regional benchmark bond return index for Hong Kong SAR, the 10-year EFN return index of Hong Kong SAR is excluded from the cross-country average calculation. It should be noted that conclusions as to whether the bond markets are converging or diverging may well differ, depending on the choice of dominant regional external markets.

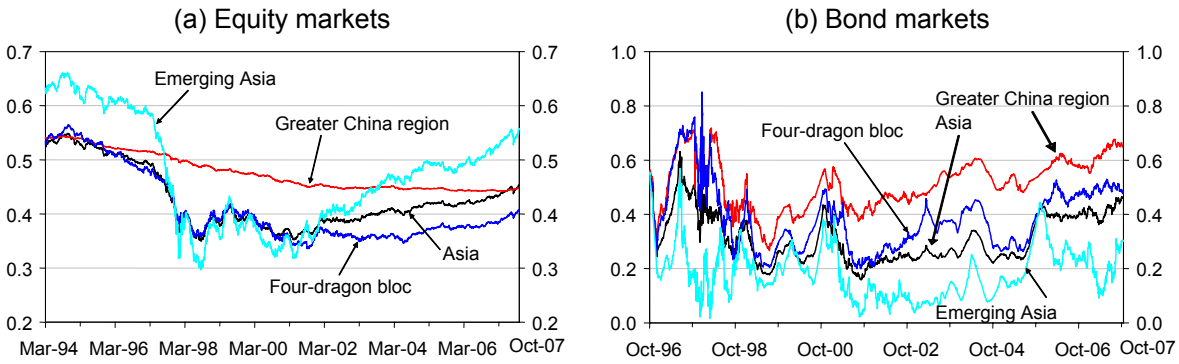
[31] Based on a similar methodology, Aggarwal, Lucey and Muckley (2004) show that the 12 European equity markets are highly sensitive to the equity markets in both Frankfurt and London, with their estimated indicators tending towards zero over the period from 1989 to 2002. These results are interpreted as indicating price convergence among the 12 European equity markets.

Figure 3

Haldane and Hall sensitivity indicator (ß)

(Equity market equation:): $\ln E_{MSCI,t} - \ln E_{i,t} = \alpha_{ei,t} + \beta_{ei,t}\left(\ln E_{MSCI,t} - \ln E_{US,t}\right) + \varepsilon_{ei,t}$

(Bond market equation: $\ln Y^{i}_{RBM,t} - \ln Y_{i,t} = \alpha_{yi,t} + \beta_{yi,t}(\ln Y^{i}_{RBM,t} - \ln Y_{US,t}) + \varepsilon_{yi,t}$)



In the above equations, $E_{i,t}$ 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. $Y_{i,t}$ is the local government bond return index of economy *i* at time *t*, $Y^{i}_{RBM,t}$ is the regional benchmark bond return index (ie the simple average government bond return indices of all economies except economy *i*) of economy *i* at time *t* and $Y_{US,t}$ is the dominant external factor at time *t* proxied by the US Treasury bond return index.

Source: HKMA staff estimates.

4.3 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.[32] If the standardised trace statistic is consistently greater than one, it suggests that the null hypothesis of no cointegration can be rejected. On the other hand, if the standardised trace statistic is less than one, the null hypothesis of no cointegration cannot be rejected. One can also assess the number of cointegrating relationships (through the examination of the number of cointegrating vectors) discovered within regional blocs of financial markets. The more cointegrating relationships one finds, the higher the cointegration between the financial markets in the group.[33] Here we adopt a three-year rolling cointegration estimation for equity

[32] Kasa (1992) was one of the first to use the cointegration technique to assess the integration of stock indices. 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 of 11 Asian equity markets (or indices), convergence has occurred if 10 cointegrating vectors are found between the equity markets, 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.

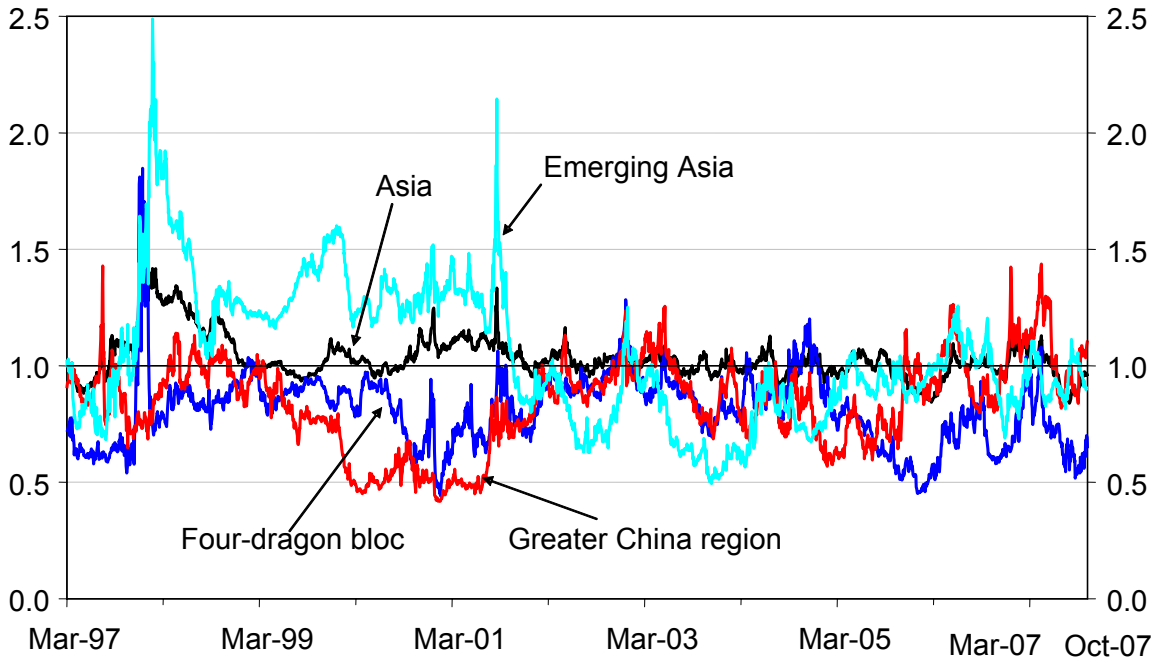
[33] In a system of *n* series, a condition for complete cointegration is that there be *n* – 1 cointegrating vectors. For example, with 10 bond indices for Asia as a whole, if nine cointegrating vectors are found between these indices convergence has occurred, and these bond markets are said to be completely integrated.

markets and a two-year one for bond markets, and their standardised trace statistics are plotted over time in Figures 4 and 5, respectively.[34]

Figure 4

Equity market cointegration

Three-year rolling standardised trace statistics



Source: HKMA staff estimates.

As shown in Figure 4, the standardised trace statistics for Asian equity markets as a group show very weak signs of a cointegrating relationship as they are not consistently greater than one. Tests of the null hypothesis of more than one cointegrating vector are rejected for Asia as a whole.[35] The same applies to the other regional blocs, and their respective standardised trace statistics fluctuate widely. A significant indication of cointegration was found during the Asian financial crisis, when the standardised trace statistics of the four-dragon markets and the emerging Asian markets surged and were consistently greater than one, indicating that these Asian equity markets were more likely cointegrated.[36] After the crisis, the indicator for the emerging Asian markets remained significantly greater than one until mid-2001, while that for the four-dragon markets dropped below one. At other times during the study period,

[34] Ideally, a wider window (say, three years) is better to capture the long-run relationship in the cointegration measure. However, due to the unavailability of data, the rolling window for bond markets is fixed at two years.

[35] In our rolling analysis, no more than one cointegrating vector is found either for Asia as a whole or for the three regional blocs. This result is similar to that of Click and Plummer (2005), who employ the Johansen VAR model 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.

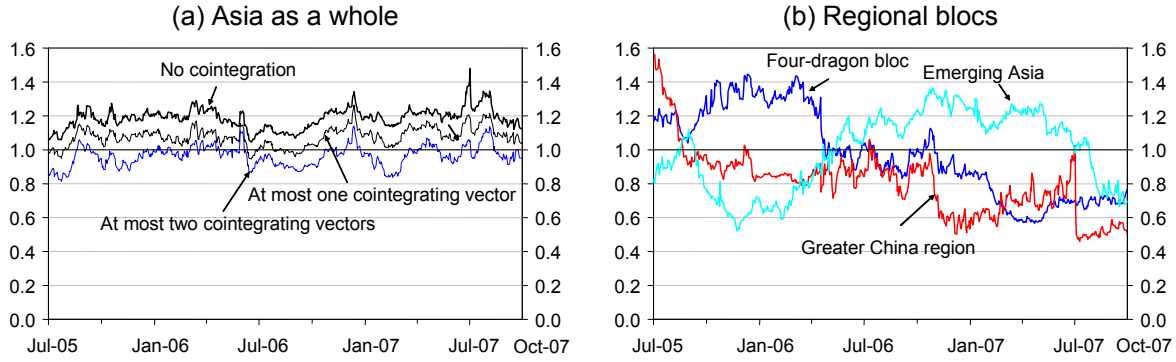
[36] However, one should be cautious in interpreting the cointegration results as a sign of market integration during the Asian financial crisis. Market contagion and volatility spillover may also have contributed to the strong cointegrating relationship during that period.

the statistics were not consistently greater than one, suggesting no cointegration between the equity markets in the regional blocs.[37]

Figure 5

Bond market cointegration

Two-year rolling standardised trace statistics



Source: HKMA staff estimates.

