1. Introduction

Not very long ago developments in most Asian markets other than Japan were little more than an afterthought to western observers. The People's Republic of China did not even have operating stock markets until 1992 and most other Asian exchanges seemingly remained too limited in size to exert any meaningful influences on the United States or other major western financial centers. The 1997-1998 Asian financial crisis brought home how interconnected the world had become, however, as the collapse of the Thai baht's peg with the US dollar in July 1997 exerted shockwaves around the world. Although the most devastating moves occurred in neighbouring East Asian economies like Indonesia and Malaysia, which had shared Thailand's reliance upon a dollar peg, major market moves were also seen in the United States and other western markets. Mainland China's own financial markets were aided by capital controls that helped shield the economy from the worst of the Asian financial crisis. [1] The extraordinary growth since that time is reflected in the fact that the Shanghai Stock Exchange stood in sixth place in the world (based on domestic market capitalization) in 2009, just behind the London Stock Exchange. In May 2007 former Federal reserve Chairman Alan Greenspan was already expressing concern that there had been too much of a good thing, stating that the Chinese market gains were becoming "unsustainable" and that a "dramatic correction" was inevitable (see Lima and Kennedy, 2007). While Greenspan's view actually seemed to receive some initial vindication a few months later, it is telling that the market was garnering such worldwide attention in the first place.

Although Authers (2010, p. 2) refers to the “Shanghai Surprise” to describe what happened in world stock markets on February 27, 2007, when the Shanghai Composite Index fell by over 9% in a day while the S&P 500 fell by more than 3%, he is surely incorrect in arguing that this event “marked the start of the worst global financial crisis for at least 80 years, ...”. On the contrary, the Shanghai Stock Exchange went on to enjoy a 96% rise in 2007 (after having

[1] Some have argued that China not only fared relatively well during the Asian financial crisis but also played a role in initiating it through the 1994 currency devaluation that secured export advantages vis-à-vis other Asian economies. While export competition from China almost certainly played a role in the problems experienced elsewhere in the region (Khan and Islam, 2008), it is unlikely that the exchange rate devaluation by China was itself the key trigger as the weighted average effect on prevailing Chinese exchange rates at the time amounted to only around 10% (Lardy, 2005). The 1994 depreciation, in fact, merely capped off a gradual move towards more market-determined exchange rates in the post-1978 period (see Burdekin, 2008, chapter 1).

already doubled in 2006), peaking at the end of October 2007 months after most western stock markets had begun falling in the face of the credit crunch that manifested itself over the summer. Indeed, while the subsequent collapse of the Shanghai market index from above 6000 in October 2007 to below 2000 in October 2008 was even more dramatic than the declines seen in most major world markets, the broad sequence of events hardly suggests the Shanghai market playing any part in signalling the global financial crisis.[2] Indeed, the integration of mainland China's financial markets with other world markets remains very much an open question. For example, continued capital controls and restrictions on foreign entry into China's financial markets and limitations on purchases of offshore securities by local Chinese investors have been associated with ongoing price differentials between the share prices of mainland Chinese companies in Shanghai vs. their prices in Hong Kong and New York (cf, Arquette, Brown and Burdekin, 2008). Such differentials have persisted even for the large, and highly liquid, large Chinese state-owned banks that had IPOs in Hong Kong during 2005-2006 (Burdekin and Yang, 2010), seemingly lending support to ongoing claims that the Shanghai market is segmented even from Hong Kong (cf, Wang and Jiang, 2004; Chong and Su, 2006).

This paper seeks to shed new light on the degree of Asia-Pacific market integration, and the actual extent to which Shanghai has become more linked with other markets, by examining short-run and long-run relationships between stock returns. Although there is already a large literature bearing on the question of financial market integration, past work has generally not offered a comprehensive examination of the group of Asia-Pacific markets nor included data extending through the onset of the global financial crisis.[3] Such an analysis seems overdue given the higher profile of the Asia-Pacific region driven not only by the growth in the Chinese markets but also a general rise in financial market integration on a global scale that has helped

[2] To be fair Authers (2010, chapter 17) uses the February 2007 event in Shanghai as a pretext for pointing out that it may have led investors to wake up to the fact that many economies around the world were over-leveraged and that a major correction in several asset markets was in the offing.

[3] Given the potential scope for herding behaviour, events in one market can affect another even if there are barriers like capital controls that stop money flowing freely between them – such that mainland China's capital controls, for example, do not automatically preclude co-movement with other markets. Market interactions can themselves involve monsoonal effects and spillover effects rather than just pure contagion (Masson, 1998). Both monsoonal and spillover effects can be explained by a combination of economic fundamentals and the susceptibility of countries to common shocks. Pure contagion, on the other hand, arises from factors that cannot be associated with fundamentals, often reflecting panic during times of crisis but also potentially being triggered by more mundane channels such as portfolio rebalancing (Liang and Willett, 2009).

make regional developments more relevant to the west.[4] This has been accompanied by an intensification of trading within the Asia-Pacific region itself, some efforts at policy coordination (e.g., the Chiang Mai initiative), and improved trading technology. The ongoing global financial crisis adds another element raise interest in understanding the links between equity markets, particularly between the seemingly more resilient Asia-Pacific markets and the United States. It is these linkages, both short-term and long-term, that are the focus of our empirical work.

Our econometric analysis confirms the importance of shifts in market behaviour during crisis periods while also suggesting that the evidence for contagion-type effects remains very much dependent on which market group one examines. For example, notwithstanding considerable evidence of contagion-type effects between the mature Asia-Pacific markets and those of the emerging variety, there is virtually no evidence of contagion between the benchmark markets of the United States and Japan and the more mature regional markets such as Australia, Hong Kong and Korea. The Shanghai market plays a significant role in influencing many other regional markets over our 1995-2010 sample period, with its growing influence clearly evident in the sharply rising conditional correlation of returns around the outbreak of global financial crisis in 2007 – just as the US market's relationship with the Asia-Pacific equity markets falls off. Meanwhile, long-run links between these stock markets over the post-Asian financial crisis period are seen to be highly sensitive to the actual size of returns. When returns are relatively high, an oft seen feature of the Shanghai market in recent years, this pulls several other markets in the same direction. As restricting attention to the means of the distribution would not offer a full or accurate picture of how and whether stock returns move together in this case, we employ quantile cointegration analysis to examine the long-run market interrelationships.

2. Related Literature

There are at least three issues that are germane to a study of the relationship between equity returns. These include policies and related developments that promote international

[4] This same increase in financial integration can also weaken the incentive to acquire detailed information about individual financial markets), however, thereby effectively promoting a rise in the incidence of contagion (Calvo and Mendoza, 2000).

financial market integration over time, contagion-type effects, financial crises and other events that can change the degree to which stock prices across countries are attracted to each other.[5] Among the time series studies of stock market integration, Chancharoenchai and Dibooglu (2006) and Tai (2007) estimate GARCH type models either for a set of smaller Asian economies alone or paired with Japan and the United States. Varying sampling frequencies are employed in such studies, with some also estimating VAR-type models and utilizing impulse responses and variance decompositions (cf, Janakiramanan and Lamba, 1998). Another set of time series studies focuses on the long-run, or cointegrating, relationship between sets of stock market indices (cf, Fernandez-Serrano and Sosvilla-Rivero, 2001; Chen, Firth, and Rui, 2002; Leong and Felmingham, 2003).[6]

Support for cointegrating relationships can be most sensitive to the sample period. For example, Tian (2007) suggests that the Shanghai market's own ties to other markets increased after the Asian financial crisis. Whereas no cointegrating relationships are found using pre-1998 data, Tian (2007) finds support for cointegration between the Shanghai A-share market and the Hong Kong, Taiwanese and (to a lesser extent) US markets over the 1998-2007 period. Huyghebaert and Wang (2010) suggest that the Asian financial crisis merely precipitated a temporary increase in cointegration among the East Asian stock markets, however, with the Hong Kong and Singapore markets being the only ones to have any substantial bearing on other regional markets after the end of the crisis. Interestingly, while Huyghebaert and Wang (2010) do find ongoing links with the US market, they do not detect any significant linkages with the mainland Chinese markets either before, during or after the crisis (albeit over a data set extending to just 2003). Lin, Menkveld and Yang (2009) similarly find low correlations between the mainland Chinese markets and major Western markets extending through their 1992-2006 period. The question of whether the Shanghai market really has remained isolated from other regional and world markets despite its tremendous recent growth is one of the key questions reexamined below using a data set extended through 2010.

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[5] There is a vast literature on all of these topics and no brief summary can do it justice. Nevertheless, King and Wadhwani (1990) and King, Sentana, and Wadhwani (1994) are two seminal pieces.

[6] Since the approach of this paper is of the time series variety applied to the behaviour of market-wide indices we leave out studies that rely on, say, a version of the capital asset pricing model (CAPM) and then proceed to specify an econometric model of the cross-section of individual stock returns (cf, Kizys and Pierdzioch, 2009).

