Financial Cycles in Asian Countries[1]

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Abstract

This paper investigates empirically the characteristics of financial cycles by two methodologies: analyses using turning points and frequency-based filters. Our sample is a large database covering 11 Asian countries over the period 1960 to 2013. We examine the frequency, duration and amplitude of the cycles in credit, house prices and equity prices, as well as their synchronization within a country and across countries. We find, first, that financial cycles in the Asian countries were longer and severer than the business cycle in output, while not as long as the financial cycle in developed countries. Second, the credit cycle displays a quite skewed shape with exceptionally longer and stronger expansions than contractions; equity prices have the greatest volatility, as well as the shortest cycle duration and greatest amplitude. Third, financial cycle peaks are very closely followed by financial crises. Finally, the cycle in a financial variable is highly synchronized within and across countries.

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1. Introduction

Financial development facilitates the mobilization of capital and its allocation to investment. It also increases the rate of technological innovation and productivity growth. Consequently, a country's financial development is one key determinant of its economic performance. A number of researchers emphasize the importance of financial development for the real economy (King and Levine, 1993[2] and Barro, 1997). To illustrate, Levine and Zervos (1998), found that stock market liquidity and banking development in 47 countries over the period 1976-1993 had a positive effect on economic growth, capital accumulation and productivity. Moreover, Fase (2001) suggests that the development of the financial system has a greater impact on growth in a developing country than in mature economies.

Asset prices in financial markets are subject to cycles with an expansion ending in a financial crisis, which is followed by a downturn that ends in a trough. Booms in asset prices are often attributed to excessive optimism among the market participants; conversely, downturns can be attributed to excessive pessimism. Movements in asset prices are often associated with cycles in the availability and cost of credit.

Financial cycles can be among the determinants of business cycles in economic activity measured by output and employment. A simple explanation of the impact of a financial cycle on economics activity is as follows. A boom in asset prices causes a credit expansion which lowers the cost of capital, stimulates investment and subsequently leads to an economic boom. Eventually, some of the investments do not prove to be sufficiently profitable, which causes a collapse in asset prices, with the economy moving from boom to bust -- which is often followed by a banking or currency crisis.

Financial cycles are thus critical to the study of business cycles and the related analytical and policy challenges without understanding the nature of the financial cycle, so that macroeconomics needs to incorporate financial behavior in a sufficiently realistic manner. As a prelude to doing so requires an understanding of the basic characteristics of financial cycles themselves. The main objective of this paper is to establishing these characteristics.

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[2] They studied 77 countries over the period 1960-1989, indicating a causal relationship from financial development to economic growth in the early stages of economic development.

While the 2008 global financial crisis spurred many researchers to investigate the major characteristics of financial cycle in advanced economies (e.g., Detken and Smets, 2004; Goodhart and Hoffman, 2008; Schularick and Taylaor, 2009, etc.)[3], there are few studies on this topic for Asian countries. Among such studies, Poměnková (2014) employs the wavelet spectrum analysis to study globalization and business cycles in China and G7 countries. He (2012) develops a multi-level structural factor model to study Asian business cycle synchronization. Glick (2013) presents the empirical evidence on asset markets linkage between China and eight Asian economies: Indonesia, Korea, Malaysia, Philippines, Singapore, Twaiwan, Thailand and India.

By contrast with the financial markets in developed countries, The financial markets in most Asian countries are in earlier stages of liberalization and development s, so that they tend to be more turbulent and fragile, as well as subject to greater intervention and control by governments. Further, in these economies, banking tends to be highly concentrated and dominates the financial markets; only recently have Asian economies become less-bank centered and developed equity and bond markets.

The main contribution of this paper is to fill the gap in the study of the financial cycle in Asian countries. It examines whether there exists a financial cycle in Asia and, if so, examines its main characteristics, such as frequency, duration, amplitude and slope. It then investigates if there is a relationship between financial cycle and economic crises. It also investigates the degree of synchronization of financial cycles within and across countries.

The remainder of this paper is organized as follows. Second 2 describes the data and specifies the methodologies used to identify the cycles and create the index of synchronization within a country and across countries. Sections 3 to 5 present graphs and results on the set of selected variables. Section 6 summarizes and concludes.

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[3] Detken and Smets (2004), Goodhart and Hoffman (2008), Schularick (2009) have shed light on the empirical behavior of the relationship between credit, asset prices and real economic activity. Borio and Lowe (2002), Alessi and Detken (2009) and Gerdesmeier, et al (2010) develop leading indicators of financial distress. Morover, English, et al (2005), Borio and Lowe (2004), Ng (2011), and Hatzius, et al (2010) investigate the estimating properties for economic activity of various financial indicators beyond interest rates. Benetrix and Lane (2011) show that fiscal variables also co-vary with the financial cycle.

2. Data and methodology

2.1 Data

While many different variables, such as interest rates, volatility, risk premium, default rate, nonperforming loans, etc., can be used in the study of financial cycles, this paper focuses on credit, property price and equity prices. Since credit links saving and investment, it is likely to be the most obvious candidate for the analysis of financial cycles. The nature of credit cycles has been examined in many studies including Kiyotaki and Moore (1996), Gorton and He (2005), Myerson (2011) and Greenwood and Hanson (2011). House and equity prices also have been employed in several earlier studies, including Pagan and Sossounov (2003), Gomez and Perez de Gracia (2003), and Hall, McDermott and Tremewan (2006). In addition, Lowe (2001) points that movement in property prices appears to have been more important for the development of financial cycles than equity prices. Borio (1994) emphasizes that the mutually reinforcing relationship between credit and asset prices lies at the heart of financial cycles.

This paper explores the behavior of the quarterly series of credit, house prices and equity prices for 11 Asian countries and areas (China, Hong Kong, Taiwan, Japan, South Korea, India, Indonesia, Malaysia, Philippines, Thailand, Singapore) over our sample periods, which differ because of data availability.

Credit series are from DataStream, and mostly from the 1960s to 2013. Property prices are from the Bank for International Settlements (BIS) and the statistics departments of the countries, and provide of indices of house or land prices, depending on the availability of the data. Equity prices are represented by share price indices weighted with the market value of outstanding shares. The data on them comes mainly from DataStream. Nominal values have been deflated by the CPI to yield real values and is then converted to logs. For comparability, each series is normalized by setting its value in 2005 Q1 at 100.

We employ two methodologies to identify financial cycles in our selected three variables. The first is 'turning-point analysis'. It identifies the peaks and troughs in the series and summarizes their behavior between those phases.[4] The second methodology is: frequency-based filter analysis.