Figure 5a shows that for bond markets in Asia as a whole, the null hypothesis of no cointegration can be rejected as the standardised trace statistics are consistently greater than one. However, the null hypotheses of more than one cointegrating relationship (through the examination of the number of cointegrating vectors) are mostly rejected as the standardised trace statistics are less than one. This suggests that there is only a weak cointegration among the 10 government bond markets in the region since only one cointegrating relationship can be found. Asian bond markets are much less cointegrated than bond markets in the EU countries, suggesting a low degree of integration in Asia.[38] For regional blocs, Figure 5b indicates that cointegration was found between bond markets in the four-dragon bloc between 2005 and mid-2006, but that this cointegrating relationship disappeared afterwards. Such a cointegrating relationship was shown among bond markets in emerging Asia from March 2006 to July 2007. Judging from these results, the extent of integration in equity and bond markets is weak.

4.4 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 pointed out by Edwards, Biscarri and de Gracia (2003), the construction of the cycle synchronisation indicator, the concordance index, depends on the proper identification of different phases in the market cycles. In Figure 6, as an example, we show the evolution of the Hang Seng Index (in

[37] Our results are in line with the findings of Manning (2002) and Click and Plummer (2005), which show that Asian equity markets only partially converge and that the integration process is not complete. Findings for the European markets are similar. Using the same rolling approach, Pascual (2003) and Aggarwal, Lucey and Muckley (2004) find no evidence of increasing cointegration among different European equity markets.

[38] Using the same dynamic cointegration approach, Lucey, Kim and Wu (2004) show that the number of cointegrating vectors from 10 EU countries' bond markets ranges from three to seven over the study period, from January 1999 to October 2003. They conclude that the 10 European bond markets form an integrated system but that there is little evidence that the system is increasingly converging.

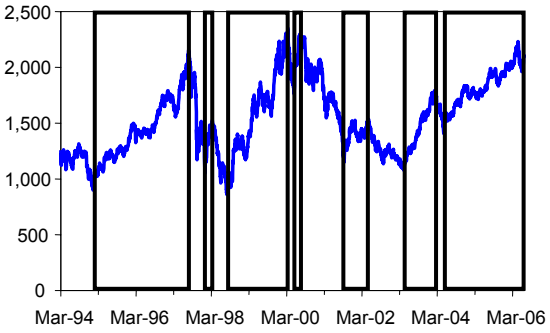
US dollars) and Hong Kong SAR's 10-year EFN return index, respectively, with their bull periods framed for visual inspection using the methodology suggested by Edwards, Biscarri and de Gracia.[39]

Figure 6

Equity and bond market cycles in Hong Kong SAR

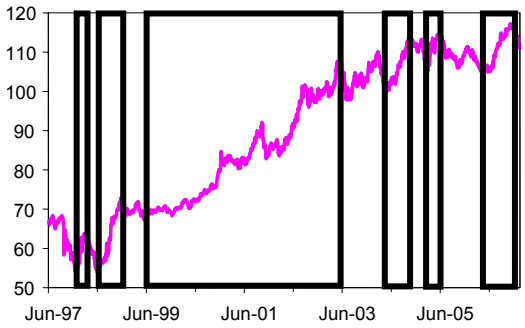
(a) Hang Seng Index

Price index denominated in US dollars



(b) 10-year EFN return index

Return index denominated in US dollars



Framed areas represent bull phases.

Source: HKMA staff estimates.

Pairwise concordance indices derived from equation (3) of the appendix over the respective sample periods for equity and bond markets are presented in Tables 4 and 5.[40]

Except for the equity markets in China and Thailand, the concordances of other Asian equity markets are quite high, averaging about 0.66 or above. This implies that for the whole period, over 66% of the time the cycles of Asian equity markets were aligned. The two equity markets in China have the lowest concordance indices of all the markets in the region; cycles in China's equity markets were aligned with those of other Asian markets only about 57% of the time. In terms of regional blocs, if we take the MSCI AC Far East Free Index as representative of the whole Asia region, the four-dragon bloc has an average concordance of 0.79 with the MSCI Index, which is higher than those of the greater China region (0.63) and emerging Asia (0.73). These results suggest that the equity market cycles in the four-dragon bloc are more aligned than those in the other blocs with equity market cycles in the region.

Table 5 shows that the pairwise concordances of bond markets are slightly lower than those of equity markets, averaging 0.6 and above, with the exception of Japan, which averages 0.47. This implies that over the sample periods, the bond market cycles in the region are aligned with one another more than 60% of the time.

[39] Refer to the appendix for the rules for identifying peaks and troughs.

[40] As bond market cycles are quite similar for all maturities, this section presents only the finding for the 10-year government bond indices.

Table 4

Concordance indices of equity markets

	China		HK									Region	
	SHA	SZA	H-shares	HSI	TW	SG	KR	ID	MY	TH	PH	JP	MSFE	US
China														
SHA	1	1.00	0.59	0.53	0.61	0.46	0.55	0.45	0.50	0.44	0.58	0.55	0.52	0.44
SZA		1	0.59	0.53	0.61	0.46	0.42	0.45	0.50	0.44	0.58	0.55	0.52	0.44
HK														
H-shares			1	0.70	0.74	0.60	0.57	0.82	0.70	0.70	0.74	0.62	0.57	0.64
HSI				1	0.81	0.79	0.68	0.77	0.83	0.54	0.70	0.77	0.76	0.79
TW					1	0.69	0.61	0.79	0.79	0.61	0.72	0.74	0.68	0.77
SG						1	0.83	0.72	0.82	0.67	0.75	0.87	0.94	0.66
KR							1	0.70	0.77	0.71	0.67	0.78	0.77	0.64
ID								1	0.86	0.70	0.78	0.71	0.70	0.72
MY									1	0.66	0.76	0.77	0.80	0.76
TH										1	0.65	0.63	0.61	0.58
PH											1	0.79	0.80	0.59
JP												1	0.92	0.59
Region														
MSFE													1	0.63
US														1

HSI = Hong Kong SAR's Hang Seng Index; H-shares = Hong Kong SAR's Hang Seng China Enterprises Index; HK = Hong Kong SAR; ID = Indonesia; JP = Japan; KR = Korea; MSFE = MSCI AC Far East Free Index; MY = Malaysia; PH = Philippines; SG = Singapore; SHA = Shanghai A shares; SZA = Shenzhen A shares; TH = Thailand; TW = Taiwan (China); US = equity market in the United States with a one-day lag.

Source: HKMA staff estimates.

Table 5

Concordance indices of Asian government bond markets (10-year maturity)

	China	HK	TW	SG	KR	PH	TH	ID	MY	JP
China	1	0.76	0.63	0.67	0.74	0.73	0.65	0.48	0.70	0.61
HK		1	0.72	0.65	0.64	0.66	0.74	0.54	0.72	0.43
TW			1	0.61	0.74	0.64	0.68	0.44	0.80	0.50
SG				1	0.71	0.54	0.58	0.83	0.61	0.46
KR					1	0.69	0.73	0.73	0.77	0.45
PH						1	0.73	0.70	0.83	0.46
TH							1	0.77	0.78	0.46
ID								1	0.69	0.49
MY									1	0.37
JP										1

HK = Hong Kong SAR; ID = Indonesia; JP = Japan; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; TW = Taiwan (China). It should be noted that as the starting dates of the government bond data are different (see Table 2b), the number of data samples involved in the derivation of the concordance indices for each pair of economies is not the same. For instance, the starting date in the calculation of the concordance index between the bond markets of Hong Kong SAR and Taiwan (China) is July 1997, January 2002 for China and Hong Kong SAR and March 2004 for Hong Kong SAR and Indonesia. Caution should be taken when comparing the concordance indices.

Source: HKMA staff estimates.