The existing time series evidence on the whole offers considerable support for financial shocks being transmitted regionally and for shocks from the United States also being transmitted to the Asia-Pacific region. Moreover, crises that spread beyond a single country (as in 1997-1998) are typically found to have lasting effects on the degree of financial market integration and may even shift the pole of influence to a different country or perhaps region. Finally, there is a suggestion, though it is rarely formally tested, that distance or proximity to a market also has an effect on the degree of financial market integration (cf, Bayoumi, Fazio, Kumar, and MacDonald 2007).[7] There is little consensus on the identification of contagion, however, stemming in part from questions over the particular shocks involved, the source and severity of the financial crises themselves and, finally, the transmission mechanism of such shocks (cf, Didier, Mauro, and Schmukler, 2008). There are widely varying statistical devices used to detect contagion with a number of studies, such as Kleimeier, Lenhert, and Verschoor (2008), adopting the corrected correlation test of Forbes and Rigobon (2002). Others interpret the notion of contagion by examining of the strength of correlations, in both the mean and the variance, through time.[8]

Although cointegration testing of long-run interrelationships has been widely employed as a means of assessing financial market integration, the vast majority of such work focuses only on the means of the return distributions.[9] This conventional approach fails to fully take

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[7] Dungey, Fry and Martin (2006) provide a useful guide for some of the factors that can either limit or enhance the prospects for contagion-type effects and they review the advantages and disadvantages of different econometric approaches to testing for the presence of contagion-type phenomena. Key considerations are strong economic fundamentals as a device to guard against contagion, the relatively greater sensitivity of emerging markets to contagion effects, and the conduit role played by developed markets in transmitting shocks around the globe.

[8] Chiang, Jeon, and Li (2007), for example, are able to determine the role of contagion in the early part of the Asian crisis of 1997-1998. The standard correlation measures used in the literature are less well suited to offer insights about when contagion takes over from interdependence, however. Indeed, as Pesaran and Pick (2007), Dungey, Fry, and Martin (2009) and Dungey et al. (2010) have shown, there are a number of problems with correlation measures of stock market integration, including sample selection bias. And, even when researchers use identical datasets the results can differ as the power and size properties of existing testing strategies are often quite poor (Pesaran and Pick, 2007; Dungey, Fry and Martin, 2009). The extent to which international linkages help explain the spread of financial crises is a further area of controversy, with Frankel and Saravelos (2010) pointing to the usefulness of such measures as foreign exchange reserves and real exchange rates whereas Rose and Spiegel (2009, 2010) find little role for such factors in accounting for the spreading of the post-2007 global financial crisis.

[9] The outcome of such analyses may also be influenced by whether the study in question allows for a break in the long-run relationship of interest. Controlling for such breaks is more likely to lead to the conclusion that stock price indices are attracted to each other in a statistical sense (as in Fernandez-Serrano and Sosvilla-Rivero, 2001). Instead of asking whether coefficients in the cointegrating vector can change over time holding constant the

into account any mutual attraction that may be concentrated at other locations in the distribution of returns, which is especially problematic for emerging markets that tend to have more extreme observations than mature markets. With the emergence of China as a major economic power, along with the skyrocketing growth of the Shanghai stock market, it is clearly important to properly account for its role within the Asia-Pacific region and its relationships with major world markets like the United States. Our analysis examines interrelationships across the full range of the return distribution in order such questions as the importance of Asia-Pacific market linkages with the Chinese financial markets and with the benchmark Japanese and US markets. We find that evidence of such interdependence is particularly strong at the higher end of the return distributions and that up-to-date data confirm a high degree of cointegration with the Shanghai market notwithstanding the continued capital account restrictions imposed by the Chinese government.

3. Data and Methodology

Since the premise of the paper is that both short- and long-run considerations drive the relationship between equity returns in the Asia-Pacific region over our rather eventful 1995-2010 sample period, an eclectic approach is likely to be more informative than reliance on a single technique. The suite of suite of econometric estimates that we utilize are presented and discussed here along with the basic properties of the data. Our sample comprises daily data from January 4, 1995 to July 15, 2010 for twelve stock market indices in the Asia-Pacific region as well as for the S&P 500 US stock market index, all drawn from the Bloomberg terminal. We consider the following regional or economic groupings: the US S&P500 and the Japanese Nikkei 225 are treated as benchmark indices; the Hang Seng (Hong Kong), the ASX (Australia), NZAE (New Zealand), KOSPI (Korea), and Straits Times (Singapore) form a group of more mature Asia-Pacific markets; and the TWSE (Taiwan), FBMKLCI (Malaysia), JCI (Indonesia), PCOMP (Philippines), SET (Thailand), and Shanghai (China) make up the group of stock markets for the

number of cointegrating vectors, it may be more instructive to ask whether the number of cointegrating vectors can change over time, however (Siklos and Ng, 2001). After all, financial market integration is likely an evolutionary process occasionally interrupted by large shocks in the world economy.

emerging markets region.[10] Data for weekends are excluded while for holidays, following the usual practice in the literature, the previous day's return fills in the missing observations.[11] As a result, we end up with a total of 4051 observations, with the exception of the Straits data which begin on 31 August 1999 resulting in 2837 observations. Next, all series were converted into returns by taking the first log difference of the index and multiplying the series by 100. The levels for the indexes considered are plotted in Figure 1, which, as expected, reveals some degree of common movement.

Since we also wish to examine the robustness of our results to changes in the underlying economic conditions, we supplement the index data described above with dates for recession and expansionary phases of the business cycle in the various economies considered. While the NBER reference cycle chronology (www.nber.org/cycles.html) is the obvious source for the United States, for the other economies in the sample we rely on the dates provided by the Economic Cycle Research Institute (http://www.businesscycle.com/home/). Recession and expansion dates are not available from this source for Indonesia, Philippines, Malaysia, Thailand, Hong Kong, and Singapore, while no recession period at all is recorded during our sample for mainland China.[12] Finally, to examine the sensitivity of the results to various types of financial crises we rely on the dates frequently used in the literature, chosen based on the sources given in Serwa and Bohl (2005) for crises until 2002. The dating of the subsequent global financial crisis is based on the St. Louis Fed's financial crisis timeline (http://timeline.stlouisfed.org/). We chose to date the beginning of the global financial crisis on June 7, 2007 when Bear Sterns suspended redemptions from some of its instruments

[10] For completeness, we also report some results in the next section using the index for the Shanghai B market, Shenzhen's B market, and Hong Kong's H-share market. The principal focus of the empirical work, however, is on the role of the Shanghai A-share index.

[11] This practice normally works for most stock markets considered. However, in some Asian markets (e.g., Taiwan and Japan) there is one period of the year (sometimes known as "golden week") when markets are closed for several days at a time. In these instances we chose to fill the gaps with via interpolation. The results shown below nevertheless appear insensitive to the exclusion of holidays, which typically represent less than 10% of the total number of observations used in the econometric analysis below.

[12] For Hong Kong and Singapore it is doubtful that any recession was recorded during the sample except when the United States entered recession in December 2007. Given the experience of neighbouring economies like Taiwan, as well as other sources we consulted, it seems likely that Hong Kong suffered a recession over the September 2008 to March 2009 period – while Singapore is said to have experienced a recession in 2001Q2 and again from 2008Q3-2009Q2.

previously labeled of the “high grade” variety. While there can be disagreement about the precise date when this crisis began, almost all observers focus on the summer 2007 events.[13]

The techniques that we apply to the data range from a description of stylized facts, including an examination of the autocorrelation and persistence properties of the data, to tests of contagion and dynamic conditional correlation as well as various estimates of the nature of the cointegrating relationship between series. Table 1 provides information about the distribution of equity returns for each of the stock markets considered and details the fraction of the sample within each range of values for returns. Comparing mature and benchmark markets against the emerging markets in our sample we immediately see that there are more extreme returns among the emerging markets than elsewhere. Indeed, the frequency of high and low returns (e.g., greater than 2% or less than -2% daily) is far more prevalent among the emerging market returns than in the mature or benchmark markets in the sample.

The simple unconditional correlations in returns are presented in Table 2. Many studies display such measures to motivate further econometric analyses of the relationship between equity returns. Since the present application includes a fairly large number of returns and, as seen, from Figure 1, these change through time, it is likely preferable to consider a correlation measure that allows for changes in the mean and volatility across the various markets examined. Engle’s (2002) dynamic conditional correlation model (DCC) is well suited to the task.[14] Although readers are referred to Engle (2002), and the voluminous literature that has since emerged, the basic idea is as follows. In the multivariate case the conditional covariance matrix (H) of returns (r_t) would be written

$$H_t = D_t R D_t\,, \quad D_t = diag\{\sqrt{h_{it}}\}$$

Where R is the correlation matrix.[15] In DCC models, R becomes time-varying but H must be unity so that

$$H_t = D_t R_t D_t$$

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[13] Sensitivity tests conducted by choosing alternative crisis dates (not shown) confirmed that all results presented below are robust to the different dating schemes.

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[14] The inspiration for the technique stems from the ease with which multivariate GARCH models become over-parameterized.

[15] Where $h_{it} = E_{t-1}(r_{it}^2), \quad r_{it} = \sqrt{h_{it}}\varepsilon_{it}\,, \quad \varepsilon \sim N(0,1)$.