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[4] For some other dating methods, see Stock and Watson (2010) and Sinai (2010).

2.2 Turning-point methodology

We first apply the traditional cycle-dating turning-point analysis, originally proposed by Burns and Mitchell (1946) for dating the business cycle, to identify the peaks and troughs in the financial cycle. Among recent studies using this method are Bry and Boschan (1971) and Harding and Pagan (2002) for business cycle analysis. Claessens, et al, (2011) and Drehmann (2012) use this method for identifying financial cycles in several more advanced countries.

Financial cycles can be established using detrended series or the first differences of the values of the variables. The former method yields the financial cycle as a deviation from the trend value. It suffers from the problem that the addition of new data can affect the estimated trend, and thus the estimated cycle. Therefore, this paper uses the second method. This method, which yields turning points, is robust to the inclusion of newly available data.

The turning-point algorithm searches for local maxima and minima over the series. Besides the basic local maxima and minima searches, this algorithm uses additional censoring rules to identify the cycles. These require the specifications on: (1) the minimum length of the cycle (the distance between two consecutive peaks or troughs); (2) minimum length of each phase (contraction from peak to trough or expansion from trough to peak) of the cycle; (3) peaks and troughs to appear alternately; and (4) a trough (peak) to be lower (higher) than the preceding peak (trough).

Following Harding and Pagan (2002), we consider first short-term the financial cycle. For this cycle, we set the cycle length as 4 quarters and every phase length to be at least 2 quarters. To identify financial crises, which often result in major and long-lasting output losses, we also use medium-term frequencies, for which we set the minimum cycle length window at 8 quarters, so that the phase (contraction or expansion) length would be at least 4 quarters. These assumptions lead to the algorithm specified in Table 2.2. In this table, a point in a quarterly financial series Y_t occurs at t if it satisfies the condition in the second column and can be marked as a peak or trough.

Table 2.2 Turning-point algorithms

Short-term (ST) algorithm	Conditions
Peak Y_t	$\Delta Y_{t,t-i} > 0\ for\ \forall i \in [-2,-1,1,2]$
Trough Y_t	$\Delta Y_{t,t-i} < 0\ for\ \forall i \in [-2,-1,1,2]$
Medium-term (MT) algorithm	
Peak Y_t	$\Delta Y_{t,t-i} > 0\ for\ \forall i \in [-4,-3,-2,-1,1,2,3,4]$
Trough Y_t	$\Delta Y_{t,t-i} < 0\ for\ \forall i \in [-4,-3,-2,-1,1,2,3,4]$

2.3 Frequency-based filter methodology

There are several time-series filters commonly used in macroeconomic and financial research to separate the behavior of a time series into trend, cyclical and irregular components. A band-pass filter is a device that passes frequencies within a certain range and rejects frequencies outside that range. In our paper, this filter is used to isolate different cycle terms and decide on the most important one to compare with that of business cycle, which usually has a duration between 5 to 32 quarters (Christiano and Fitzgerald, 2003 and Comin and Gertler, 2006). Since the data is that of quarterly growth rates, and since the growth rates of macroeconomic series tend to be stationary, the filter also excludes a drift in the series (Comin and Gertler, 2006).

Christiano and Fitzgerald (2003) expresses a time series x_t in terms of frequency ω_i, as in equation (2.3.1):

$$x_t = a_0 + \sum_{i=0}^{n}\{\alpha_i \cos(\omega_i t) + \beta_i \sin(\omega_i t)\} + e_t \quad (2.3.1)$$

A specific time series has different frequency components. Let y_t denotes the data generated by applying the band pass filter $\widehat{y_t}$ to the raw data x_t, and approximate y_t by $\widehat{y_t}$ to minimize the mean square error. That is, minimize:

$$E[(y_t - \widehat{y_t})^2 | x] \quad (2.3.2)$$

To isolate the component of x_t with period of oscillation between p_l and p_u, $\widehat{y_t}$ is computed as: $\widehat{y_t} = B_0 x_t + B_1 x_{t+1} + \cdots + B_{T-1-t} x_{T-1} + \widetilde{B}_{T-t} x_T + B_1 x_{t-1} + \cdots + B_{t-2} x_2 + \widetilde{B}_{t-1} x_1$ (2.3.3)

For t = 3, 4, … , T-2,

$$B_j = \frac{\text{sing}(jb) - \sin(ja)}{\pi j}, \quad j \geq 1 \tag{2.3.4}$$

$$B_0 = \frac{b-a}{\pi}, \ a = \frac{2\pi}{p_u}, b = \frac{2\pi}{p_l}$$

After applying the filter $\widehat{y_t}$, the components of x_t with frequency within the lower and upper bounds will be drawn out and the rest of the signals that are out of the range will be offset and excluded by the filter. For example, if the data are quarterly and $p_l = 6$ and $p_u = 32$, then y_t is the component of x_t with periodicities between 1.5 and 8 years.

2.4 Synchronization

In order to examine synchronization within a country and across countries, we create an index initially developed by Harding and Pagan (2002b). Define a concordance index CI_{xy} for variable x and y, over period t = 1, … T, as follows:

$$CI_{xy} = \frac{1}{T}\sum_{t=1}^{T}[C_t^x \cdot C_t^y + (1 - C_t^x) \cdot (1 - C_t^y)] \tag{2.4.1}$$

Where C_t^x={0, if x is in downturn phase at time t; 1, if x is in expansion phase at time t}

C_t^y={0, if y is in downturn phase at time t; 1, if y is in expansion phase at time t}

The concordance index measures concordance of the two series by measuring the fraction of time that they are in the same phase of their respective cycles. If the index is equal to 1, the series are perfectly pro-cyclical; it equals zero if they are countercyclical. Therefore, at the level of variables level, this index measures the extent to which the financial variables within a country coincide with each other; at the country level, this index measures the extent to which financial cycles in different countries coincide over time.

3. Empirical Analysis

3.1 Turning-point analysis: short-term and medium-term cycles

After searching the local maximum and minimum points in the individual series by applying the turning-point dating algorithm, we obtain a set of peaks and troughs for each variable. Table 3.1 captures these features of financial cycles across our set of 11 countries (China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, India, Indonesia, Singapore and Philippines). The results describe the estimated cycle in the terms of frequency, amplitude, duration and slope.

The turning-point dating method identifies 203 complete short-term financial cycles and 125 full medium-term cycles over the sample periods, whose length is dictated by the availability of the data. Among our variables, credit has the longest historic data length from 1950s to 2013, followed by equity prices from 1970s to 2013 and house prices from the 1980s to the present.