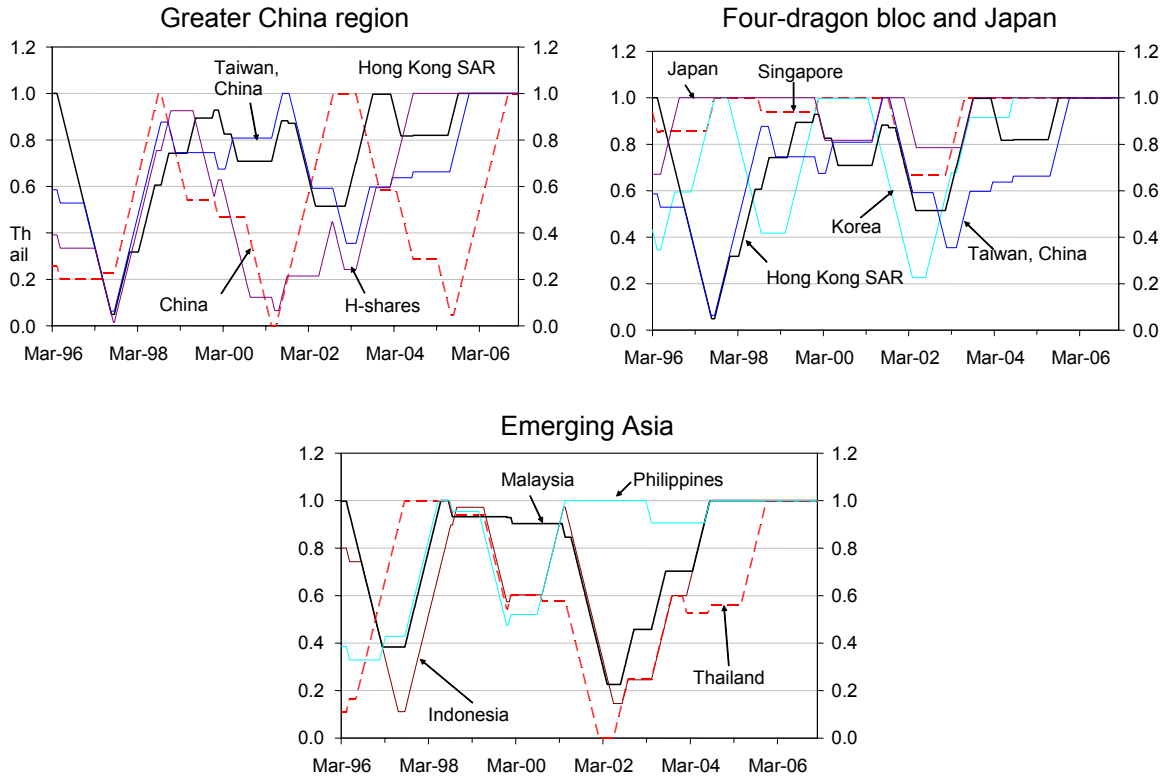
Using a window of 16 months (which is equivalent to the length of one complete market cycle), the pairwise intramarket rolling concordance indices (*RCI*s) are derived for economies *i* and *j* (based on equation (3) in the appendix). The value of the *RCI* ranges from zero

(perfect misalignment of phases) to one (perfect alignment). An upward (downward) trend in the *RCI* signals increased (decreased) market cycle concordance, which is regarded as a sign of greater (less) market integration. Plotting the *RCI* over time thus provides a picture of how an economy's financial market cycle coincides with other markets' cycles. Taking the MSCI AC Far East Index as the regional equity market proxy, Figure 7 shows the *RCI*s between the regional proxy and individual Asian equity markets.[41]

The graphs in Figure 7 show that equity markets in the four-dragon bloc and Japan have consistently higher *RCI*s – over 0.5 – while the *RCI*s of equity markets in China vary considerably. These suggest that equity market cycles in China are not very synchronised with the regional proxy. The *RCI*s of equity markets in emerging Asia also fluctuate widely. All the *RCI*s reached the reading of one recently, suggesting that equity market cycles in the region are in perfect synchronisation. In summary, the equity market cycles in the four-dragon bloc and Japan are highly coincident with the regional market proxy. Those in emerging Asia and China are less aligned in general, but they also reached perfect synchronisation over the past year.

Figure 7

***RCI*s of Asian equity markets against regional market proxy**



It should be noted that as the local peak or trough is located by comparing the bond index level at time *t* with the levels throughout *t* – 174 days and *t* + 174 days (approximately eight months before and after time *t*), the *RCI*s are calculated up to February 2007, which is eight months before the end of the sample period.

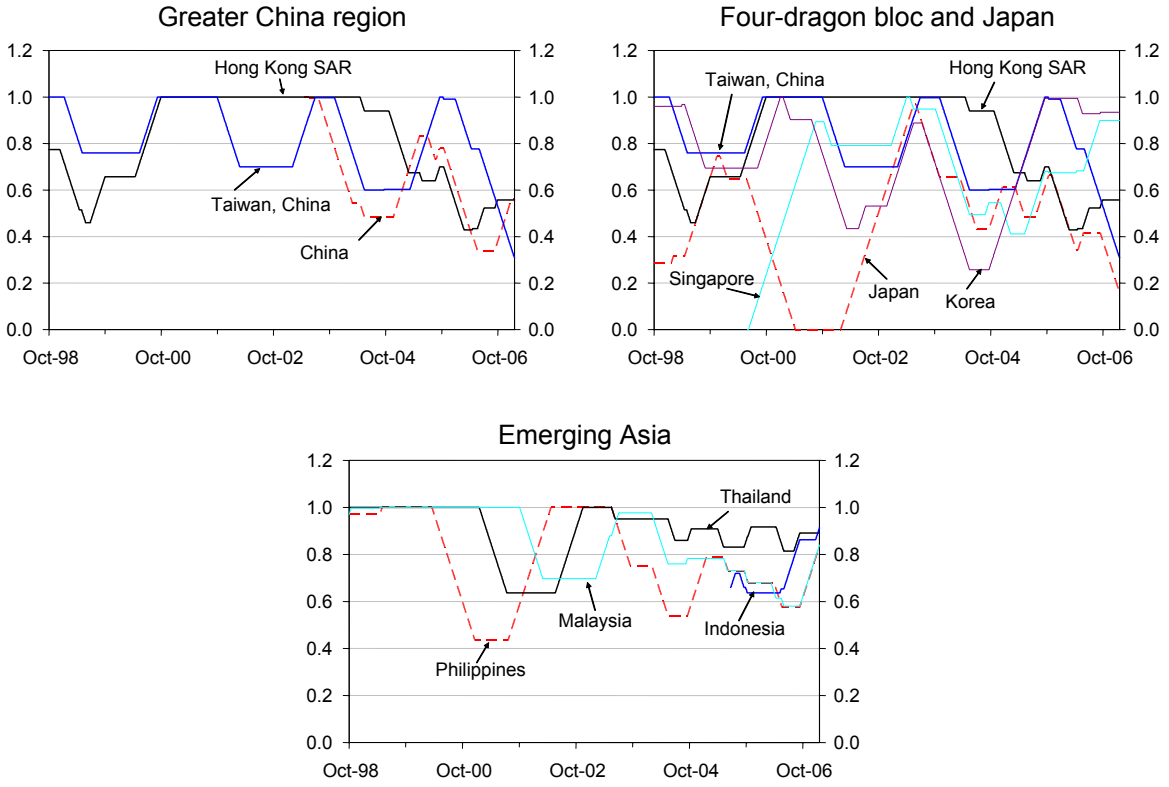
Source: HKMA staff estimates.

[41] During the search for peaks and troughs, multiple peaks (troughs) were found, but only the highest (lowest) of consecutive peaks (troughs) was taken as the peak (trough) of the cycle. Hence, for a complete cycle, there is only one peak and one trough.

The graphs in Figure 8 show that bond market cycles are quite synchronised for the Asian region as a whole. The *RCI*s for bond markets in the region – except those of Japan, Korea and Singapore – tend to fluctuate within a narrow range. It is noted that the *RCI*s for bond markets in the greater China region (China, Hong Kong SAR and Taiwan (China)) and Japan are lower than those for emerging Asia as well as for Korea and Singapore. While the *RCI*s for equity markets are more divergent and more volatile than those for bond markets, they are closer to one than the *RCI*s for the bond markets. This greater synchronisation suggests that Asia's equity markets are more integrated than its bond markets.

Figure 8

_RCI_s of Asian government 10-year bond indices against regional bond proxies



The individual bond market's regional index is proxied by the cross-country average bond index of the corresponding maturity, excluding the bond index of that market itself. It should be noted that as the local peak or trough is located by comparing the bond index level at time *t* with the levels throughout *t* – 174 days and *t* + 174 days (approximately eight months before and after time *t*), the *RCI*s are calculated up to February 2007, which is eight months before the end of the sample period.

Source: HKMA staff estimates.

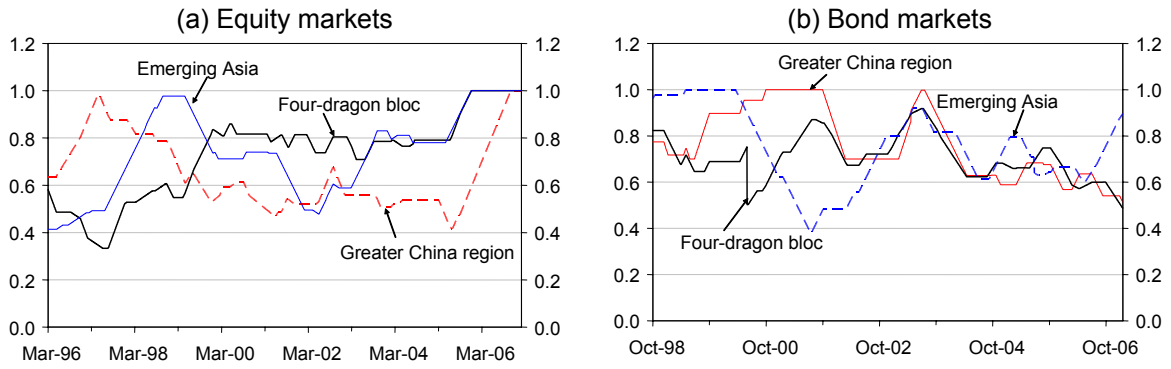
Figure 9 takes a closer look at the average *RCI*s for the three regional blocs.