Another correlation type measure, known as contagion Chow tests (Dungey, Fry and Martin, 2005; Dungey, Fry and Martin, 2009) seeks to differentiate between correlations that stem from interdependence in stock returns versus correlations that arise because there are no fundamental reasons (other than the fact that markets are facing a crisis-type atmosphere) for equity returns in this case to be correlated. In our case, we model and test all combinations of contagion that may exist between equity returns in the Asia-Pacific region, relying on the contagion Chow test. For simplicity, the test specification is shown for the case of three returns although, in principle, the specification shown below can be generalized to include more series. First, assume that crisis and non-crisis episodes can be identified. Dummy variables take on the value of one for the crisis sample, and zero otherwise. Next, we normalize equity returns by the standard deviation of returns during the normal or non-crisis periods. For *n* returns there are *n*-equations to assess the direction of contagion. Continuing with the example of three returns we have:

$$\begin{aligned}
\tilde{s}_{1t} &= \omega_1^{'} + \theta_1^{'} C_t + \theta_{21}^{'} \tilde{s}_{2t} + \theta_{31}^{'} \tilde{s}_{3t} + \lambda_{12} \tilde{s}_{2t} C_t + \lambda_{13} \tilde{s}_{3t} C_t + \xi_{1t} \\
\tilde{s}_{2t} &= \omega_2^{'} + \theta_2^{'} C_t + \theta_{22}^{'} \tilde{s}_{2t} + \theta_{32}^{'} \tilde{s}_{3t} + \lambda_{21} \tilde{s}_{2t} C_t + \lambda_{23} \tilde{s}_{3t} C_t + \xi_{2t} \\
\tilde{s}_{3t} &= \omega_3^{'} + \theta_3^{'} C_t + \theta_{23}^{'} \tilde{s}_{2t} + \theta_{33}^{'} \tilde{s}_{3t} + \lambda_{31} \tilde{s}_{2t} C_t + \lambda_{32} \tilde{s}_{3t} C_t + \xi_{3t}
\end{aligned} \quad (1.1)$$

where $\tilde{s}_{it}$ are the normalized returns for markets i=1,n, and C_t is the crisis dummy.

The tests for contagion are based on the null hypothesis that coefficients $\lambda_{ij} = 0$.[16] While the unconditional nature of these correlations is understood and recognized by researchers, it is important to also appreciate that such correlations not only can change through time (see Figure 2) and, perhaps more importantly, may be sensitive to their location in the distribution of equity returns. For example, if correlations become more extreme during crises or recessionary periods in some economies but not others, or generally increase during certain phases of economic activity, then an unconditional correlation over the entire distribution of returns will not reveal sensitivities to underlying changes in the economic environment. An obvious alternative, of course, is to consider a sub-sample. However, it is not

[16] Joint tests for whether there is contagion from markets i to markets j or k, where $j \neq k$ are also possible. See Dungey, Fry, and Martin (2009).

always obvious how to properly select such a sample. Moreover, even if one opts for a data-driven technique to choose a sub-sample, one may still inadvertently omit observations relevant to an understanding of what moves the relationship between stock returns over time and across regions. Instead, we turn to correlations such as those shown in Table 3 may be more revealing. There, the correlations in returns for the first two and last two quantiles are shown. The Table 3 correlations are vastly different from the ones shown in Table 1 for many of the pairs considered, especially for the Nikkei index. Moreover, the correlations can also differ according to whether we are focusing on the top or bottom ends of the returns distributions when observations consistently deviate from the mean (or median).

To investigate whether returns in certain parts of the distribution are attracted to each other in a statistical sense, that is, whether there is an underlying long-run equilibrium type relationship between them, we next turn to cointegration testing. Following Xiao (2009), the conventional cointegrating relationship between two or more variables can be written in scalar form as

$$s_{1t} = \beta_1 + \beta_2 s_{2t} + \beta_3 s_{3t} + ... + u_t \qquad (1.2)$$

where s_{it} i=1, n are the log levels of the stock indexes potentially attracted to each other in the long-run. The quantile cointegrating relationship restricts the analysis to certain parts of the distribution of returns. For example, at the upper quantile we ask whether episodes of high returns (i.e., returns in the upper 25% percentile of the distribution of returns), relative to the rest of the distribution of returns, are attracted to episodes of higher returns in the distribution of returns in other markets. We similarly search for this relationship at the lower end of the quantile range. In terms of equation (1.2), this would be rewritten as

$$Q_{s_{1t}}[\tau] = \beta(\tau)_1 + \beta(\tau)_2 s_{2t} + \beta(\tau)_3 s_{3t} + ... + F_u^{-1}(\tau) \qquad (1.3)$$

where the cointegrating relationship is now expressed as a function of the quantiles τ and $F_{u_t}^{-1}(\tau)$ denotes the common distribution function of the errors (Koenker, 2005).

The long-run relationship between the series is, in reality, a function of the quantile examined by the researcher. Although the cointegrating coefficients do not change through time, the nature of the attraction in returns from one market to another (or others) changes according to whether the returns examined are restricted to lie within a certain percentile range as opposed to examining only the mean (or median) of the distribution of returns. The quantile approach is preferred when there is some asymmetry or evidence of "fat tails" in the distribution of series.[17] Not only are such fat tails typically present in stock return data of the type analyzed in this study but also the data properties laid out in Table 3 clearly point to important differences between the emerging market and mature market return distributions and significant variation across the different quantiles. It would therefore be most inadvisable in this case to restrict the cointegration analysis to the means of the distributions alone.

4. Empirical Results

A. Persistence of Returns

We compare the persistence of equity returns across crisis and non-crisis periods in Table 4. In almost all cases the persistence parameter is lower in the crisis period than in the non-crisis period, consistent with there being less predictability in equity returns under such extreme conditions as the Asian financial crisis. Indeed, markets in four of the countries hit hardest by that crisis, namely Korea, Malaysia, the Philippines and Thailand, all feature reduced persistence during crisis periods overall as do the Australian and New Zealand markets. Indonesia's persistence is almost the same in both periods, however, as is true also for Japan and Taiwan. Clear increases in persistence during crisis periods are seen for the Hong Kong, the Shanghai A and Shenzhen A markets, and the US S&P 500. With the exception of Hong Kong, the findings might be due, in part, to the markets being less exposed to some of the crises. The United States was less exposed to the Asian financial crisis while the Chinese markets were somewhat insulated by capital controls at that time as well as benefiting from China's continued growth after the onset of the global financial crisis of 2008-9.

[17] The version developed by Xiao (2009) is best suited for bivariate relationships since it builds on the original Engle-Granger cointegration framework. Although there is as yet no established multivariate extension to the quantile cointegration approach, this is still preferable to standard cointegration test results using the Johansen testing methodology given the properties of our data. Also, given our interest in the separate role of China and the United States in influencing equity returns elsewhere we are less interested in how much cointegration there is. Rather we are interested, among other things, in whether any cointegration can be detected in the data.

B. Contagion Tests

The Chow-based contagion tests presented in Table 5 reveal some variation according to the mix of markets considered. When only the mature and benchmark markets are analyzed (Panel A), very little evidence of contagion emerges. The Australian market faces contagion only from the Japanese Nikkei 225, the Hang Seng index faces contagion only from the Korean market, and none of the US, New Zealand or Korean markets faces contagion from any of the other markets in the group. Somewhat more contagion is seen when we combine the benchmark markets with the emerging market group (Panel B). Here we see the Malaysian and Thai markets both experiencing contagion from the S&P500 and from Shanghai, while the Shanghai market is responsive to contagion emanating from Malaysia in an indication of a two-way link between these particular markets. There is no evidence of any contagion flowing to the Indonesian, Philippine or Taiwanese markets. The US S&P500 is seen as experiencing contagion from each of the Malaysian, Taiwanese and Thai markets. This result almost certainly derives from transmission of the Asian financial crisis. Whereas the US economy naturally suffered much less than the Asian economies, the US stock market declines that occurred as the crisis unfolded may well explain the significant contagion test results. Whereas the neighboring Asian economies suffered from their direct exposure to the macroeconomic fallout in the region, it is not unreasonable to see the US market losses as more due to a loss of investor confidence, or classic contagion, rather than to the immediate consequences for the macroeconomy. The additional indicated contagion to the Thai market emanating from Shanghai and the S&P500 is interesting in that it suggests a second link between the Shanghai market and the other Asian markets.

The most widespread evidence of contagion is found when we combine the mature and emerging markets but exclude the Japanese and US benchmark markets. Contagion from Thailand to the New Zealand and Korean markets, and from the Korean market to Hong Kong, could well again reflect Asian financial crisis effects. There is also indicated two-way contagion between the New Zealand and Taiwanese markets and between the Hong Kong and Taiwanese markets. As with the Panel B results, we see contagion from Shanghai to the Malaysian market plus contagion from Malaysia to Shanghai. The Panel B and Panel C results therefore both point to linkages between the Shanghai market and the Malaysian and Thai exchanges. This suggests that it should not be automatically assumed that the Shanghai market's strongest ties are with Hong Kong, which, after all, has an entirely different economic structure and currency despite technically being part of the same country.