As shown in Table 3.1, the medium-term cycle has a longer duration, stronger amplitude and more violent slope in each financial series. Therefore, we select the medium-term cycle rather than the short-term one for comparison with the business cycle. The following analysis concentrates on the medium-term cycle.

Frequency can be represented by the cycle duration, which can be the average number of quarters from peak to peak, or from trough to trough. In the third column of Table 3.1, the medium-term cycle of equity prices lasts about 24 quarters (6 years), while housing prices lasts about 32 quarters (8 years) and credit lasts about 48 quarters (12 years). That is, credit has the lowest frequency, while equity prices display the highest frequency, attesting to its greater volatility among the three selected indicators of the financial market.

Amplitude implies the intensity of the variables in each own cycle. Looking at the medium-cycle statistics in columns 4 and 5 of Table 3.1, the amplitude of the expansions is 17.94, 12.77 and 6.52 percent for, respectively, credit, equity price and housing price while it is 2.69, 9.96 and 4 percent, respectively, for declines in credit, equity price and housing price. The skewed shape of the cycle is most pronounced in credit, which has the highest amplitude in expansions but the lowest one in contractions, while housing prices have relatively modest changes both in upturns or downturn. Overall, the amplitude of recoveries is much severe than that of contractions.

Column 6 and 7 of Table 3.1 show the downturns from peak to trough last, on average, about 10-14 quarters, while the upturn tend to be much longer at 13-37 quarters. To illustrate the differences, credit expansions last, on average, about 37 quarters while housing prices so over 17 quarters and equity price over 13 quarters. These findings suggest that financial expansions in the financial cycle last longer than contractions from peak to trough, so that the financial cycle exhibits a skewed distribution.

The slope of a financial expansion (contraction) is the ratio of its amplitude to its duration. That is, the slope indicates the 'speed' of the movement. The last two columns of

Table 3.1 show that this speed of upturns in credit and housing prices is quite similar, at about 0.5 percent per quarter, while equity prices tend to move much faster -- by about three times more than those in credit and housing prices. Additionally, the slope of expansions is very much greater than that of contractions.

To summarize our findings so far, first, the financial cycle is skewed; contractions tend to have sharper declines in short periods, while expansions are often much longer and slower. Second, the cycle in credit displays the most skewed shape with extraordinarily longer and stronger expansions than contractions; by comparison, the cycle in equity prices is the most volatile one, with the shortest cycle duration and the greatest amplitude. Third, the medium-term cycle, which lasts 24 to 48 quarters (6 - 12 years), provides a description of the characteristics of financial cycles than the short-term ones. Finally, comparing our results with those obtained by Drehmann (2012) for developed economies, the duration of whose cycle was estimated as about 8 - 18 years, the financial cycle in developed economies lasted about 1.5 times longer than the one in our selected Asian countries.

3.2 Frequency-based filter analysis

Frequency-based filter analysis allows separation of the components on the basis of frequencies and shows the results visually and quantitatively. Figure 3.2.1 shows the cyclical shape of Chinese housing prices on the basis of different frequency band filters. We calculate the standard deviation and the ratio of the standard deviation to the range length (standard deviation per quarter). A higher ratio index means that the component is more volatile or has greater amplitude per quarter unit than the other components in the series, so that this index can be interpreted as indicating their importance in shaping the dynamics of the variable.

By construction, the different components are independent of each other. The two graphs at the left corner represent the original data and the growth rate. The frequency bands have been split into several ranges. The graphs in the first row are very noisy since they pertain to the lowest frequency components and the index decreases dramatically from 0.52 to 0.1, indicating a strong cyclical signal in the very low frequency with 4 to 30 quarters. Another strong component is in the range from 24 to 48 quarters (6-12 years): it is the most volatile, with greater amplitude than other cases (except in the extremely high frequency range). In other words, the cycles of periodicities between 6 to 12 years are more important in shaping the cyclical behavior of Chinese housing prices than those with other durations. Although the high index appears in the very high frequency, it represents the data noise and has no pronounced cyclical shape, so that the duration of 6 to 12 years represents the cyclical behavior of housing price in China. This is confirmed by the results in medium-term cycle using the turning-point method.

One more graphs and tables are shown in order to narrow down the range and find the cyclical components with different frequencies. Table 3.2.1 calculates the different frequency ranges from 4 to 112 with the interval of 12 quarters. In this table, durations of 16 to 28 quarters and 28 to 40 quarters have the highest and most significant cyclical index. Making the interval smaller and searching the range in greater detail, Figure 3.3.2 illustrates the cyclical index for an interval of 4 quarters (1 year). The filter is used show housing prices in a 3 dimensional graph. This graph supports our earlier findings.

Table 3.2.2 summarizes the frequency ranges. It applies the frequency-based filter to the data on each country and shows pronounced and complete cyclical patterns. From the aspect of volatility, the cyclical components of credit are between 6 and 12 years for China, Japan, Hong Kong, Taiwan, India and Singapore; those for Korea, Thailand, Indonesia and Philippines are considerably longer at between 18 and 24 years. On average, the cycle in equity prices is shortest one, following by that of housing prices. In addition, the cyclical pattern is the least pronounced for credit. Comparing this finding with that for economies with advanced financial markets, whose cycles of periodicities were estimated by Drehmann (2012) as being between 8 and 30 years, the cyclical duration in our sample of Asian countries are much shorter.

3.3 Combine the two methodologies

The above two sections have investigated the financial cycles by the two methodologies, the turning-point dating algorithm and the band-pass filter. For a comparison of the cycles identified by the two methods, we combine the two results from different methods in an integration graph. Figures 3.3.1 and 3.3.2, respectively, demonstrate the results of the two algorithms for the case of Chinese housing and equity prices. For most of the countries, the dates of peaks (and the onset of contractions) and troughs (and the beginning of the expansions) and produced by the two methods are fairly close. Both methods perform well and produce well-shaped financial cycles by eliminating small fluctuations and noisy signals. Since these Asian countries have not yet developed mature financial markets, lots of components with different frequencies are included in the raw data, making it difficult to separate the typical one accurately, so that making the turning-point method convenient for identifying cycles while leaving it to frequency-based filter method to illustrate the shape of the cycle in a more visual way.