Figure 9a shows that the equity market cycles in the greater China region are generally less synchronised with each other than those in the other two regional blocs. Nonetheless, since 2006 the average *RCI* of the greater China region has picked up rapidly and, recently, the market cycles of the equity markets within the individual regional blocs have been perfectly aligned (*RCI*s equal to one). For the bond markets, Figure 9b shows that the *RCI*s for the greater China region and the four-dragon blocs have declined since late 2003 and were around 0.5 recently. On the other hand, the *RCI*s for emerging Asia rose sharply, to 0.9, over the past year. Judging from the synchronisation analysis, Asian equity markets have become

more integrated at both the economy level and the regional bloc level, while their bond market counterparts are less integrated.

Figure 9

Average *RCI* of regional blocs



Source: HKMA staff estimates.

4.5 Dynamic conditional correlation (DCC)

The GARCH (1,1)-DCC model using a two-step estimation procedure is estimated using weekly equity and bond returns. The extent of intra- and intermarket integration is given by the correlations estimated from this model. Tables 6 and 7 highlight the average pairwise intramarket DCCs over the study period.

Table 6

Average conditional correlations of equity markets

	China		HK											Region
	SHA	SZA	HSI	H-shares	TW	SG	KR	TH	MY	PH	ID	JP	US	MSFE
China														
SHA	1	0.92	0.13	0.21	0.07	0.09	0.05	0.05	0.11	0.07	0.10	0.08	0.02	0.10
SZA		1	0.10	0.17	0.06	0.06	0.04	0.02	0.12	0.04	0.08	0.07	0.01	0.09
HK														
HSI			1	0.59	0.38	0.64	0.47	0.41	0.40	0.34	0.38	0.38	0.46	0.53
H-shares				1	0.24	0.43	0.33	0.32	0.29	0.25	0.30	0.21	0.24	0.33
TW					1	0.40	0.38	0.32	0.31	0.30	0.26	0.27	0.29	0.38
SG						1	0.44	0.52	0.53	0.46	0.49	0.40	0.39	0.56
KR							1	0.39	0.26	0.32	0.29	0.39	0.33	0.51
TH								1	0.42	0.43	0.48	0.29	0.27	0.41
MY									1	0.37	0.46	0.28	0.26	0.40
PH										1	0.47	0.26	0.26	0.34
ID											1	0.24	0.22	0.35
JP												1	0.30	0.93
US													1	0.37
Region														
MSFE														1

HSI = Hong Kong SAR's Hang Seng Index; H-shares = Hong Kong SAR's Hang Seng China Enterprises Index; HK = Hong Kong SAR; ID = Indonesia; JP = Japan; KR = Korea; MSFE = MSCI AC Far East Free Index; MY = Malaysia; PH = Philippines; SG = Singapore; SHA = Shanghai A shares; SZA = Shenzhen A shares; TH = Thailand; TW = Taiwan (China); US = United States.

Source: HKMA staff estimates.

Table 6 shows that while Asian equity markets are positively correlated, the markets in China are far less correlated with the rest of the equity markets in the region, with average conditional correlations typically around 0.1 or less. The DCCs for Hong Kong SAR range from 0.12 (with China) to 0.64 (with Singapore). In terms of regional blocs, if we take the MSCI AC Far East Free Index as representative of the whole region, the four-dragon bloc has an average DCC of 0.49 with the MSCI Index, which is higher than that of the greater China region (0.29) and emerging Asia (0.37).[42]

Table 7 shows that, in general, return correlations are not very high between the bond markets in the region. Individual bond markets' DCCs with the regional benchmark return proxy (the JPMorgan EMBIG Asia Sovereign return) range from 0.08 to 0.36. While most of the pairwise average DCCs are positive, the DCCs between the bond returns of Indonesia and those of China, Hong Kong SAR and Japan are negative. Tables 6 and 7 show that the correlation between equity markets is higher than that between bond markets, implying that equity markets have greater co-movement and are more integrated than bond markets.

Table 7

Average conditional correlations of bond markets

	China	HK	TW	SG	KR	TH	MY	PH	ID	JP	US	Region JPMGBI
China	1	0.53	0.32	0.45	0.19	0.28	0.13	0.00	**−0.16**	0.31	0.69	0.32
HK		1	0.33	0.46	0.29	0.26	0.21	0.04	**−0.08**	0.29	0.58	0.36
TW			1	0.37	0.31	0.30	0.17	0.11	0.15	0.31	0.24	0.13
SG				1	0.41	0.32	0.18	0.11	0.02	0.43	0.39	0.26
KR					1	0.31	0.18	0.10	0.11	0.36	0.15	0.22
TH						1	0.23	0.16	0.16	0.25	0.17	0.18
MY							1	0.19	0.21	0.12	0.08	0.21
PH								1	0.31	0.03	**−0.08**	0.18
ID									1	**−0.08**	**−0.20**	0.08
JP										1	0.25	0.13
US											1	0.41
Region JPMGBI												1

HK = Hong Kong SAR; ID = Indonesia; JP = Japan; JPMGBI = JPMorgan EMBIG Asia Sovereign return index; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; TW = Taiwan (China); US = United States. Red and bold numbers indicate negative correlation. It should be noted that as the starting dates of the government bond return series are different (see Table 2b), the number of return series involved in the estimation of the DCCs will increase as time passes. For instance, between March 1996 and March 1998, there are six return series in the DCC estimation. The number of return series increases to nine between April 1998 and August 1998, to 10 between September 1998 and July 2001, to 11 between August 2001 and September 2003 and to 12 from October 2003 onwards. Caution should be taken when comparing the DCCs.

Source: HKMA staff estimates.

Financial market integration in the region can also be assessed by examining the interactions between the equity and bond markets of different economies. Understanding these interactions is in fact important, as they underpin the contagion effect in the region. To carry out this assessment, the average pairwise intermarket DCCs between equity and bond markets are estimated and presented in Table 8.

[42] 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.

Table 8

Average conditional correlations between equity and bond markets

Equity markets	Bond markets: China	HK	TW	SG	KR	TH	MY	PH	ID	JP	US	Region JPMGBI
China												
SHA	**−0.04**	**−0.01**	0.03	0.06	0.07	0.09	0.04	0.08	0.16	0.06	**−0.08**	0.05
SZA	**−0.05**	**−0.03**	0.01	0.04	0.07	0.08	0.03	0.06	0.08	0.06	**−0.08**	0.04
HK												
HSI	**−0.15**	0.09	0.08	0.04	0.19	0.16	0.05	0.20	0.19	0.02	**−0.15**	0.16
H-shares	**−0.09**	0.04	0.08	0.04	0.09	0.06	0.06	0.12	0.26	**−0.02**	**−0.17**	0.12
TW	**−0.20**	**−0.03**	0.18	0.03	0.09	0.11	0.07	0.21	0.32	**−0.04**	**−0.16**	0.10
SG	**−0.10**	0.08	0.12	0.15	0.23	0.21	0.16	0.29	0.36	0.06	**−0.16**	0.19
KR	**−0.12**	0.01	0.12	0.03	0.34	0.13	0.07	0.22	0.27	**−0.01**	**−0.14**	0.18
TH	**−0.05**	0.05	0.13	0.09	0.20	0.30	0.14	0.22	0.21	0.05	**−0.09**	0.20
MY	**−0.06**	0.02	0.11	0.06	0.14	0.14	0.23	0.23	0.24	0.02	**−0.07**	0.13
PH	**−0.10**	0.03	0.10	0.08	0.12	0.17	0.17	0.42	0.28	**−0.03**	**−0.13**	0.24
ID	**−0.03**	0.05	0.10	0.16	0.24	0.15	0.22	0.33	0.43	0.04	**−0.10**	0.19
JP	**−0.10**	**−0.02**	0.11	0.07	0.19	0.11	0.02	0.14	0.22	0.28	**−0.10**	0.16
US	**−0.28**	**−0.04**	**−0.04**	**−0.02**	0.13	0.01	**−0.03**	0.09	0.13	**−0.08**	**−0.13**	0.18
Region												
MSFE	**−0.12**	0.02	0.14	0.08	0.24	0.16	0.07	0.21	0.27	0.23	**−0.15**	0.19

HK = Hong Kong SAR; HSI = Hong Kong SAR's Hang Seng Index; H-shares = Hong Kong SAR's Hang Seng China Enterprises Index; ID = Indonesia; JP = Japan; JPMGBI = JPMorgan Asia Sovereign return index; KR = Korea; MSFE = MSCI AC Far East Free Index; MY = Malaysia; PH = Philippines; SG = Singapore; SHA = Shanghai A shares; SZA = Shenzhen A shares; TH = Thailand; TW = Taiwan (China); US = United States. Red and bold numbers indicate negative correlation. Bond markets are in the horizontal rows across the table and equity markets are in the vertical columns. For instance, the upper left entry is the correlation between the 10-year bond return in China and Shanghai A share index return. Immediately to the right of this entry is the correlation between 10-year Hong Kong EFN return and Shanghai A share index return.