C. Dynamic Conditional Correlations

Figures 3 and 4 further explore the relationship between the Shanghai market and other emerging Asian financial markets as well as the benchmark Japanese and US markets. In each case the correlations are conditional of the remaining mature Asian equity markets. Figure 3 reveals that the correlations between Shanghai and the other Asian equity markets not only rise quickly over our sample period as a whole but also accelerate further once the global financial crisis gets underway in 2007. Particularly sharp increases are evident for correlations between the Shanghai market and the Korean and Taiwanese markets. Figure 4 shows how the rising conditional correlations between Shanghai and the other Asian markets contrast with a much weaker relationship with the US S&P500. In particular, an outright decoupling of the S&P500 sets in from 2007 onward as the sharp declines in the S&P500 contrast with the relatively strong performance of the Asian equity markets. As noted earlier, US underperformance was particularly evident relative to the Shanghai market, which continued to rally strongly in 2007 even after the US market and most other western markets had been falling for months. Overall, the dynamic conditional correlations point to consistent and strengthening ties between Shanghai and other Asian markets but a parting of the ways with the S&P500. It remains to be seen whether this is a temporary phenomenon or a more permanent shift – and potential movement away from US leadership – that might endure even after the global financial crisis comes to an end.

D. Long-Run Quantile Cointegration Analysis

Our cointegration analysis allows us to explore the long-run co-movement between the Shanghai market and other Asia-Pacific markets relative both to each other and to the United States. Estimates for various quantile cointegrating regressions are shown in Tables 6 through

9. We focus only on the post-Asian financial crisis period in light both of our own findings of different behavior during crisis and non-crisis periods (Table 4) and a number of other studies pointing towards different relationships emerging after 1998 (cf, Tian, 2007). In order to include the Singapore market, for which daily data are available only from 1999, our overall sample period is August 31, 1999 through July 15, 2010. Results for the benchmark markets against the complete set of Asia-Pacific markets are presented in Tables 6 and 7. Table 6 provides representative findings for the 1st, 3rd and median quantiles with the Japanese Nikkei as the benchmark market and Table 7 reports the analogous findings with the US S&P500.

For the lowest, 1st quantile of the return distribution, Table 6 reveals that the Nikkei is cointegrated with all the Asia-Pacific markets except Shanghai at the 99% confidence level or higher. As we move up the distribution to the 3rd quantile, the significance levels for the Korean market and Australian markets decline slightly to the 93% and 97% confidence levels, respectively. The biggest change, however, is that the Shanghai market is cointegrated with the Nikkei at the 99% confidence level for the 3rd quantile – as compared to a confidence level of just 48% for the first quantile. It is possible that this difference reflects the extremely high volatility of the Shanghai market and associated concentration at the higher order quantiles. Finally, for the median quantile, Shanghai remains cointegrated at the 99% confidence level along with all other markets except for Australia. In general, there is consistent support for cointegration with the Nikkei for most markets. The Shanghai and Australian market results are the most sensitive to the particular quantile considered, with the Shanghai market not evidencing any cointegration at the lowest quantile and the Australian market falling short at the median quantile.

In Table 7 with the US S&P500 as the benchmark, most Asia-Pacific markets again feature cointegration at the 99% confidence level or higher for the 1st quantile of the distribution. This time, the Shanghai market is part of this group but there is no significant cointegration with the Philippine and Thai markets. For the 3rd quantile, the Thai stock exchange joins the majority of other markets in featuring cointegration at the 99% confidence level or higher but there remains no significant relationship with the Philippine market. Finally, for the median quantile, all markets but Thailand are cointegrated with the S&P500 at the 99%

confidence level or higher. Thus, relative to the US market, it is the relationship with Philippine and Thai markets that varies most across the different quantiles. As with the results with the Japanese market as the benchmark, most Asia-Pacific markets feature significant cointegration across all the different quantiles. Nevertheless, the inferences for Shanghai, and for the Australian, Philippine and Thai markets, vary dramatically across the different quantiles. With both benchmarks, the most wide-ranging evidence of cointegration emerges at the 3rd quantile, suggesting that it is at the higher frequencies that the strongest ties emerge for the broad group of Asia-Pacific markets.[18]

In Tables 8 and 9 we focus on the interrelationships between the Asia-Pacific markets with the Japanese and US benchmark markets excluded. In view of the particular attention that has been focused on the rise of China, we use the Hong Kong and Shanghai markets as our dual reference points. Table 8 shows that the Hang Seng index is consistently cointegrated with all markets except those of Malaysia, Philippines and Thailand at the 99% confidence level or higher across each of the 1st , 3rd, and median quantiles. And even with respect to these three markets, significant cointegration is seen in two cases out of three. The Hang Seng's cointegration with the Shanghai market across all three different quantiles appears to contradict claims that the price differentials between A-shares and H-shares imply that the two markets are segmented. On the contrary, the two markets appear to share a mutual attraction to each other over our sample period.

Table 9 provides an analogous perspective on interdependence amongst the Asia-Pacific market across the different quantiles, but this time focused on Shanghai. For the highest, 3rd quantile, the Shanghai market is significantly cointegrated with all the other Asia-Pacific markets at the 93% confidence level or higher. In this case, the actual confidence level exceeds 99% in all cases save those of the Korean and New Zealand markets (96% and 93% levels,

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[18] As shown in Appendix Table A.1, analysis of the same groups of countries over the same time period using standard cointegration identifies much weaker results – with no significant cointegrating relationships seen for the Korean, Malaysian, New Zealand, Shanghai or Thai markets under either benchmark. Moreover, in contrast to the quantile cointegrations results, both benchmark Japanese and US markets appear to be disconnected from the Asia-Pacific group. Given the variation over the different quantiles seen in Tables 6 and 7, and concentration at higher frequencies, this simply reinforces the importance of not limiting the analysis to the means of the distributions alone.

respectively). For the median quantile, the confidence level for cointegration with the Taiwanese market declines to 95% but reaches the 99% confidence level for all other markets except Korea (36%). Across these two quantiles there is therefore consistent evidence of cointegration of the Shanghai markets with all Asia-Pacific equity markets except Korea. The lowest, 1st quantile reveals the weakest evidence of cointegration, with confidence levels of just 30% for Indonesia and 3% for Thailand. Moreover, while the Korean market does now evidence cointegration at the 99% confidence level, the confidence levels for the Malaysian and Philippine markets decline to 90% and 95%, respectively.

The Shanghai market is therefore found to be consistently cointegrated with the more mature Asia-Pacific markets but the cointegrating relationships with the other emerging markets in the region appear to be a bit weaker and less consistent than those evidenced for the Hang Seng. Both the Hang Seng and Shanghai markets feature less than robust cointegrating relationships with Thailand whereas the Indonesian and Korean markets were consistently cointegrated with the Hang Seng notwithstanding their more ambiguous relationship with the Shanghai market. Especially given mainland China's capital controls and more nascent financial markets, the similarities with the Hang Seng's pattern of cointegration are probably the most striking feature of the results, however. Our results suggest that, while the Shanghai market may not be quite as widely linked to other Asia-Pacific markets as Hong Kong, it comes surprisingly close and reveals significant cointegration with most of these markets across the range of different quantiles. The fact that the weakest evidence of cointegration is concentrated at the lowest quantile of the return distribution may itself reflect the preponderance of the Shanghai market observations being located among the higher quantiles of the return distribution -- in line with ongoing extreme volatility levels that have certainly showed no sign of abating in the post-2007 period.

6. Conclusions

This paper's empirical work applies a variety of short-run and long-run econometric techniques to a broad group of Asia-Pacific stock markets and the United States over the 1995-2010 period. Our empirical work confirms the importance of crises in affecting the persistence of equity returns in the Asia-Pacific region but yields only limited support for contagion effects. There is evidence of contagion extending to the US market from the Malaysian, Taiwanese and Thai markets, however, while instances of contagion within the region include transmission between Shanghai and the Malaysia and Thai markets. Dynamic conditional correlations suggest rising co-movement among all the Asia-Pacific markets over time that accelerates after the onset of the global financial crisis in 2007, just as the US market seems to decouple from the regional markets. It will be interesting to see if subsequent data confirm whether this apparent move away from US leadership is just a temporary phenomenon or is signaling a more enduring shift in the pole of influence.

Our tests for long-run cointegrating relationships utilize a post-Asian financial crisis sample of 1999-2010 and employ quantile regression techniques to allow for variation over the spectrum of the return distributions. The tendency for emerging market stock return data, such as that of the volatile Shanghai market, to be concentrated at the higher end of the distribution means that conventional cointegration analysis may be unreliable as it focuses only on the means. In contrast to Huyghebaert and Wang (2010), whose standard cointegration analysis suggests continued isolation of the mainland Chinese markets, we find substantial evidence of integration of the Shanghai market with the US market and many other regional exchanges. Cointegration is particularly prevalent at the higher end of the distribution. Our results suggest that the enormous growth of the Shanghai market in the new millennium has indeed been accompanied a meaningful level of integration with other regional and world markets in spite of the capital controls that continue to be imposed by the Chinese government.