4. The Financial Cycle with Financial Crises

Since a financial crisis is a sign of financial distress, it is useful to check the relationship between the cyclical phases in the financial variables and the timing and incidence of crises. Financial crises are associated with the onset of the contraction phase of the financial cycles. Table 4.1 indicates the closeness of financial crises in Asia with the peaks (the beginning of the contractions) derived by the two statistical methodologies by the time distance between the date marking the onset of a financial crisis and the nearest peak in each variable.

The second column of Table 4.1 shows the dates of financial crises as being around 1997 and 2008. Most of the peaks identified by both the methodologies are less than one year away from these dates. From the table, the closeness measured by the frequency-based filter tends on average to be 2 quarters larger than that derived by the turning-point method. The negative numbers imply that the peaks are prior to the onset of crises, which is consistent with the common assumption that crises start with excess liquidity, followed by speculative manias, culminating in a bubble and subsequent crash.

Table 4.2 provides further information on the relationship between cyclical peaks and crises. For both short-term cycles and medium-term cycles, it examines the peaks and crises within 12 quarters. First, about 30-35% of the peaks are close to crises. The link between the peaks and crises is tighter in medium-term cycles than in the short-term cycles because of the latter's higher percentage of peaks occurring close to crises. Second, cycles that begin with peaks close to crises tend to be longer for each of the variables and have greater amplitude in credit and house prices in the medium-term cycles. For example, for credit, peaks close to crises in the medium-term cycles have 44 percent greater amplitude. Their duration of 55.9 quarters is also much greater than the duration of peaks that are not close to crises.

5. Synchronization of Financial Cycles

This section investigates the synchronization between the financial cycles within a country and across countries. The synchronization represents how concordant the two series are during some specific period. It measures the fraction of time the two series are in the same phase of their respective cycles. An index is unity if the two series are perfectly pro-cyclical; it is zero if the two are counter-cyclical.

5.1 Synchronization within countries

Table 5.1 shows the concordance between financial cycles in each country. The last two rows of this table show the mean and median statistics. The synchronization between any two financial markets is around 0.55; that is, the two are in the same phase for about 55 percent of the time. This finding compares with that provided by Claessens (2011A) for developed economics, who found that credit and housing prices in developed economies is highly synchronized but the linkage of equity prices with the other variables is relatively weak. Our findings indicate that does not apply for our set of countries, especially with respect to equity prices. Financial markets in developing economies are usually not well developed and the fluctuations in credit, house prices and equity prices are quite similar. Moreover, governments play essential roles in these markets by rigorous regulations.

Another finding on the synchronization within a country is that the more mature the financial market, the higher degree of synchronization that exists between our financial variables. In Table 5.1, Japan and Hong Kong, both of which are financial centers, have the greatest synchronization: the indices for Japan are 0.74, 0.69 and 0.68 and the indices for Hong King are 0.64, 0.57 and 0.65.

5.2 Synchronization across countries

Table 5.2.1 provides the synchronization statistics between cycles across countries. For this table, the synchronization statistic for each country pair is first computed. The highest degree of cross-country synchronization is between cycles in credit (with the average at about 0.61), while the least concordance is between cycles in housing prices. This finding is broadly consistent with the notion that credit and equity markets are more closely integrated across countries than the housing market: both credit (financial capital) and equities are tradable assets in the international financial markets. However, house and land are non-tradable in the international market; further, in some countries they are controlled firmly by governments. However, case in spite of this non-tradable nature and possibility of government control, the synchronization level of housing prices across countries is about 0.5. Our overall finding of greater synchronizations of credit and equity prices than of house prices is consistent with the findings reported for advanced countries by Claessens (2011A) and Terrones (2004).

We next examine synchronization across countries for individual variables. The concordances of credit, housing prices and equity prices across countries are shown in Tables 5.2.2, 5.2.3 and 5.2.4, respectively. In the case of credit, Korea has the highest synchronization with other countries, following by Hong Kong, Japan, Thailand, Indonesia and Philippines. Korea and Hong Kong are also the top first and second places in the table for housing prices; Japan, Taiwan and China are also quite high. Looking at the cycles in equity price, Japan ranks at the one, followed by Taiwan, Korea and India.

6. Conclusions

As early as the 1940s, Burns and Mitchell began to establish the empirical characteristics of business cycles. Numerous studies have repeated this exercise for developed economies. By comparison, however, there is very limited empirical work on the financial cycle, especially for developing economies. This paper, to some extent, contributes to the agenda.

This paper employs two statistic methodologies, turning-point analysis and frequency-based filter, for studying the financial cycle in Asian countries, using data for quite a long time period (since the 1960s). It analyzes financial cycles in several ways: first, it documents the basic characteristics, such as frequency, duration and amplitude, for individual financial series in each country and across countries. Second, it examines the relationship of the financial cycle with financial crisis. Third, it investigates the synchronization of financial cycles within and across countries.

Our findings are as follows. First, both the turning-point and frequency-based filters show that the financial cycle length can be narrowed down to 6 to 12 years, which is shorter than the length for the developed economies, which have a financial cycle ranging from about 8 to 30 years -- slightly longer than the business cycle in economic activity, which has a cycle length of 1.5 to 8 years. Second, the financial cycles display a skewed shape with longer and stronger expansions than contractions. Third, cycles in house and equity prices are more pronounced than in credit. Fourth, the peaks of the financial cycles tend to coincide very closely with financial crises, with the ones closer to crises having longer expansion periods and greater amplitude. Fifth, the degree of synchronization across countries is higher for credit and equity cycles than for the cycle in house prices. Among our set of countries, Japan, Korea, Hong Kong and Taiwan are more highly synchronized with the rest of Asian countries in all of the three financial variables.

References

Aikman, D., A. Haldane, and B. Nelson, 2010, "Curbing the credit cycle," Paper presented at the Columbia University Center on Capitalism and Society Annual Conference, New York.

Alessi, L., and C. Detken, 2009, "Real time' early warning indicators for costly asset price boom/bust cycles: a role for global liquidity," European Central Bank, 1039.

Barro, R. J., 1997, "Determinants of Economic Growth: A Cross-country Empirical Study," National Bureau of Economic Research, London: MIT Press.

Benetrix, A., and P. R. Lane, 2011, "Financial Cycles and Fiscal Cycles," Paper presented at the EUI-IMF Conference "Fiscal Policy, Stabilization and Sustainability", Florence.

Bernanke, B. S., M. Gertler, and S. Gilchrist, 1999, "The Financial Accelerator in A Quantitative Business Cycle Framework." *Handbook of macroeconomics*, 1, 1341-1393.