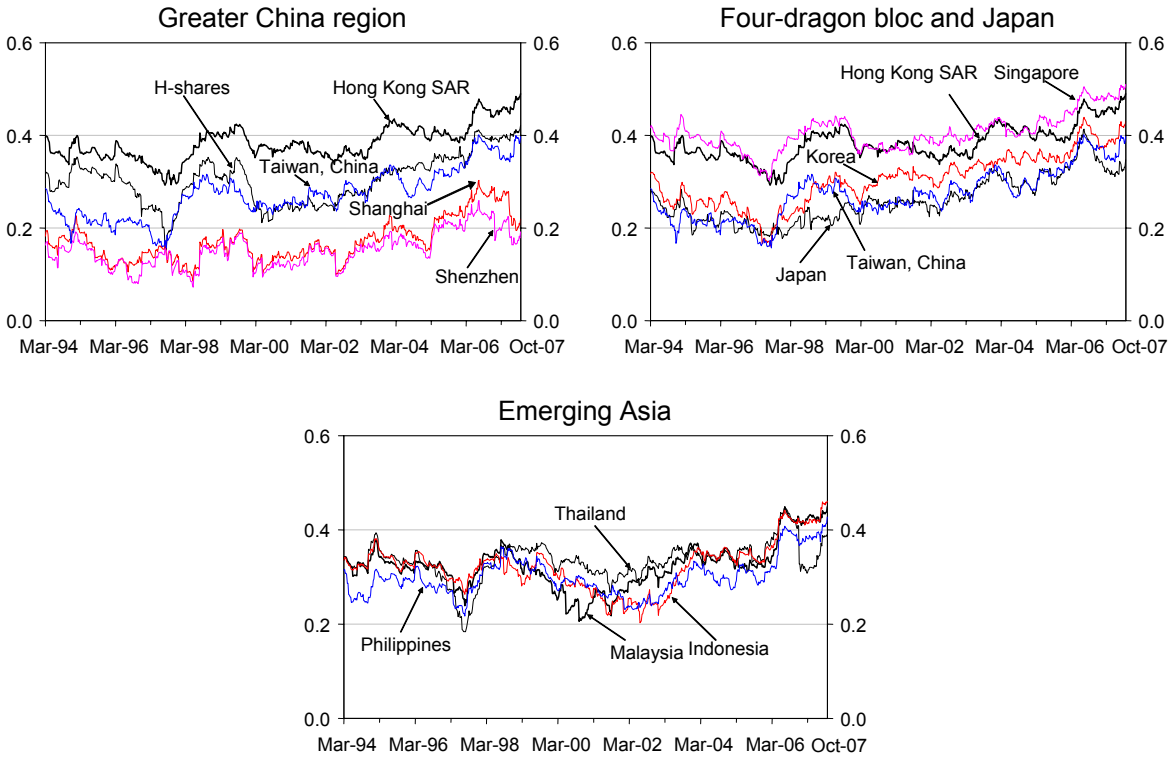
Source: HKMA staff estimates.

Table 8 presents several observations. First, all the equity markets surveyed are negatively correlated with bond markets in China and the United States, even though the degree of correlation is low. Second, equity and bond markets within all of the Asian economies – with the exception of China – are positively correlated. The equity-bond intermarket correlation within an economy ranges from a high of 0.43 in Indonesia to a low of 0.09 in Hong Kong SAR. Third, each Asian equity market is either negatively correlated with at least one bond market in another economy (China) or correlation is positive but very low (less than 0.1). This implies that portfolio risk can be diversified across economies in Asia or internationally. However, risk diversification through intermarket holdings of equities and bonds within an Asian economy may not be effective due to the positive correlation of returns. Fourth, there seems to be asymmetry in the correlation of a few markets. For instance, while the correlation between the Hong Kong SAR's bond market and the equity benchmark of MSCI AC Far East Free Index is 0.02, the correlation between the Hong Kong SAR's equity market and the bond benchmark of the JPMorgan EMBIG Asia Sovereign return index is much higher, at 0.16. The same is true for Taiwan (China) and Singapore. While China's bond market is negatively correlated with the MSCI equity benchmark index, its two A share equity markets are positively correlated with the JPMorgan bond index. The asymmetry implies that one should choose the appropriate markets (or benchmark) with care to obtain optimal risk diversification.

Figures 10 to 12 depict the time-varying intramarket return correlations in the Asia region, while Figures 13 to 15 show the time-varying intermarket return correlations.

Figure 10

DCCs of individual Asian equity markets with other equity markets



Source: HKMA staff estimates.

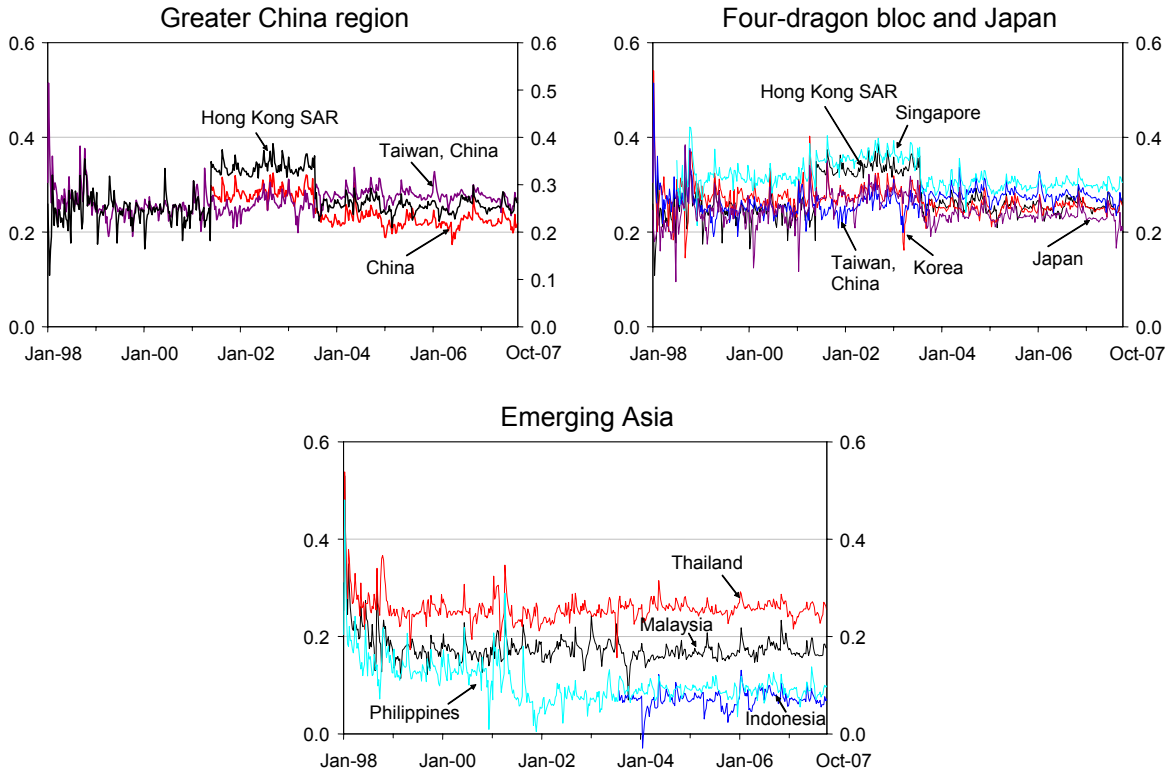
The graphs in Figure 10 show that among the equity markets in the greater China region, those in China have the lowest correlation with other Asian markets. Even though there have been signs that correlation with other markets in the region has been increasing in the past two years, it is still only around 0.2, compared with equity markets in Taiwan (China) and Hong Kong SAR's H-shares (between 0.2 and 0.4) and Hong Kong SAR (between 0.3 and 0.5). Among the equity markets in the four-dragon bloc, the correlations of Hong Kong SAR and Singapore with the other Asian equity markets are quite similar and range from 0.3 to 0.5. The correlations of Taiwan (China), Korea and Japan are slightly lower, ranging from 0.16 to 0.43. The DCCs of emerging Asia's equity markets are similar to those in the four-dragon bloc and are closely packed together, with correlations ranging between 0.19 and 0.46. Overall, except for the equity markets in China and Japan, Asia's equity markets have shown increasing correlation with each other in the past year, but correlation remains low, between 0.4 and 0.5. The return correlation given by the DCC in Asia is slightly smaller than that in the European Economic and Monetary Union (EMU).[43]

Figure 11 depicts the average intrabond market DCCs between the returns of individual markets' 10-year bonds and those of the other bond markets.

[43] In their investigation of the correlation of global equity returns, Cappiello, Engle and Sheppard (2003) show that equity return correlations both within and outside the EMU increased after 1999, with average DCCs rising from 0.5 to 0.7.

Figure 11

DCCs of individual Asian bond markets with other bond markets



Source: HKMA staff estimates.

The graphs in Figure 11 indicate a fairly low level of average correlation, about 0.1 to 0.3 at the end of October 2007, between bond returns in individual markets and those in the other bond markets. The DCCs of Indonesia, the Philippines and Malaysia – less than 0.2 – are among the lowest in the region. A much greater degree of return correlation is found in Europe.[44] The DCCs for bond returns are also more volatile and lower than those for equity returns. The rather flat DCCs in Figure 11 also indicate that there has not been much progress in terms of bond market integration within Asia.