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Table 1: Distribution of Equity Returns

(% of Observations)

<table>
<tr><th>Range</th><th>S&P500</th><th>Nikkei</th><th>KLCI</th><th>JCI</th><th>KOSPI</th><th>NZAO</th><th>PCOMP</th><th>SET</th><th>SHNG</th><th>STRAITS</th><th>TWSE</th><th>ASX</th><th>Hang Seng</th></tr>
<tr><td>[-5,-4)</td><td></td><td></td><td>0.79</td><td>1.78</td><td>2.67</td><td>0.15</td><td>1.33</td><td>1.16</td><td>2.47</td><td></td><td>1.33</td><td></td><td>1.73</td></tr>
<tr><td>[-4,-3)</td><td>1.60</td><td>2.62</td><td rowspan="2">3.50</td><td>1.51</td><td>2.79</td><td>0.20</td><td rowspan="2">4.91</td><td rowspan="2">7.53</td><td rowspan="2">6.81</td><td>2.08</td><td>2.47</td><td>0.89</td><td rowspan="2">6.81</td></tr>
<tr><td>[-3,-2)</td><td>2.94</td><td>5.50</td><td>3.87</td><td>5.77</td><td>0.79</td><td>3.56</td><td>4.52</td><td>1.60</td></tr>
<tr><td>[-2,-1)</td><td>10.07</td><td>12.96</td><td rowspan="2">43.63</td><td>10.69</td><td>11.97</td><td>6.69</td><td rowspan="2">43.58</td><td rowspan="2">41.98</td><td rowspan="2">37.65</td><td>11.42</td><td>11.70</td><td>8.00</td><td rowspan="2">39.46</td></tr>
<tr><td>[-1,0)</td><td>31.61</td><td>29.52</td><td>28.55</td><td>23.82</td><td>39.57</td><td>31.27</td><td>28.99</td><td>36.72</td></tr>
<tr><td>[0,1)</td><td>39.07</td><td>29.13</td><td rowspan="2">47.93</td><td>33.07</td><td>29.10</td><td>44.85</td><td rowspan="2">43.68</td><td rowspan="2">41.09</td><td rowspan="2">43.87</td><td>34.76</td><td>29.51</td><td>41.95</td><td rowspan="2">43.48</td></tr>
<tr><td>[1,2)</td><td>10.71</td><td>14.02</td><td>13.55</td><td>14.04</td><td>6.64</td><td>12.209</td><td>13.83</td><td>9.03</td></tr>
<tr><td>[2,3)</td><td>2.57</td><td>4.34</td><td rowspan="2">3.16</td><td>4.07</td><td>5.26</td><td>0.91</td><td rowspan="2">5.60</td><td rowspan="2">6.71</td><td rowspan="2">7.43</td><td>3.17</td><td>4.74</td><td>1.11</td><td rowspan="2">7.06</td></tr>
<tr><td>[3,4)</td><td>1.38</td><td>1.89</td><td>1.41</td><td>2.15</td><td>0.18</td><td>1.56</td><td>2.91</td><td>0.68</td></tr>
<tr><td>[4,5)</td><td></td><td></td><td>0.98</td><td>1.51</td><td>2.43</td><td></td><td>0.89</td><td>1.53</td><td>1.77</td><td></td><td></td><td></td><td>1.14</td></tr>
<tr><td>Mean</td><td>.026</td><td>-.050</td><td>.012</td><td>.046</td><td>.0009</td><td>.014</td><td>.008</td><td>-.003</td><td>.031</td><td>-.0005</td><td>.006</td><td>.024</td><td>.034</td></tr>
<tr><td>S.D.</td><td>1.251</td><td>1.491</td><td>1.403</td><td>1.617</td><td>1.916</td><td>.789</td><td>1.471</td><td>1.668</td><td>1.873</td><td>1.310</td><td>1.550</td><td>.980</td><td>1.724</td></tr>
<tr><td>Median</td><td>.070</td><td>-.02</td><td>.037</td><td>.090</td><td>.081</td><td>.035</td><td>.000</td><td>-.019</td><td>.079</td><td>.050</td><td>.027</td><td>.045</td><td>.054</td></tr>
<tr><td>Test</td><td>-2.25
(.02)</td><td>-1.29
(.20)</td><td>-1.09
(.28)</td><td>-1.74
(.08)</td><td>-2.63
(.01)</td><td>-1.69
(.09)</td><td>.33
(.74)</td><td>.02
(.54)</td><td>-1.64
(.10)</td><td>-2.05
(04)</td><td>-.88
(.38)</td><td>-1.35
(.18)</td><td>-.72
(.47)</td></tr>
</table>

Notes: ***Range*** refers to daily equity returns defined as log change of the level of the relevant index multiplied by 100; ***S.D.*** is the standard deviations; and ***Test*** refers to a test of the null whether the mean and median returns are the same.

KEY:**S&P500** represents the US market; **Nikkei** represents the Japanese market; **KLCI** is the Malaysian market index; **JCI** is the Indonesian Jakarta market index; **KOSPI** is the Korean market index; **NZAO** is the New Zealand All Ordinaries index; **PCOMP** is the Philippine composite index; **SET** is the Thai market index; **SHNG** is the Shanghai Composite index; **STRAITS** is the Singapore Straits-Times index; **TWSE** is Taiwan's Taipei market index; **ASX** is the Australian market index; and **Hang Seng** is the main Hong Kong index.

Table 2: Pairwise Unconditional Correlations in Equity Returns

	S&P 500	Nikkei
Hang Seng	.18*	.54*
ASX	.10*	.57*
NZAO	-.02	.37*
KOSPI	.13*	.45*
STRAITS	.21*	.59*
TWSE	.08*	.38*
KLCI	.05*	.27*
JCI	.06*	.32*
PCOMP	.04*	.29*
SET	.12*	.28*
SHANGHAI	-.00	.13*
Memo		
SHANGHAI B	.003	.11*
SHENZHEN B	.01	.14*
H Shares	.11*	.40*

Notes: The values in the table represent the pairwise correlations between either the S&P 500 or the Nikkei and the markets listed in the first column, and

* indicates that the correlations are statistically different from zero at the 95% confidence level or better.

Table 3: Pairwise Unconditional Correlations of Equity Returns by Quantile

	S&P 500		Nikkei	
	Q<=.2	Q>=.8	Q<=.2	Q>=.8
Hang Seng	0.10***	0.03	0.20***	0.14***
ASX	0.06**	-0.01	0.16***	0.13***
NZAO	0.03	0.01	0.09***	0.05**
KOSPI	0.09*	0.03	0.20***	0.11***
STRAITS	0.08**	0.07***	0.14***	0.07**
TWSE	0.03	0.02	0.20***	0.09***
KLCI	0.03	-0.02	0.15***	0.07**
JCI	0.05	-0.01	0.12***	0.11***
PCOMP	0.07*	-0.02	0.13***	0.06**
SET	0.07**	0.01	0.15***	0.10***
SHANGHAI	0.0004	-0.03	0.13***	0.07**
Memo				
SHANGHAI B	-0.03	-0.03	0.13***	0.05*
SHENZHEN B	-0.01	-0.03	0.13***	0.05**
H Shares	0.10***	0.04	0.16***	0.11***

Notes: Q<=.2 and Q>=.8 refers to quantiles below or equal to 0.2 and higher than or equal to 0.8, respectively, and
***, **, and * denotes significance at the 99% level, 95%, and 90% confidence levels, respectively.
(Also see the notes to Table 2.)

Table 4: Persistence of Stock Returns: Crisis vs. Non-Crisis Periods

Stock Index	Full Sample	Crisis Only Sample
S&P 500	-.06***	-.10***
Nikkei	-.04**	-.04
Hang Seng	-.01	-.06**
ASX	-.03*	-.02
NZAO	.06***	.04
KOSPI	.06***	.02
STRAITS	.01	-.001
TWSE	.02	.02
KLCI	.07***	-.002
JCI	.18***	.19***
PCOMP	.17***	.15***
SET	.07***	.05*
Shanghai	.01	.001
Memo		
Shanghai A	.02	.07***
Shanghai B	.11***	.08***
Shenzhen	.04**	.08***
Shenzhen A	.04***	.08***
Shenzhen B	.11***	.11***
H shares	.11***	.07***

Notes: The values shown above are the coefficient estimates from an AR(1) model of equity returns for each sample period. The full sample is January 4, 1995 to July 15, 2010.

Table 5: Chow-based Contagion Tests

Contagion from	*Contagion to*
A. Benchmark-Mature	
None	S&P 500
None	Nikkei
Nikkei	ASX
None	NZAO
None	KOSPI
KOSPI	Hang Seng
B. Benchmark-EMEs	
KLCI, TWSE, SET	S&P 500
Shanghai, S&P 500	FBMKLCI
None	TWSE
None	JCI
Shanghai, S&P 500	SET
None	PCOMP
KLCI	Shanghai
C. Mature – EMEs	
None	ASX
TWSE, SET	NZAO
SET	KOSPI
KOSPI	Hang Seng
Shanghai	FBMKLCI
Hang Seng, NZAO	TWSE
None	JCI
NZAO, Shanghai	SET
None	PCOMP
KLCI	Shanghai

Notes: The results are based on specification (1.1) in the text and are based on rejection of the null hypothesis that $\lambda_{ij} = 0, i \neq j$, with i defined as being the market where contagion is 'from' while j is the market where contagion is 'to'. See notes to Table 1 for key to markets. Shanghai is the Shanghai composite index.