Borio, C., N. Kennedy, and S. Prowse, 1994, "Exploring Aggregate Asset Price Fluctuations across Countries: Measurement, Determinants and Monetary Policy Implications." BIS Economic Paper 40.

Borio, C. E., and P. W. Lowe, 2002, "Asset prices, financial and monetary stability: exploring the nexus," BIS Working Paper 114.

Borio, C. E., and P. Lowe, 2004, "Securing sustainable price stability: should credit come back from the wilderness?" BIS Working Paper 157.

Borio, C., 2012, "The Financial Cycles and Macroeconomics: What Have We Learn?" BIS Working Paper 395.

Bry, G., and C. Boschan, 1971, "Cyclical Analysis of Time Series: Selected Procedure and Computer Programs," National Bureau of Economic Research, Technical Paper 20.

Burns, A. F., and W. C. Mitchell, 1946, "Measuring Business Cycles," National Bureau of Economic Research Books, New York.

Christiano, L., R. Motto, and M. Rostagno, 2010, "Financial Factors in Economic Fluctuations," ECB Working Paper 1192.

Claessens, S., M. A. Kose, and M. E. Terrones, 2011a, "Financial cycles: What? How? When?" IMF Working Paper WP/11/76.

Claessens, S., M. A. Kose, and M. E. Terrones, 2011b, "How do Business and Financial Cycles Interact?" IMF Working Paper WP/11/88.

Comin, D., and M. Gertler, 2006, "Medium-term business cycles," *American Economic Review* 96 (3), 523-51.

Detken, C., and F. Smets, 2004, "Asset price booms and monetary policy," ECB Working Paper Series 364.

Fase, M. M. G., 2001, "Financial Intermediation and Long-Run Economic Growth in The

Netherlands between 1900 and 2000," *Economologues, Tiburg, Tiburg University*, 85–98.

Gerdesmeier, D., H. E. Reimers, and Roffia, B., 2010, "Asset Price Misalignments and the Role of Money and Credit," *International Finance* 13 (3), 377-407.

Glick, R., and M. Hutchison, 2013, "China's Financial Linkages with Asia and The Global Financial Crisis," *Journal of International Money and Finance* 39, 186-206.

Goodhart, C., and B. Hofmann, 2008, "House Prices, Money, Credit, and the Macroeconomy," *Oxford Review of Economic Policy* 24, 180-205.

Gorton, G. B., and Ping He, 2008, "Bank Credit Cycles," *The Review of Economic Studies* 75, 1181-1214.

Hall, V. B., C. J. McDermott, and J. Tremewan, 2006, "The Ups and Downs of New Zealand House Prices," *Motu Economic and Public Policy Research.*

Harding, D., and A. Pagan, 2002, "Dissecting the Cycle: A Methodological Investigation," *Journal of Monetary Economics* 49, 365-381.

Hatzius, J., P. Hooper, F. Mishkin, K. Schoenholtz, and M. Watson, 2010, "Financial Conditions Indexes: A Fresh Look after the Financial Crisis," NBER Working Papers 16150.

He, D., and W. Liao, 2012, "Asian business cycle synchronization," *Pacific Economic Review* 17 (1), 106-135.

King, R. G., and Levine, R, 1993, "Finance and Growth: Schumpeter might be Right," *Quarterly Journal of Economics* 108 (3), 277–291.

Kiyotaki, N., and J. Moore, 1997, "Credit Cycles," *Journal of Political Economy* 105 (2), 211–248.

Levine, R., and S. Zervos, 1998, "Stock Markets, Banks and Economic Growth," *American Economic Review* 88 (3), 537-558.

Ng, T., 2011, "The Predictive Content of Financial Cycle Measures for Output Fluctuations," *BIS Quarterly Review*, 53-65.

Poměnková, J., J. Fidrmuc, and I. Korhonen, 2014, "China and the World Economy: Wavelet Spectrum Analysis of Business Cycles," Bank of Finland Discussion Papers 5.

Schularick, M., and A. Taylor, 2009, "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," NBER Working Paper 15512.

Sinai, A., 2010, "The Business Cycle in a Changing Economy: Conceptualization, Measurement, Dating," *American Economic Review: Papers and Proceedings* 100, 25–9.

Stock, J. H., and M. W. Watson, 2010, "Indicators for Dating Business Cycles: Cross-History Selection and Comparisons," *American Economic Review: Papers and Proceedings* 100, 16–19.

Terrones, M., and C. Otrok, 2004, "The Global House Price Boom." *IMF World Economic Outlook,* 71-136.

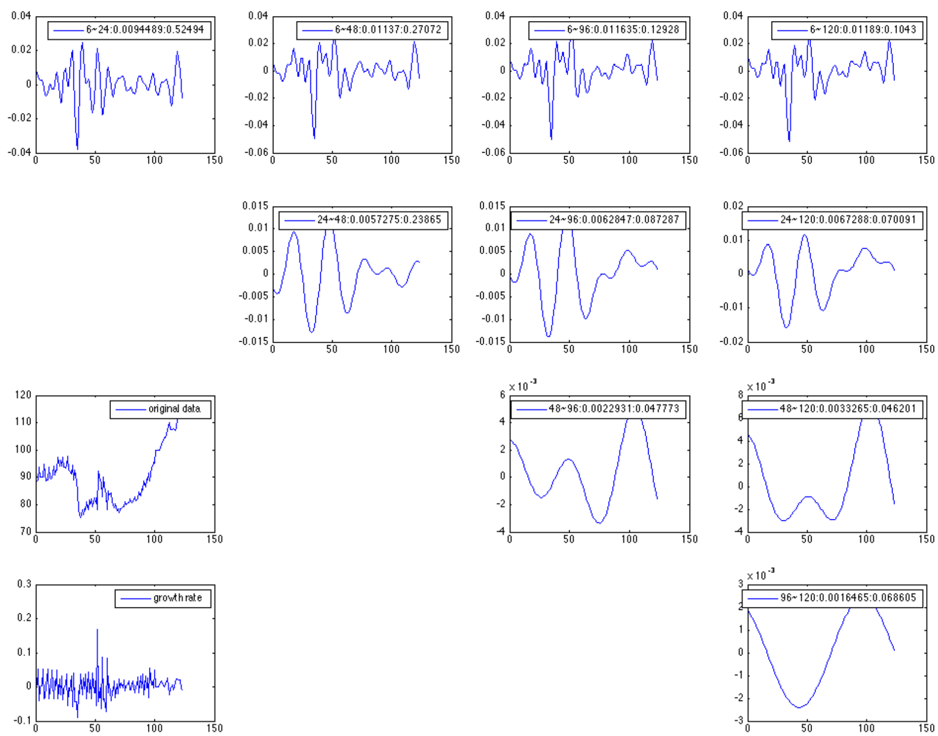
Appendix

Table 3.1 Characteristics of short-term and medium-term cycles: individual series for all Asian Countries[1]
(Turning-point Analysis)