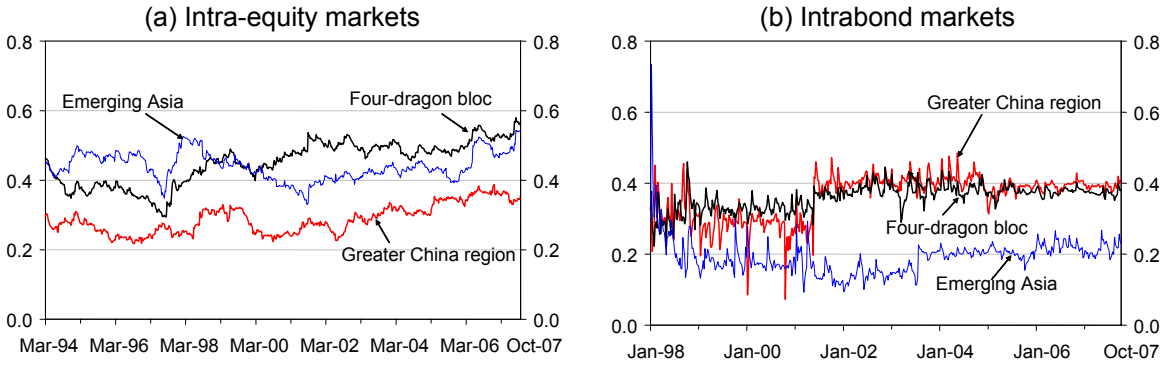
Figure 12 focuses on the patterns of the average intra-equity and intrabond market DCCs of the three regional blocs. Figure 12a shows that equity markets in the greater China region are less integrated with each other than those in the four-dragon bloc or even emerging Asia. Nonetheless, equity markets in all three regional blocs, with rising DCCs, show signs of increasing integration. It is noted that the average DCC of the equity markets in emerging Asia was higher than that of the four-dragon bloc before 2000. After 2000, the DCC of the four-dragon bloc surpassed that of emerging Asia, suggesting that the equity markets' integration is higher in the four-dragon bloc than in the other two regional blocs. In Figure 12b, bond markets in the greater China region and the four-dragon bloc are relatively more correlated with each other than with those in emerging Asia. Nonetheless, the degree

[44] In their investigation of bond return correlation between members of the EMU, Cappiello, Engle and Sheppard (2003) show that the average DCC fluctuated between 0.7 and 0.9 before 1999 and that correlation was almost perfect after the introduction of the euro in January 1999.

of correlation, which is only about 0.4, is not high, and it is also lower than that of the equity markets. Furthermore, while the intra-equity market DCCs within the three regional blocs show signs of increasing integration, the intrabond market DCCs show no such signs.

Figure 12

Average intramarket DCCs of regional blocs

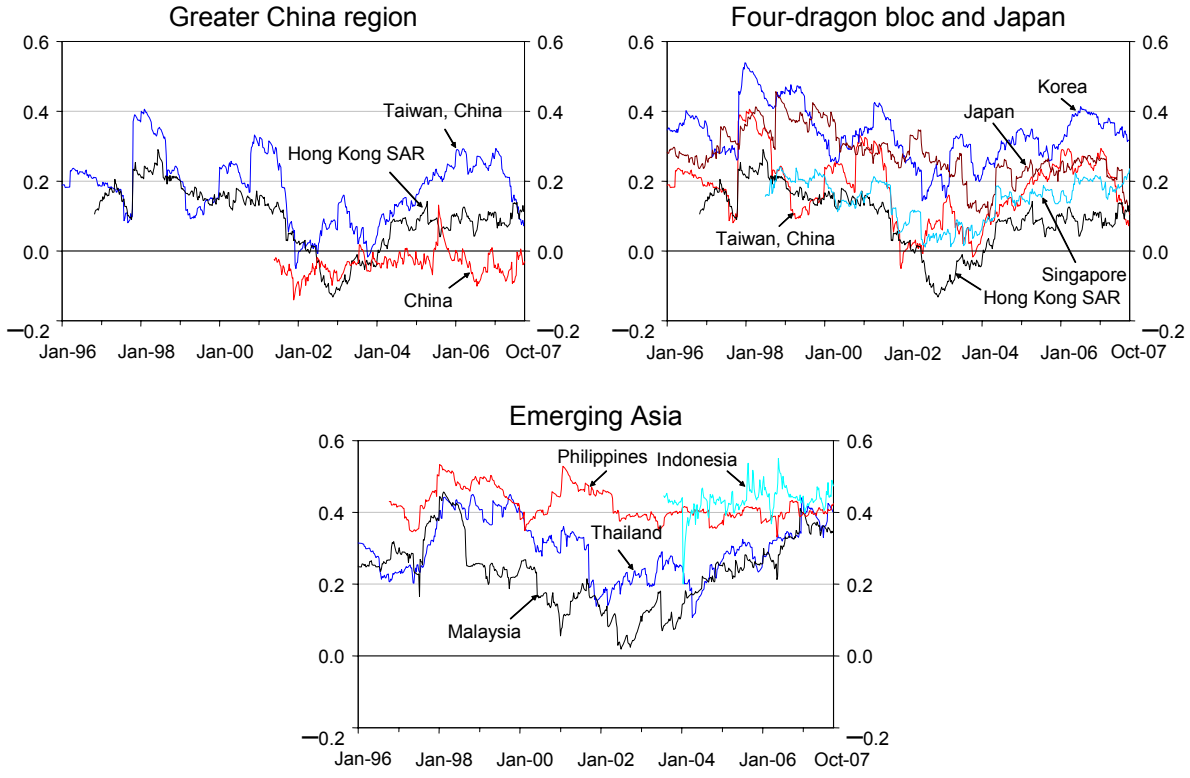


Source: HKMA staff estimates.

Financial market integration among different assets in the region can also be assessed by examining the intermarket co-movement of bond and equity returns. Figures 13 to 15 illustrate the inter-equity-bond market return correlations within and across Asian economies.

Figure 13

DCCs of inter-equity-bond markets within an economy



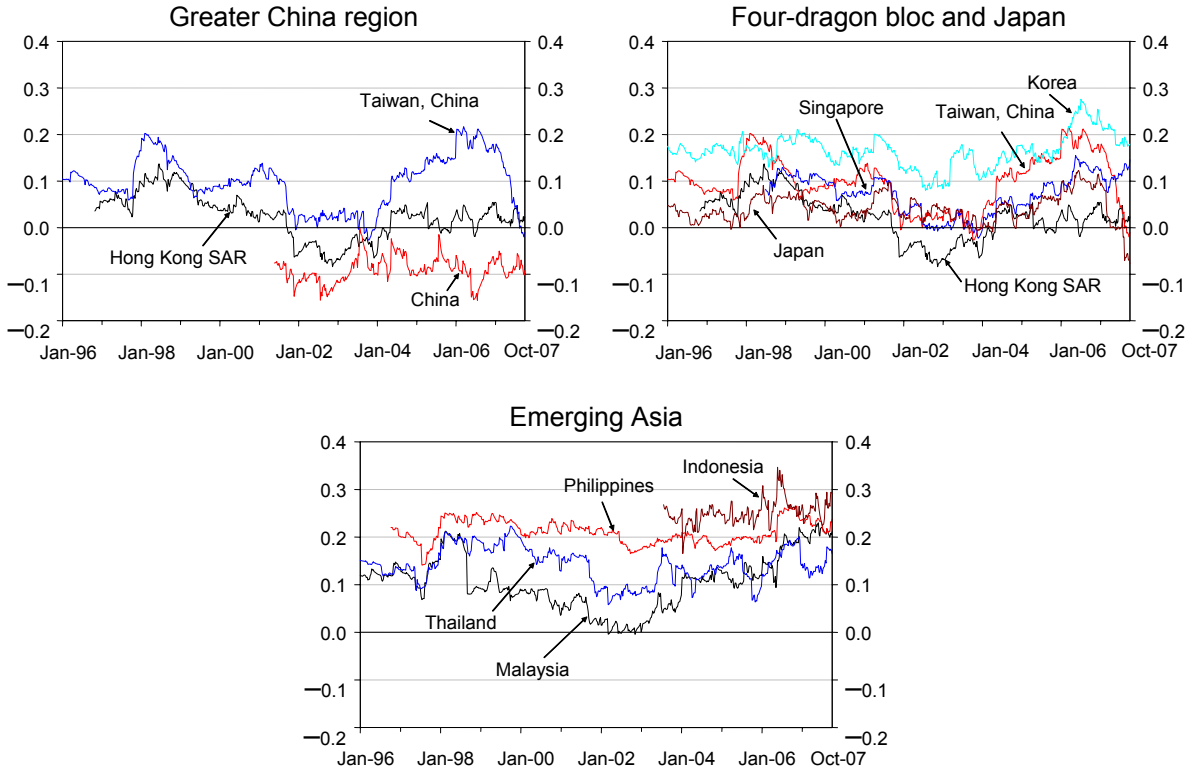
Source: HKMA staff estimates.

The graphs in Figure 13 show that except for China's equity and bond markets, the DCCs of inter-equity-bond markets within an economy are mostly positive over the study period. While the inter-equity-bond correlations in Malaysia and Thailand have been increasing over the past five years, the correlations in other Asian economies have either remained steady (Hong Kong SAR, Singapore, the Philippines and Indonesia) or shown signs of declining (Japan, Korea and Taiwan, China).