Table 6: Quantile Cointegrating Regressions for the Nikkei vs. All Asia-Pacific Markets

1st Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.35	0.22	1.61	0.11
TWSE	0.32	0.03	9.86	0.00
FBMKLCI	-0.46	0.07	-6.87	0.00
JCI	-0.20	0.03	-7.64	0.00
PCOMP	0.22	0.03	6.54	0.00
SET	-0.31	0.02	-13.37	0.00
SHANGHAI	-0.01	0.01	-0.64	0.52
HANG SENG	0.16	0.04	4.51	0.00
KOSPI	0.14	0.02	6.67	0.00
NZAO	0.91	0.03	30.62	0.00
ASX	-0.40	0.05	-8.06	0.00
STRAITS	0.75	0.08	9.78	0.00

3rd Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.54	0.20	-7.54	0.00
TWSE	0.53	0.03	19.16	0.00
FBMKLCI	-0.28	0.04	-7.18	0.00
JCI	-0.27	0.04	-7.54	0.00
PCOMP	0.20	0.04	5.23	0.00
SET	-0.33	0.03	-11.90	0.00
SHANGHAI	-0.24	0.01	-27.48	0.00
HANG SENG	0.36	0.04	9.68	0.00
KOSPI	0.05	0.03	1.78	0.07
NZAO	0.58	0.09	6.56	0.00
ASX	0.14	0.07	2.11	0.03
STRAITS	0.48	0.04	10.85	0.00

Median Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.41	0.24	-1.71	0.09
TWSE	0.36	0.03	10.46	0.00
FBMKLCI	-0.48	0.05	-9.50	0.00
JCI	-0.27	0.02	-11.06	0.00
PCOMP	0.13	0.03	4.11	0.00
SET	-0.30	0.02	-17.98	0.00
SHANGHAI	-0.13	0.01	-12.19	0.00
HANG SENG	0.20	0.04	5.62	0.00
KOSPI	0.16	0.03	5.64	0.00
NZAO	0.66	0.04	17.70	0.00
ASX	-0.02	0.04	-0.40	0.69
STRAITS	0.82	0.08	10.06	0.00

Note: Estimates based on specification (1.2) in the text for the quantiles shown. The sample is 1999-2010 as data availability is reduced incorporating STRAITS in the dataset. (See Table 1 for a KEY to the market definitions).

Table 7: Quantile Cointegrating Regressions for the S&P500 vs. All Asia-Pacific Markets

1st Quantile

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.00	0.14	-7.32	0.00
TWSE	0.32	0.02	14.92	0.00
FBMKLCI	-0.24	0.02	-9.62	0.00
JCF	-0.17	0.01	-11.78	0.00
PCOMP	0.02	0.02	0.88	0.38
SET	0.01	0.01	1.24	0.22
SHANGHAI	-0.08	0.01	-15.79	0.00
HANG SENG	0.24	0.02	10.97	0.00
KOSPI	-0.22	0.01	-17.74	0.00
NZAO	0.12	0.02	5.93	0.00
ASX	0.30	0.03	11.72	0.00
STRAITS	0.57	0.03	16.22	0.00

3rd Quantile

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.39	0.10	-3.93	0.00
TWSE	0.28	0.01	20.21	0.00
FBMKLCI	-0.15	0.02	-9.51	0.00
JCI	-0.16	0.01	-12.66	0.00
PCOMP	0.01	0.01	1.04	0.30
SET	-0.03	0.01	-4.48	0.00
SHANGHAI	-0.04	0.00	-11.60	0.00
HANG SENG	0.26	0.01	17.70	0.00
KOSPI	-0.19	0.01	-17.29	0.00
NZAO	0.17	0.02	9.86	0.00
ASX	0.25	0.02	12.16	0.00
STRAITS	0.42	0.02	16.90	0.00

Median Quantile

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.83	0.16	-5.20	0.00
TWSE	0.28	0.02	12.09	0.00
FBMKLCI	-0.17	0.03	-6.59	0.00
JCI	-0.18	0.02	-10.47	0.00
PCOMP	0.06	0.02	2.93	0.00
SET	0.01	0.01	0.67	0.50
SHANGHAI	-0.07	0.01	-9.99	0.00
HANG SENG	0.27	0.02	12.89	0.00
KOSPI	-0.21	0.01	-14.09	0.00
NZAO	0.13	0.02	5.80	0.00
ASX	0.27	0.03	8.56	0.00
STRAITS	0.48	0.04	13.77	0.00

See notes to Table 6.

Table 8: Quantile Cointegrating Regressions for the Hang Seng vs. Other Asia-Pacific Markets

1st Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.08	0.18	17.59	0.00
TWSE	0.35	0.03	12.37	0.00
FBMKLCI	-0.37	0.04	-8.43	0.00
JCI	0.34	0.02	14.28	0.00
PCOMP	-0.27	0.03	-9.78	0.00
SET	-0.06	0.02	-3.70	0.00
SHANGHAI	0.07	0.01	10.11	0.00
KOSPI	-0.28	0.02	-13.10	0.00
NZAO	-0.27	0.03	-9.18	0.00
ASX	0.27	0.04	7.38	0.00
STRAITS	0.90	0.03	25.75	0.00
3rd Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.92	0.15	12.59	0.00
TWSE	0.16	0.02	6.42	0.00
FBMKLCI	-0.01	0.04	-0.16	0.87
JCI	0.05	0.02	2.48	0.01
PCOMP	-0.01	0.02	-0.23	0.82
SET	-0.03	0.02	-1.84	0.07
SHANGHAI	0.11	0.01	13.09	0.00
KOSPI	-0.09	0.02	-4.30	0.00
NZAO	-0.28	0.04	-7.34	0.00
ASX	0.23	0.05	5.05	0.00
STRAITS	0.80	0.03	24.67	0.00
Median Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.18	0.19	17.09	0.00
TWSE	0.27	0.03	9.86	0.00
FBMKLCI	-0.28	0.04	-6.92	0.00
JCI	0.23	0.03	7.99	0.00
PCOMP	-0.09	0.03	-3.09	0.00
SET	-0.01	0.02	-0.17	0.86
SHANGHAI	0.07	0.01	8.52	0.00
KOSPI	-0.25	0.02	-13.03	0.00
NZAO	-0.39	0.04	-8.73	0.00
ASX	0.29	0.03	9.10	0.00
STRAITS	0.84	0.02	44.66	0.00

See notes to Table 6.

Table 9: Quantile Cointegrating Regressions for Shanghai vs. Other Asia-Pacific Markets

1st Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.06	1.49	1.39	0.17
TWSE	0.51	0.06	8.83	0.00
FBMKLCI	0.40	0.24	1.65	0.10
JCI	0.03	0.083	0.38	0.70
PCOMP	0.19	0.10	1.96	0.05
SET	0.04	0.10	0.04	0.97
HANG SENG	0.72	0.08	9.42	0.00
KOSPI	-0.53	0.05	-11.42	0.00
NZAO	-2.00	0.12	-17.30	0.00
ASX	1.92	0.13	14.36	0.00
STRAITS	-1.20	0.17	-7.08	0.00

3rd Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.2	0.63	-9.94	0.00
TWSE	-0.19	0.07	-2.75	0.01
FBMKLCI	1.07	0.13	8.45	0.00
JCI	-0.48	0.07	-6.63	0.00
PCOMP	0.82	0.07	12.35	0.00
SET	-0.20	0.06	-3.51	0.00
HANG SENG	1.13	0.10	11.84	0.00
KOSPI	0.10	0.05	2.06	0.04
NZAO	-0.25	0.14	-1.80	0.07
ASX	1.09	0.10	11.06	0.00
STRAITS	-1.59	0.11	-14.21	0.00

Median Quantile Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.32	1.17	-2.85	0.00
TWSE	-0.21	0.11	-1.94	0.05
FBMKLCI	1.69	0.25	6.66	0.00
JCI	-0.46	0.11	-4.17	0.00
PCOMP	0.48	0.13	3.66	0.00
SET	-0.23	0.07	-3.56	0.00
HANG SENG	0.90	0.13	6.78	0.00
KOSPI	-0.04	0.09	-0.46	0.64
NZAO	-0.92	0.12	-7.48	0.00
ASX	1.09	0.11	9.85	0.00
STRAITS	-1.17	0.18	-6.49	0.00

See notes to Table 6.