	Cycles[2]		**Amplitude[3] (In percent)**		**Duration (Number of quarters)**		**Slope[4] (Speed of cycle)**	
Short-term cycle	Number	Duration[5]	Expansion	Contraction	Expansion	Contraction	Expansion	Contraction
Credit	57	32.25	17.94	-2.69	26.28	5.97	0.68	-0.45
House price	60.5	22.57	6.52	-4.01	12.46	10.11	0.52	-0.40
Equity price	86	16.37	12.77	-9.96	8.94	7.43	1.43	-1.34
Medium-term cycle								
Credit	31.5	47.32	20.79	-4.53	37.75	9.57	0.55	-0.47
House price	38.5	31.14	7.94	-5.14	17.14	14.00	0.46	-0.37
Equity price	55.5	24.24	16.43	-11.82	13.42	10.82	1.22	-1.09

1. Results based on the mean of the distribution in all these Asian countries; 2. Cycle number is the total number of cycles in the three variables, and 0.5 means half a cycle (from peak to trough or trough to peak); 3. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 4. The slope of expansion is the amplitude from trough to peak divided by the duration; the slope of contraction is the amplitude from peak to trough divided by the duration; 5. The duration of the full cycle is the summary duration of expansion and contraction.

Fig. 3.2.1 Cyclical Components of Housing Prices in China



Note: the numbers in these sub-figures are the frequency range, standard deviation and the ratio of the standard deviation to the range size (standard deviation per quarter).

Table 3.2.1 The Cyclical Index of Different Bands of Components of China House

Rang	16 Q	28 Q	40 Q	52 Q	64 Q	76 Q	88 Q	100 Q	112 Q
4 Q	1.249179	0.655607	0.453775	0.343038	0.276452	0.230670	0.197634	0.173340	0.154903
16 Q	NA	0.374024	0.262505	0.184936	0.144590	0.116569	0.097002	0.084228	0.075771
28 Q	NA	NA	0.334706	0.194879	0.142211	0.108063	0.086741	0.074488	0.067190
40 Q	NA	NA	NA	0.153570	0.118851	0.083697	0.063336	0.055001	0.051963
52 Q	NA	NA	NA	NA	0.111022	0.068464	0.045869	0.041035	0.042441
64 Q	NA	NA	NA	NA	NA	0.044669	0.039306	0.044375	0.048084
76 Q	NA	NA	NA	NA	NA	NA	0.055944	0.061397	0.062286
88 Q	NA	NA	NA	NA	NA	NA	NA	0.070257	0.069211
100 Q	NA	NA	NA	NA	NA	NA	NA	NA	0.070299

Note: The first column is the beginning of range, and the first row is the end of range. For instance, the column for 88 Q and the row for 28Q has 0.0867, indicating that cyclical index (the ratio of standard deviation to the range) of the component with the frequency from 28 to 88 quarters is 0.0867.

Fig. 3.2.2: 3D Cyclical Index of house prices in China

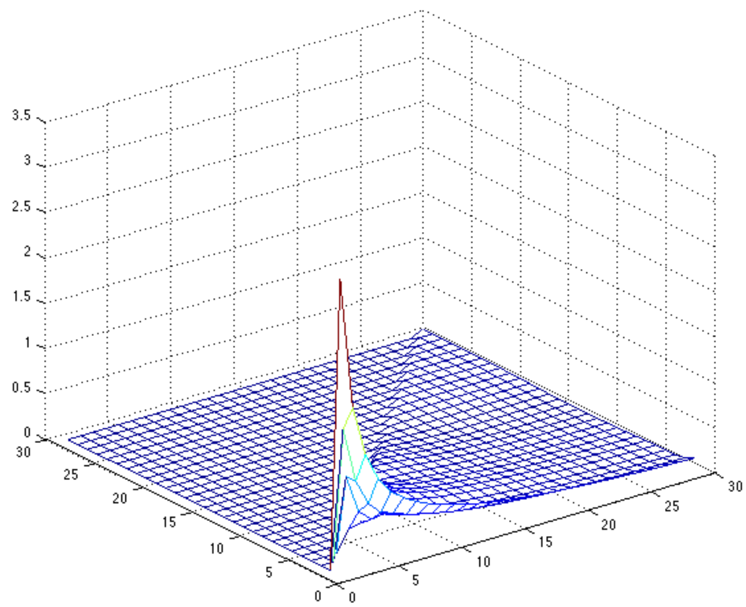
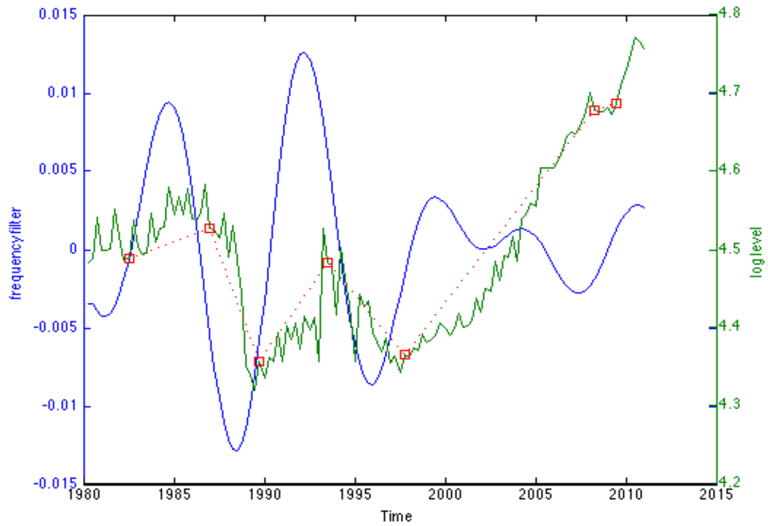