The graphs in Figure 14 show the average DCCs between individual bond market returns and Asian equity market returns. Again, the DCCs of bond market returns in China are negatively correlated with Asian equity market returns, while the DCCs of other Asian bond markets are mostly positively correlated with Asian equity market returns. That said, we note that the DCCs of bond market returns in Japan and Taiwan (China) have been negatively correlated with Asian equity market returns since September 2007. Figure 15 compares the inter-equity-bond correlations within and across the regional blocs.

Figure 14

DCCs of individual bond markets with other Asian equity markets



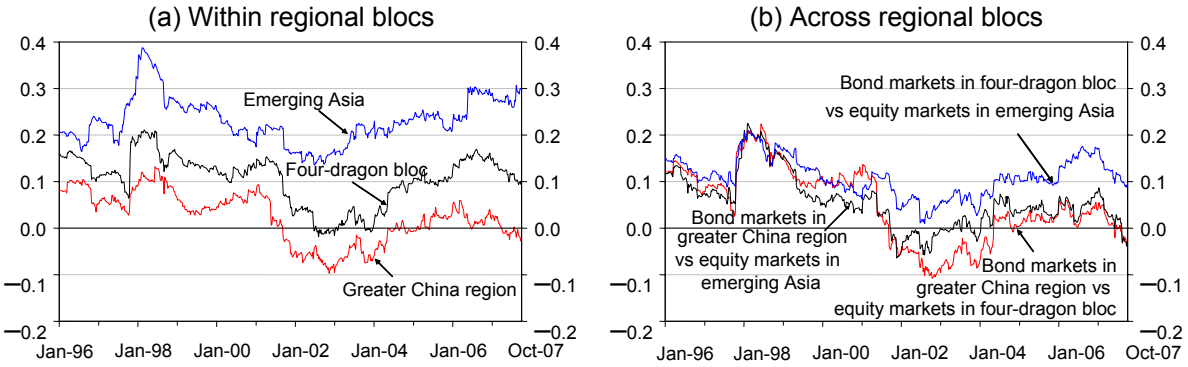
Source: HKMA staff estimates.

Figure 15a shows the average DCCs between individual bond market returns and equity market returns within the same regional bloc, whereas Figure 15b shows the inter-equity-bond DCCs across different regional blocs. The patterns are very similar. Focusing on Figure 15a, the positive inter-equity-bond market correlation increased sharply during the Asian financial crisis and declined steadily (and turned negative for the greater China region) between 1999 and 2002. The declining trend was reversed in 2003, but the correlations have been falling again over the past year. Among the three regional blocs, emerging Asia has the highest inter-equity-bond market DCCs, while those of the greater China region are the lowest (and are sometimes negative). Therefore, diversification of risk between equities and bonds is more effective in the greater China region than in emerging Asia.

Turning to Figure 15b, the average DCCs across the various regional blocs show similar patterns and more co-movement than in Figure 15a, at least before 2001. As in Figure 15a, the cross-regional inter-equity-bond correlations were mostly positive, and they rose sharply during the Asian financial crisis. The positive correlations declined after the crisis. Figure 15b also shows that the inter-equity-bond correlations between bond markets within the greater China region and the equity markets of the other two regional blocs turned negative between October 2001 and May 2004. While the correlations reverted to positive after May 2004, they were again slightly negative at the end of October 2007. On the other hand, the inter-equity-bond correlations between bond markets within the four-dragon bloc and equity markets within emerging Asia remained positive throughout the study period. The results suggest that risk could be diversified by investing in bonds in the greater China region and equity markets in the other two regional blocs.

Figure 15

Inter-equity-bond DCCs within and across regional blocs



Source: HKMA staff estimates.

5. Summary and discussion

Table 9 provides a summary of the current status of equity and bond market integration, broken down by the first four indicators, while Table 10 shows the results by DCC.

Given the different focus of each of the indicators in Tables 9 and 10, the picture that emerges from the empirical results is not completely uniform. Nevertheless, most indicators suggest that both the equity and the bond markets in Asia are only weakly integrated and the integration process is not complete. The equity return dispersions or differentials have been rising since 2006 after years of decline, suggesting an increased equity return divergence within Asia. Meanwhile, bond return dispersion and differentials have fluctuated in a narrow range since 2001, indicating that a reasonable degree of bond market integration has been achieved but that further improvement has not been observed. The results from the Haldane and Hall (1991) approach indicate that the integration process, as illustrated by the sensitivity indicator, is far from complete, as individual equity and bond market indices are more or less equally responsive to both global and regional influences. The results from the dynamic cointegration method also indicate weak integration. A finding common to all four indicators is that the price convergence process appears to be more complete in the mature markets of the region, such as Hong Kong SAR, Japan, Korea and Singapore (as suggested by the indicators from the return dispersion and differentials, as well as the Haldane and Hall (1991) approach), than those in the markets of emerging Asia. In the region, equity market cycles are more aligned than bond market cycles in terms of return co-movement based on the

DCC. In other words, the integration of Asia's equity markets is more advanced than the integration of its bond markets. While China's equity markets were less integrated than equity markets in other regional blocs, the degree of integration of its bond markets was similar to that in the four-dragon bloc.

Table 9

Summary of current financial market integration in Asia

Method	Indication of market integration	Current status of market integration	
		Equity market	Bond market
Cross-market return dispersion and return differential	Lower return dispersion and smaller return differential imply higher return convergence	After years of falling return dispersion and differentials, both indicators edged up slightly in 2007	Both indicators have fluctuated steadily since 2001, suggesting that a reasonable degree of integration has been achieved
Haldane and Hall (1991) Kalman filter method	Unweighted average ß moving towards zero indicates an increasing sensitivity to regional influence	Considerable progress in integration was observed in both markets during the 1990s, but no significant improvement has been observed since 2002	
Dynamic cointegration analysis	Standardised trace statistics consistently greater than one indicate the presence of a long-run relationship between equity markets	Only weak cointegration and no indication of further improvement in both markets	
Market cycle synchronisation	An upward trend in the *RCI* signals increased market concordance	The average *RCI*s of equity markets are higher than those of bond markets, suggesting greater equity market concordance	

Table 10

Summary of current financial market integration in Asia

Method	Indication of market integration	Current status of market integration		
		Intra-equity market	Intrabond market	Inter-equity-bond market
Dynamic conditional correlation (DCC)	The higher the time-varying correlation, the larger the co-movement between markets	Higher and improving level of DCCs (0.2 to 0.5)	Low level of DCCs (0.1 to 0.3) and no improvement	Mostly positively correlated at a low level (less than 0.3), except for China's bond market and Asian equity markets, which are negatively correlated

On the evolution and status of integration, much progress was made in the region during the 1990s with respect to greater return convergence. However, the convergence process has appeared to be at a standstill, or even regressing, since 2002. On the other hand, return co-movements have increased between Asian equity markets, with the exception of China's, while Asian bond market correlation was at a standstill. In addition to indicating greater integration of Asian equity markets, the increased equity return correlation may heighten concern about the contagion effect between Asian equity markets.

On the question of the relative importance of regional and global factors, this study, based on the Haldane and Hall (1991) approach, shows that both factors are important to Asian equity and bond markets. For Asia as a whole, sensitivity to the United States' influence has been increasing since 2001. However, the impacts on the financial markets in different economies are not the same. For instance, while equity markets in emerging Asia are becoming more sensitive to the influence of US markets, Asia's bond markets are less sensitive to their US counterparts than they are to those in the other two regional blocs.

With regard to the issues of contagion and risk diversification, the DCC results show that, except for China, inter-equity-bond correlations are mostly positive in Asian economies. This suggests that risk diversification through equities and bonds within the same economy is ineffective. On the other hand, equity and bond investment within or across regional blocs may contribute to risk diversification. This is particularly true for equity-bond-investment within the greater China region, or for using bond markets in the greater China region as the anchor against equity market investment in the other two regional blocs.

In summary, the empirical results from these indicators provide a general picture of equity and bond market integration, but the extent and speed of integration in the region varies. The evidence broadly supports the observation that Asia has witnessed a lot of progress over the years in achieving greater regional financial integration in the equity and bond markets. However, the extent of integration still seems to be limited. The process appears to have stalled in recent years, and the two major regional blocs – mature and emerging 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' holdings of Asian assets also indicate a lower degree of regional integration in Asian capital markets. In comparison, European equity and bond markets appear to be more integrated as (a) the equity return dispersion in Europe dropped by more than half between 1999 and 2005, from over 500 bps to about 200 bps, and the yield spread dispersion has been zero since 2001, (b) their index movements are more sensitive to the regional benchmark index and (c) their return correlations are much higher.