APPENDIX

Table A.1: Standard Cointegrating Regressions for the Means of the Distributions Alone

A. Nikkei and All Asia-Pacific Markets

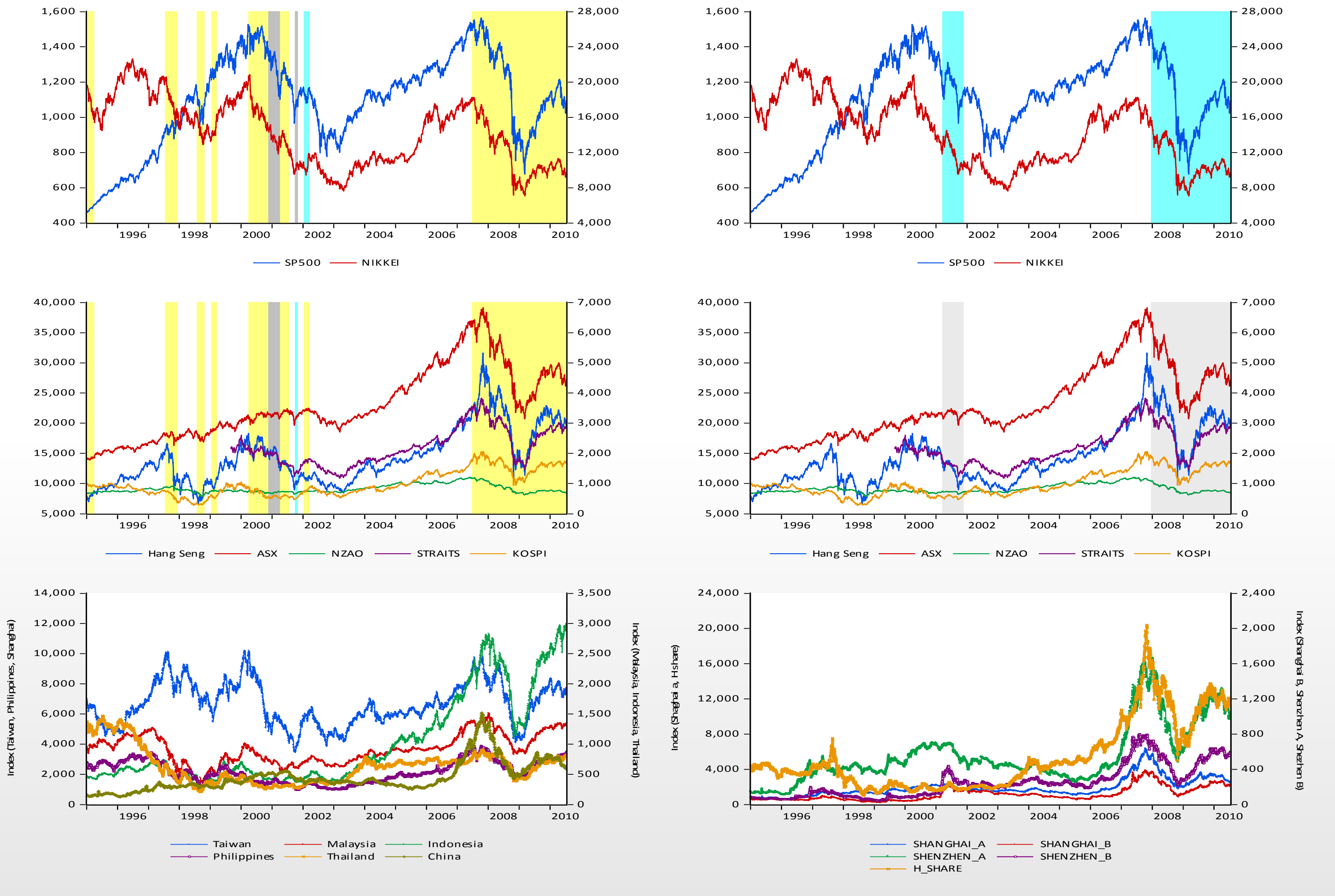
Variable	tau-statistic	Prob.	z-Statistic	Prob.
TWSE	-5.68	0.14	-78.57	0.03
FBMKLCI	-5.35	0.27	-60.71	0.18
JCI	-6.32	0.03	-100.28	0.00
PCOMP	-6.43	0.02	-84.45	0.01
SET	-4.66	0.63	-50.36	0.42
SHANGHAI	-3.24	0.99	-22.18	0.99
HANG SENG	-5.00	0.44	-56.34	0.27
KOSPI	-5.44	0.23	-59.90	0.20
NZAO	-5.42	0.24	-61.40	0.17
ASX	-5.83	0.11	-67.63	0.09
STRAITS	-5.82	0.11	-74.02	0.05
NIKKEI	-4.67	0.62	-46.06	0.54

B. S&P500 and All Asia-Pacific Markets

Variable	tau-statistic	Prob.	z-Statistic	Prob.
TWSE	-6.07	0.06	-87.83	0.01
FBMKLCI	-5.24	0.32	-58.44	0.23
JCI	-6.20	0.04	-94.67	0.00
PCOMP	-6.47	0.02	-85.43	0.01
SET	-3.89	0.92	-36.24	0.81
SHANGHAI	-3.44	0.98	-23.93	0.98
HANG SENG	-5.55	0.19	-76.65	0.03
KOSPI	-5.64	0.16	-64.19	0.13
NZAO	-5.14	0.37	-56.90	0.26
ASX	-5.49	0.21	-60.50	0.19
STRAITS	-6.26	0.03	-84.93	0.01
S&P500	-5.04	0.42	-53.65	0.33

Notes: All variables are defined as before but the cointegrating equations are now estimated on a multivariate basis – whereas quantile cointegration can only be tested on a bivariate basis; and significance levels are determined from MacKinnon (1996) p-values. The tau-statistic is the Augmented Dickey-Fuller test with the lag augmentation selected according to the Schwartz criterion; the z-statistic is based on the Elliott-Rothenberg-Stock unit root test.

Figure 1: STOCK MARKET INDEXES: Asia-Pacific and the United States



Note: The data is from Bloomberg, are daily. The markets shown are: S&P500 (US), Nikkei (Japan), Hang Seng (Hong Kong), ASX (Australia), NZAO (New Zealand), STRAITS (Singapore), KOSPI (Korea). The other indexes are listed by country name, except for Shanghai and Shenzhen which are for China. H-shares are Mainland Chinese companies whose shares are traded in Hong Kong.