Table 3.2.2 The Cycle Term in Each Country

Country	Range of Credit (Year)	Range of House (Year)	Range of Equity (Year)
China	6-12 (0.324)	6-12 (0.239)	4-9 (5.184)
Japan	7.5-12.5 (0.182)	8-16 (0.530)	6-12 (1.215)
Hong Kong	6-12 (0.608)	6-12 (0.462)	3-12 (2.440)
Taiwan	6-12 (1.835)	3-9 (0.431)	4-9 (2.544)
India	7.5-10 (0.48)	NA	5-7.5 (2.441)
Korea	20-25 (0.135)	6-8 (0.761)	6-8 (2.760)
Malaysia	10-20 (0.174)	5-10 (0.082)	5-10 (1.243)
Thailand	20-25 (0.213)	4-8 (0.421)	8-16 (1.196)
Singapore	8-16 (0.285)	5-10 (1.191)	5-10 (1.589)
Indonesia	18-24 (0.505)	8-16 (0.090)	5-10 (2.593)
Philippines	16-18 (0.870)	NA	5-10 (2.006)

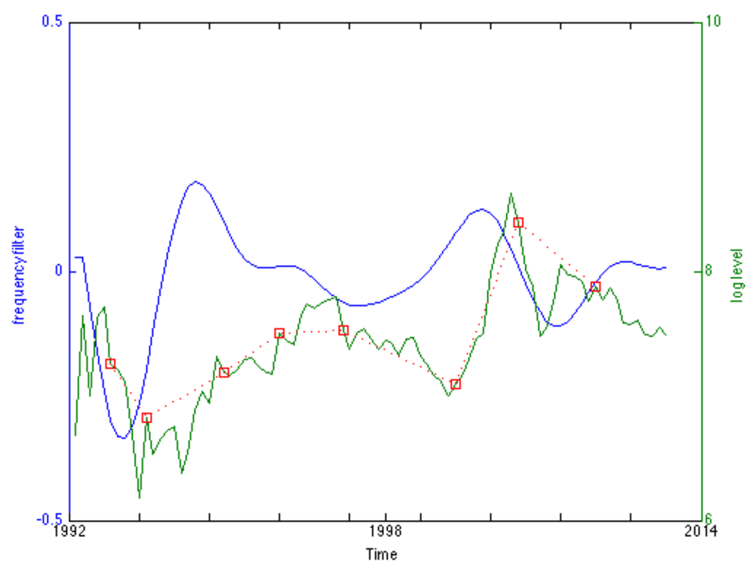
Note: The figures refer to the range of the strong cyclical component in each variable series. The numbers in brackets indicate the ratio index (standard deviation per quarter).

Fig. 3.3.1 Combination of two methods for Chinese housing prices



Note: Red squares donate the peaks and troughs of the medium-term cycle, green lines are series in log levels, blue lines are data filtered by specific frequency range and vertical lines indicate the starting point for financial crisis.

Fig. 3.3.2 Combination of two methods for Chinese equity prices



Note: Red squares donate the peaks and troughs of the medium-term cycle, green lines are series in log levels, blue lines are data filtered by specific frequency range and vertical lines indicate the starting point for a financial crisis.

Table 4.1 Financial crises and peaks in medium-term cycles: individual series

Country	Event Date[5]	Turning-point method			Frequency-based filters		
		Credit	House prices	Equity prices	Credit	House prices	Equity prices
China	1998 Q3	-19	-8*	-5	0	3	-7
	2007 Q4	-	0	0	8	-12	-6
Japan	1991 Q4	4	-5	-6	-12	-12	-
	1997 Q4	-4	-	-5	-2	0	-8
	2008 Q3	-5	-2	-4	-8	-11	-12
Hong Kong	1987 Q4	12*	6*	9	2	-5	-9
	1997 Q4	-1	-1	-3	-9	-3	-6
	2008 Q4	-1*	-3	-4	-12	-16	4
Taiwan	2008	-2*	12	-1	0	4	8
Korea	1997 Q4	0	7*	9	-	-9	10
	2008 Q4	-4*	-7	-4	9	0	-9
Malaysia	1997 Q3	1	-7*	-2	-12	-12	-12
	2009 Q1	-	-4	-4	3	7	9
Thailand	1997 Q2	2	-4	-10	-	-3	-16
	2008 Q4	0*	1	-12	16*	-12	-
Singapore	1997 Q3	5	-5	10	-6	-12	7
	2008 Q2	1*	-1	-3	-7	-9	-12
Indonesia	1997 Q3	3	3	0	-	16	-11
Philippines	1997 Q3	1	1	-4	-12	-	7
Average (MT)		-1.18	-1.07	-2.05	-3.87	-4.78	-3.71
Average (MT and ST)		-0.41	-0.94	-2.05	-2.63	-4.78	-3.71

Note: The figures refer to the distance between financial crises to the nearest peaks in quart, and the negative number indicates that the peak is prior to the crisis.

[5] Financial events: August 4, 1998, China was forced to devalue its currency; 2005-2013, Chinese property bubble started to deflate in late 2011 when housing prices began to fall, and the deflation of the property bubble is seen as one of the primary causes for China's declining economic growth in 2012; 1986-2003, Japanese asset price bubble, by August 1990, stock price had plummeted to half its peak, the asset price began to fall by late 1991 and the asset price collapsed in early 1992; Nov. 17, 1997, Japan's top 10 banks collapse under a pile of bad loans; 2000- early 2000s, Japan's recession started in the early 1990s; Nov, 2008, the Japanese Economy Minister announced that the nation was officially in a recession; October 19, 1987, the crash of Black Monday began in Hong Kong; October 23, 1997, Hong Kong's dollar was under attack; The Hong Kong economy officially slid into recession in the final quarter of 2008; Taiwan announced billions of dollars in spending and tax cuts due to declining growth and a 26 percent slump in the stock market in 2008; Oct. 23, 1997, the South Korean won began to weaken; by September 2008, South Korea fell into currency crisis; July 8, 1997, Malaysia's central bank intervenes to defend its currency; In January 2009, Malaysia protected its economy amid the global economic crisis; May 14, 1997, Thailand, with the intervention of Singapore, spent billions of dollars of its foreign reserves to defend the Thai baht against speculative attacks.

Table 4.2 Financial crisis and peaks in all cycles: Individual series

Variables	Peaks close to crisis[1]		Amplitude[3] (Percentage change)		Duration (In quarters)	
	Number[2]	Percentage	Close to crisis	Not close to crisis	Close to crisis	Not close to crisis
Short-term cycle						
Credit	18/51	35%	17.3	20.9	40.6	13.7
House prices	17/66	25.7%	7.3	5.8	17.1	7.8
Equity prices	19/87	21.8%	9.3	16.0	10.6	7.3
Medium-term cycle						
Credit	12/33	36.4%	26	18.1	55.9	22.3
House prices	13/45	28.9%	8.6	7.3	21.6	12.7
Equity prices	19/53	35.8%	13	19.8	14.9	12.3

Note: 1. The peaks that are close to a crisis are all within 3 years around the crisis date. 2. The number refers to the ratio of number of peaks close to a crisis to all financial peaks. 3. Amplitude is the percentage change of the last trough to the current peak.