Apart from local or idiosyncratic factors such as credit or liquidity risks in some Asian economies, the divergence and the lack of progress in financial market integration may be attributed to a number of factors. The first is the absence of links between jurisdictions across the whole spectrum of financial infrastructure – the trading, payment, clearing, settlement and custodian systems. Such links would facilitate movements of capital and savings across jurisdictions, leading to more financial intermediation. The second is the failure to harmonise standards in the region's capital markets – for example, the adoption of minimum acceptable international standards, which would improve investor confidence and enhance the flow of capital within the region. The third relates to the need to strengthen cooperation in financial system development, which would increase the diversity of financial intermediation channels in individual jurisdictions. Last but not least is the need to relax non-supervisory restrictions on the access of foreign financial intermediaries to domestic financial markets. Greater competition through financial services liberalisation enhances efficiency.[45]

[45] There are discussions in the region about a possible role for currency cooperation, in terms of a regional exchange rate arrangement, in reducing uncertainties about exchange rate movements, providing stability for

As pointed out by Jeon, Oh and Yang (2006), the lack of success in policy coordination may also hamper financial integration.

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

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.

Appendix: Methodology and interpretation: indicators of financial market integration

This appendix provides in detail the methodologies for constructing the different indicators for assessing financial market integration in Asia and their interpretation. All integration indicators are derived using the benchmark equity indices (or bond return indices) expressed in terms of the US dollar. For the equity market, the conversion of the benchmark index into US dollars is done by dividing the local currency index level by the local currency per US dollar exchange rate. For the bond market, returns are approximated using the holding period return, as discussed in Shiller (1979).[46] Once the bond return series (in local currency) are derived, they are converted into US dollar return series by dividing the local currency bond return series by the percentage change in the local currency per US dollar exchange rate of the respective economies.

i. Cross-market return dispersion

The idea behind the cross-market return dispersion approach introduced by Solnik and Roulet (2000) is simple and intuitive. This can be used as an alternative to the time series approach to estimating the level of correlation of financial 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 financial market returns across countries, as measured by the cross-market return dispersion, it will imply that the financial markets are not fully integrated in the sense of return convergence. In this measure, low return dispersion implies higher market integration and vice versa.[47] Based on Solnik and Roulet (2000), Adjaouté and Danthine (2003) and Baele et al (2004) use the negative relationship between dispersion and integration to assess equity market integration in Europe.

Cross-market dispersion is calculated as the standard deviation of the log differences of the benchmark equity indices (or the standard deviation of the holding period returns for bonds) of various 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 markets, is used to assess the market integration process among regional blocs. The smaller the maximum-minimum return differential between markets, the greater their return convergence.

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 the series should converge to a constant, *c,* over time, such that $\lim_{k \to \infty} E(X_{t+k} - Y_{t+k}) = 0$ *or* c, where X and Y are the two series. The convergence may be a gradual, ongoing process. If we expect convergence to increase over time, we need a measure that allows for dynamic structural change. This measure will be useful in describing the process of structural change in terms of both degree and timing. The Kalman

[46] See Footnote 25 for the formula of holding period returns.

[47] It should be noted that financial markets in different countries are not homogeneous in the sense that their returns may not be absolutely equal even though these markets are fully integrated.

filter approach suggested by Haldane and Hall (1991) is a method that can be used to measure the time-varying convergence dynamic.[48]

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

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

and the state equations as

$$\alpha_{i,t} = \alpha_{i,t-1} + \xi_t, \qquad \xi_t \sim N(0,U)$$

$$\beta_{i,t} = \beta_{i,t-1} + \mu_t, \qquad \mu_t \sim N(0,W), \tag{2}$$

where $E_{i,t}$ is the equity market index level (or bond market return index) of country *i* at time *t*, $E_{B,t}$ is the equity market index level (or bond market return index) of a dominant regional market (ie a regional equity (or bond return) 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 (or the US Treasury bond return).

We obtain the estimated parameter ß$_i$ over time via the Kalman filter. From equation (1), using equity markets as an example, 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 ß$_i$ 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 that ß$_i$ approaches one. In this measure, a tendency for ß$_i$ to move towards zero indicates the increasing sensitivity of an individual equity (or bond) market to the influence of a regional market, suggesting a higher degree of price convergence with the regional market.[49, 50]

iii. Dynamic cointegration analysis

In the literature, cointegration analysis is one of a number of traditional methods for estimating the nature and extent of financial market integration. The essence of cointegration is that the series that are cointegrated cannot deviate too much from each other, implying that there exists a long-run relationship between them. Kasa (1992) was 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. Click and Plummer

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[48] Serletis and King (1997) and Manning (2002) use the Haldane and Hall approach to measure the convergence of equity markets in the European Union and in Southeast Asia, respectively.

[49] By rearranging equation (1), we obtain the following:

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

It can be seen from equation (A1) that when ß$_i$ 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 ß$_i$ approaches one, the influence of $E_{B,t}$ is decreasing, while that of $E_{US,t}$ is increasing, which suggests that $E_{i,t}$ and $E_{US,t}$ are converging. When β_i is greater than one or becomes negative, $E_{i,t}$ appears to be diverging from $E_{B,t}$ and $E_{US,t}$.

[50] One caveat of the Haldane and Hall approach is that the conclusion of whether the equity (or bond) markets are converging or diverging may well differ depending on the choice of dominant regional market and dominant external market.

(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 therefore 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 a cointegration technique in examining market integration is that it says little about the dynamics of convergence because it fails to take into account the fact that convergence is a gradual and ongoing process. To examine the time-varying nature of convergence, a recursive cointegration test can be used. The Johansen approach, In particular, generates a statistic that can be used for this purpose. The trace statistic is a test of the general question of whether one or more cointegrating vectors exist. In the recursive cointegration approach used with an expanding sample size in Hansen and Johansen (1992), the trace statistics can be plotted over time to examine the time-varying nature of market integration. If markets are cointegrating (ie converging), the standardised trace statistic, 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 cointegrated in any sense, the standardised trace statistics will be less than one. The more cointegrating vectors found in a group of financial variables, the greater their cointegration.

Rangvid (2001) uses this recursive approach to examine the convergence among European equity markets and observes the upward trend for the trace statistics, which indicates the increasing convergence of European equity markets but without determining whether it is due to the reduction of the number of underlying stochastic trends over time as the equity markets become more integrated, or to the fact that the sample size increases over time (also known as the "the power of the test" effect). Pascual (2003) therefore proposes conducting rolling cointegration tests with a constant sample size as the estimation rolls over to the next period. Under these conditions, an upward trend in the estimated trace statistics can 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 examined in Rangvid (2001). In this study, we adopt Pascual's rolling estimation approach to eliminate the effect of increasing sample size.

iv. Synchronisation of financial market cycle approach

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

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 from bearish to bullish and vice versa. Following the rules from Edwards, Biscarri and de Gracia (2003) for locating the turning points, we identify the peaks and the troughs of financial market cycles as follows:

1. The local peak (trough) is located by comparing the market index level at time t with its index levels throughout $t - 174$ days and $t + 174$ days (approximately eight months before and after time t).[51]

[51] Edwards, Biscarri and de Gracia (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, Biscarri and de Gracia, a total cycle length of 16 months is chosen, as suggested by Pagan and Sossounov (2003).

2. Once the peaks and troughs are identified, censoring rules are applied to ensure that we do not identify spurious phases:

   – turning points within eight months of the beginning/end of the series are eliminated;

   – the peak or trough next to the endpoint of the series is eliminated if it is lower/higher than the endpoint;

   – cycles of less than 16 months are eliminated;

   – phases of less than four months are eliminated;

   – enforced alternation so that a peak is always followed by a trough and vice versa;

   – if consecutive peaks (troughs) occur, take the highest (lowest) one.

3. For periods identified as bull phases (S_t), S_t = 1, and for those identified as bear phases (B_t), B_t = 1. A rolling concordance index (*RCI*), using a window of 16 months (which is equivalent to one complete market cycle), is constructed for markets *i* and *j*, as follows:[52]

$$RCI_{ij} = \frac{1}{350}\sum_{\tau=1}^{350}\left[S_{i,t-\tau}S_{j,t-\tau} + B_{i,t-\tau}B_{j,t-\tau}\right]. \quad (3)$$

The value of the concordance index ranges from zero (perfect misalignment of phases) to one (perfect alignment).[53] An upward (downward) trend in the *RCI* signals increasing (decreasing) market concordance, implying greater (less) market integration.

v. Correlation using DCC model

Simple (or rolling) correlation analysis is one of the simplest methods for examining the co-movement of financial markets. Basically, higher correlation between markets implies greater co-movement and greater integration. The DCC model proposed by Engle and Sheppard (2001) and Engle (2002) is a new class of multivariate model particularly well suited to the examination of correlation dynamics among assets. The DCC approach has the flexibility of univariate GARCH but without the complexity of a general multivariate 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 intra- and intermarket correlations, a two-step estimation procedure of the DCC model is used. Univariate GARCH models are first estimated for each asset return series. The standardised residuals from the first step are then used to estimate the dynamic conditional correlations between asset returns. Specifically, let $z_{i,t}$ and $z_{j,t}$ be the standardised residuals of asset returns of countries *i* and *j* at time *t,* respectively, $i \neq j$. The GARCH process, as suggested in Engle (2002), is as follows:

$$q_{ij,t} = \bar{\rho}_{ij} + \alpha(z_{i,t-1}z_{j,t-1} - \bar{\rho}_{ij}) + \beta(q_{ij,t-1} - \bar{\rho}_{ij}) \quad (4)$$

and

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

[53] The concordance index is used in Harding and Pagan (2000, 2002).

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}} \tag{5}$$

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 asset returns of countries *i* and *j* at time *t*.[54]

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

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