Figure 2: Moving Correlation in Returns: Asia-Pacific and the United States

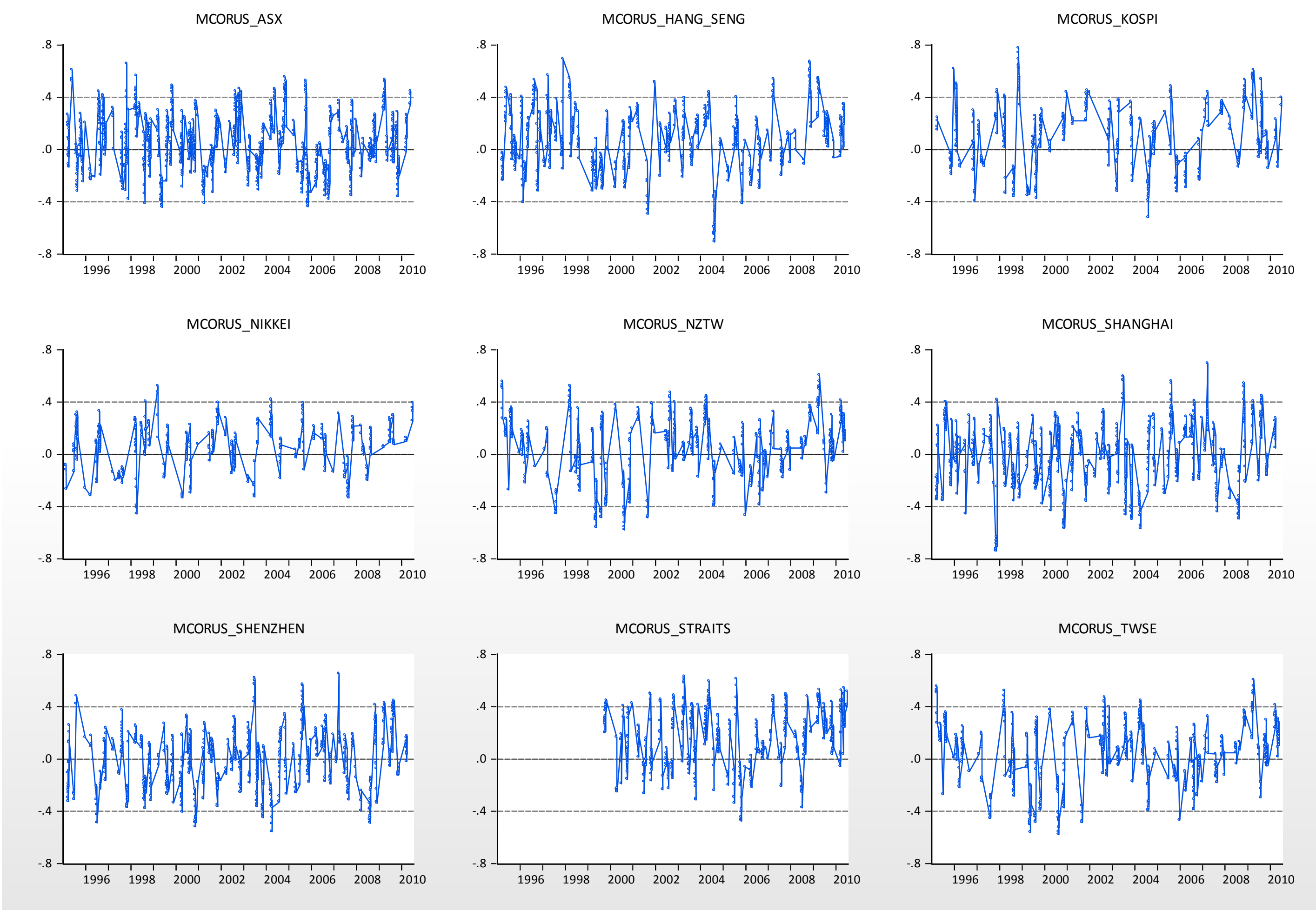
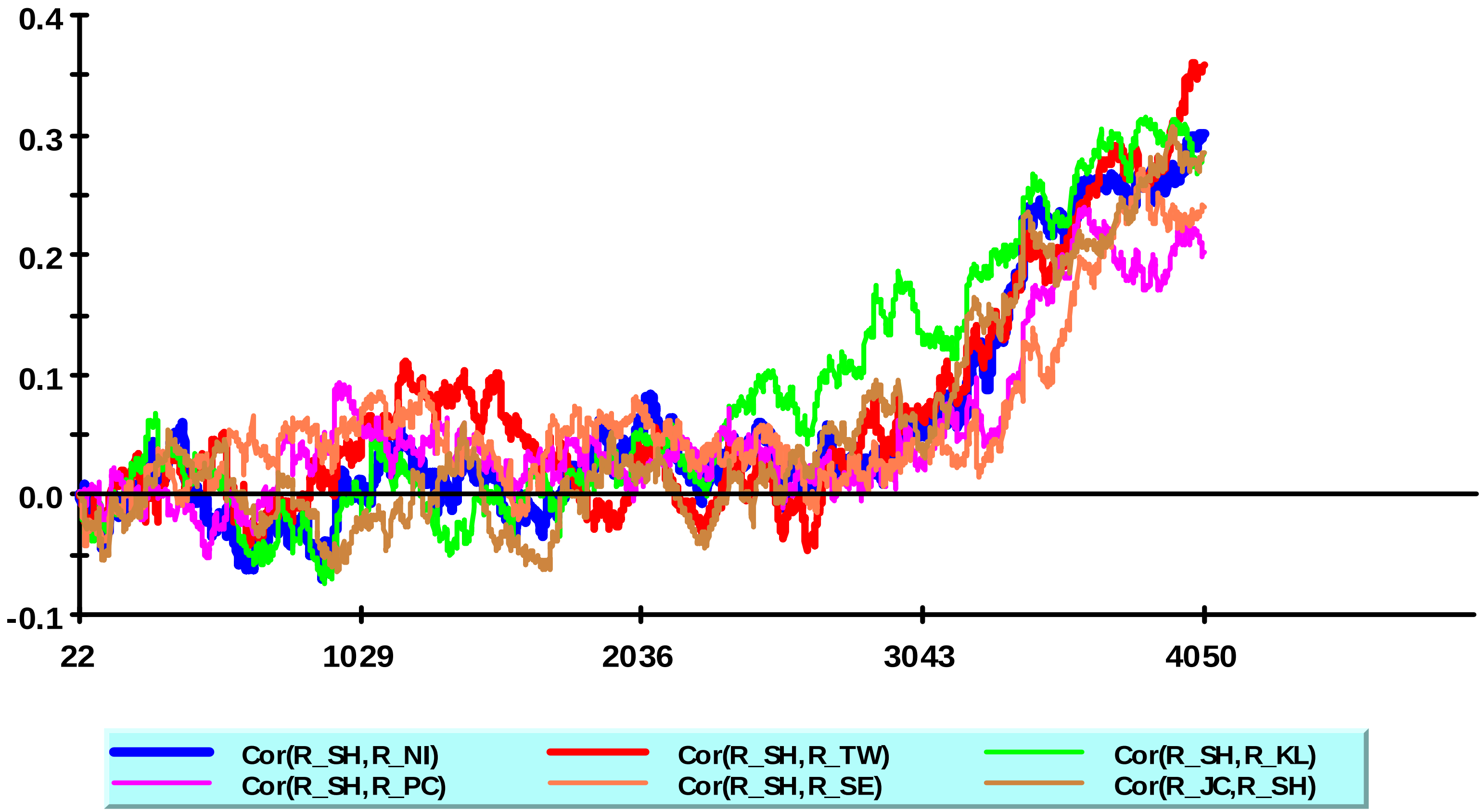
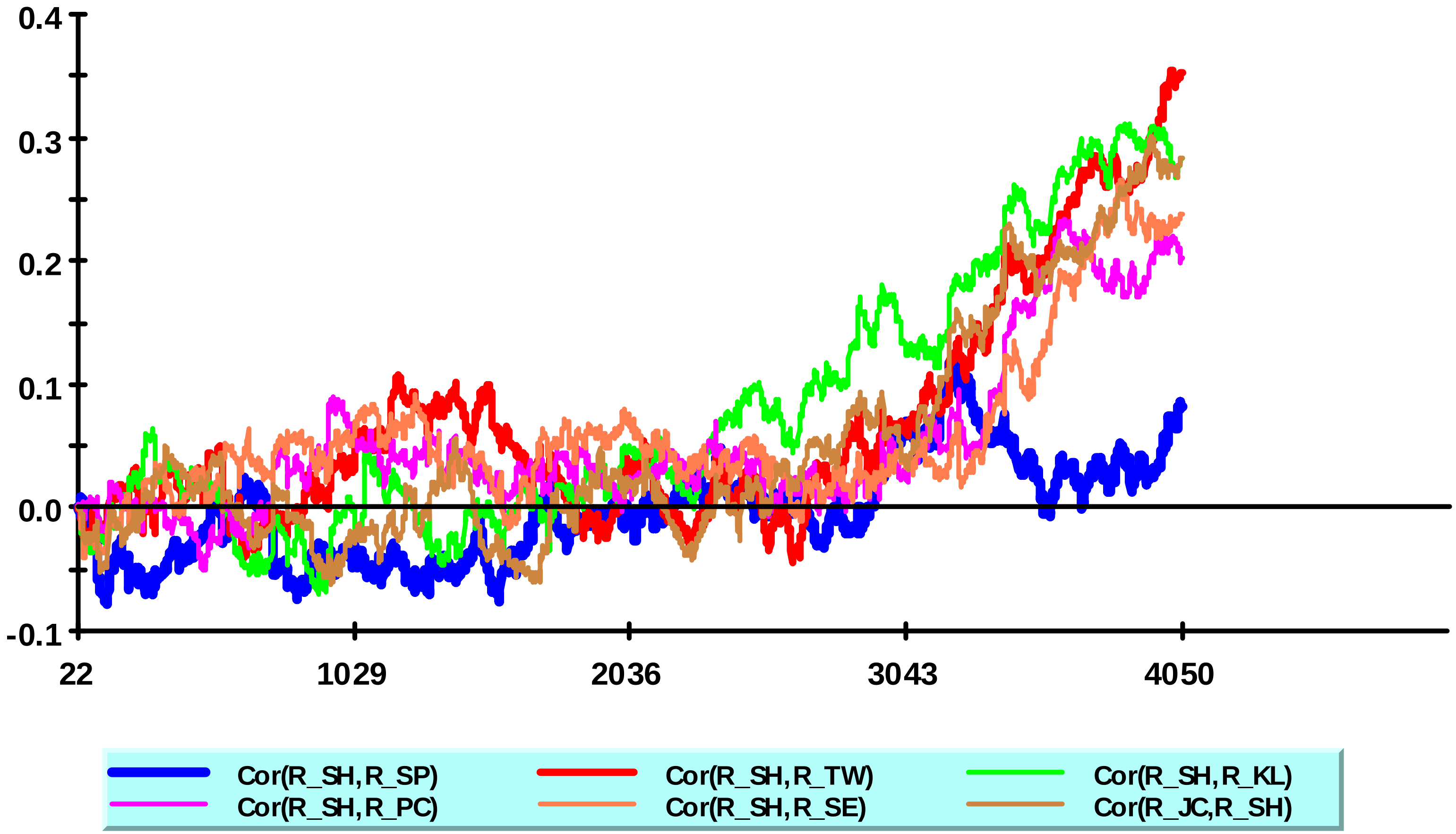


Figure 3: Dynamic Conditional Correlations for China vs. Japan and Emerging Asia



Notes: R refers to equity returns (100 times the log level of an index). The key to the indexes is SH (Shanghai), NI (Nikkei), PC (Philippines), TW (Taiwan), SE (Thailand), KL (Malaysia), JC (Indonesia).

Figure 4: Conditional Correlations: China vs. the United States and Emerging Asia



Notes: SP denotes the US S&P500 and all other terms are as defined under Figure 3