Table 5.1 Synchronization of Financial Cycle within a Country

Country	Credit and House Prices	Credit and Equity Prices	House Prices and Equity Prices
China	0.476	0.518	0.44
Hong Kong	**0.644**	**0.572**	**0.652**
Taiwan	0.424	0.321	**0.629**
Japan	**0.744**	**0.692**	**0.684**
Korea	**0.571**	0.471	0.5
Malaysia	0.47	**0.629**	0.52
Thailand	**0.57**	**0.596**	0.492
Indonesia	0.474	**0.588**	**0.517**
India	-	**0.635**	-
Singapore	**0.588**	0.431	**0.673**
Philippines	-	0.517	-
Median	0.57	0.57	0.52
Mean	0.55	0.54	0.57

Note: House prices for India and Philippines are not available. Bold indicates that the number is above the mean of 0.55.

Table 5.2.1 Synchronization of Financial Cycles cross Countries

	Credit	House Prices	Equity Prices
Mean	0.61	0.512	0.6
Median	0.619	0.5	0.599
Max	0.899	0.726	0.862
Min	0.279	0.274	0.353

Table 5.2.2 Synchronization of Financial Cycles cross Countries
(Credit)

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	0.518	0.606	**0.657**	**0.707**	0.279	0.486	**0.671**	0.386	**0.614**	0.467
6	Hong Kong	0.518	-	0.489	**0.623**	**0.652**	**0.696**	**0.899**	**0.739**	**0.768**	0.587	0.726
4	Taiwan	**0.606**	0.489	-	0.526	**0.722**	0.564	0.504	**0.639**	0.466	**0.657**	**0.661**
6	Japan	**0.657**	**0.623**	0.526	-	**0.741**	0.347	**0.762**	0.537	**0.652**	0.54	**0.672**
9	Korea	**0.707**	**0.652**	**0.722**	**0.741**	-	0.321	**0.762**	**0.792**	**0.619**	**0.688**	**0.729**
1	Malaysia	0.279	**0.696**	0.564	0.347	0.321	-	0.528	0.597	0.515	0.545	0.48
6	Thailand	0.486	**0.899**	0.504	**0.762**	**0.762**	0.528	-	0.644	**0.782**	0.497	0.762
6	Indonesia	**0.671**	**0.739**	**0.639**	0.537	**0.792**	0.597	**0.644**	-	0.55	0.785	0.594
5	India	0.386	**0.768**	0.466	**0.652**	**0.619**	0.515	**0.782**	0.55	-	0.529	0.618
5	Singapore	**0.614**	0.587	**0.657**	0.54	**0.688**	0.545	0.497	**0.785**	0.529	-	0.661
6	Philippines	0.467	**0.726**	**0.661**	**0.672**	**0.729**	0.48	**0.762**	0.594	**0.618**	**0.661**	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold indicates that the number is above the average of 0.6. # refers to the number of countries with which the synchronization is above the average.

Table 5.2.3 Synchronization of Financial Cycles cross Countries
(House Prices)

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	0.452	**0.637**	0.452	0.46	**0.726**	**0.637**	0.274	-	0.452	-
6	Hong Kong	0.452	-	**0.598**	**0.679**	**0.538**	**0.515**	**0.555**	0.439	-	**0.652**	-
4	Taiwan	**0.637**	**0.598**	-	**0.55**	**0.545**	0.492	0.484	0.432	-	0.508	-
4	Japan	0.452	**0.679**	**0.55**	-	**0.687**	0.481	0.508	0.427	-	**0.602**	-
5	Korea	0.46	**0.538**	**0.545**	**0.687**	-	0.432	0.453	**0.575**	-	**0.571**	-
2	Malaysia	**0.726**	**0.515**	0.492	0.481	0.432	-	0.461	0.288	-	0.424	-
3	Thailand	**0.637**	**0.555**	0.484	0.508	0.453	0.461	-	0.477	-	**0.57**	-
1	Indonesia	0.274	0.439	0.432	0.427	**0.575**	0.288	0.477	-	-	0.391	-
	India	-	-	-	-	-	-	-	-	-	-	-
4	Singapore	0.452	**0.652**	0.508	**0.602**	**0.571**	0.424	**0.57**	0.391	-	-	-
	Philippines	-	-	-	-	-	-	-	-	-	-	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold indicates that the number is above the average of 0.5. # refers to the number of countries with which the synchronization is above the average.

Table 5.2.4 Synchronization of Financial Cycles cross Countries
(Equity Prices)

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	**0.635**	0.388	**0.6**	0.353	**0.612**	0.529	**0.635**	0.388	0.388	0.588
5	Hong Kong	**0.635**	-	0.538	**0.652**	**0.617**	**0.639**	0.546	0.508	0.562	0.578	**0.862**
6	Taiwan	0.388	0.538	-	**0.686**	**0.838**	0.526	**0.632**	**0.608**	**0.714**	**0.775**	0.532
7	Japan	**0.6**	**0.652**	**0.686**	-	**0.662**	0.556	0.599	0.567	**0.648**	**0.765**	**0.706**
6	Korea	0.353	**0.617**	**0.838**	**0.662**	-	0.511	0.599	0.55	**0.724**	**0.824**	**0.615**
5	Malaysia	**0.612**	**0.639**	0.526	0.556	0.511	-	**0.602**	**0.808**	**0.657**	0.52	0.56
3	Thailand	0.529	0.546	**0.632**	0.599	0.599	**0.602**	-	0.533	**0.61**	0.51	0.541
3	Indonesia	**0.635**	0.508	**0.608**	0.567	0.55	**0.808**	0.533	-	0.59	0.588	0.514
6	India	0.388	0.562	**0.714**	**0.648**	**0.724**	**0.657**	**0.61**	0.59	-	**0.667**	0.59
5	Singapore	0.388	0.578	**0.775**	**0.765**	**0.824**	0.52	0.51	0.588	**0.667**	-	**0.637**
4	Philippines	0.588	**0.862**	0.532	**0.706**	**0.615**	0.56	0.541	0.514	0.59	**0.637**	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means the number is above the average of 0.6. # refers the number of countries with which the synchronization is above the average.