Financial Integration in Asia☆

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Abstract

We estimate a FAVAR model to evaluate the degree of financial integration in Asia. Integration are assumed to be driven by one unobservable regional index factor that measures intra-regional integration within the Asian countries, and four observable country factors that measures inter-regional integration with the Asian region. The unobservable regional index factor is extracted by Kalman filter. We performed forecast error variance decomposition to examine the sources of integration forces with the Asian interest rates.The main findings are that the majority of the interest rate commonality is driven by inter-regional integration where the US and EU are the two dominant factors. For Indonesia, however, Japan is the largest contributor to explaining its interest rate variability. There is limited intra-regional integration as indicated by the contribution from the regional factor and China also accounts for a rather small share of interest rate movements. When we focus on the post-2002 period, the contributions from the regional and China factors become increasingly important. Although the increase is small and the explanatory power remains modest.

Keywords: Regional real interest rate index, Kalman filter, FAVAR model, State-space model

JEL Classification: F36, G15

1. Introduction

Many countries in Asia, in parallel with the global trend at the time, embarked on the process of financial market liberalization after the demise of the Bretton-Woods system. Hong Kong, Malaysia, and Singapore lifted their interest rate controls in the mid-1970s. Japan started its gradudal process of financial liberalization with interest rate deregulation in 1970. A decade later Australia, New Zealand, Indonesia, and the Philippines implemented their deregulation measures in the early 1980s followed by Korea, Taiwan,

☆ A substantial amount of work was carried out while Shawn Leu visited the Department of Economics at the University of Cincinnati, Shawn would like to gratefully acknowledge their support and hospitality.
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and Thailand in the late 1980s (de Brouwer, 2002). In the aftermath of the Asian financial crisis, determination and efforts grew stronger to achieve greater integration to shore up financial stability in the region. Measures were put in place to restructure domestic financial institutions. There were proposals to institute an Asian bond market, which led to the Chiang Mai initiative in 2000 that established a network of currency swaps as a firewall against potential speculative attacks.

Deeper financial integration enhances the level of risk-sharing and allocative efficiency of capital which contribute to economic growth. There are two broad criteria used in the literature to evaluate the degree of financial integration, i.e., quantity- and price-based measures. In the quantity-based category, integration measurements include openness and restrictiveness in financial transactions, capital flows, and savings-investment correlation. Greater financial integration is associated with a higher degree of openness (or a lower degree of restrictiveness). The price-based category includes price differentials derived from goods and financial markets, e.g., interest rates, price indices, and asset prices. Many studies have applied econometric tests, e.g., time-series or panel unit root tests, to look for smaller price differentials that imply a greater degree of financial integration. One popular criterion from the price-based approach is to test for real interest parity. This theoretical relationship suggests that, in the absence of financial barriers and transactions costs, real interest rates should equalize between countries (Goodwin and Grennes, 1994).

Even with the presence of various market imperfections, however, it is still possible for international capital markets to become increasingly integrated. As real capital mobility rises, there should be greater convergence in the synchronicity of real interest rate movements across countries. In this paper, we assess financial integration in Asia on the premise that the forces of integration are driven by the following factors: an unobservable regional index that captures the common real interest rate fluctuations of a group of Asian countries; and four observable anchor country factors, i.e., the United States (US), the European Union (EU), Japan (JP), and China (CN), that represent external influences from major trading partners interacting with the Asian region. We estimate a factor-augmented VAR (FAVAR) model using maximum likelihood with monthly data from 1993M5 to 2012M12. The unobservable regional index factor is extracted by Kalman filter. From the estimation result we can compute the forecast error variance decomposition for each Asian interest rate. This gives the respective variance contributions from each of the factors in driving the integration process with the Asian countries. It is also a projection path of the force of integration changes from the short run to the long run.

The paper is organized as follows. Section 2 explains financial integration in terms of real capital mobility and lays out the FAVAR model. In section 3, we describe the data and their descriptive statistics, and conducts unit root test. Section 4 presents the empirical results that include the estimated unobservable regional index factor, the parameter estimates, impulse response functions to the factor shocks, forecast error variance decomposition of the Asian real interest rates, and sub-sample estimation. Section 5 concludes.

2. Econometric methodology

2.1. Financial integration in terms of real capital mobility

Assuming perfect capital mobility, investors are able to move financial capital across countries in search of higher returns. As a result, the equilibrium condition in the money and foreign exchange markets is described by the uncovered interest parity (UIP):

$$i_{t,k} = i^*_{t,k} + \Delta s^e_{t+k} \tag{1}$$

where $i_{t,k}$ is the k-period nominal interest rate and s_t is the spot exchange rate defined as the domestic price of foreign currency in logarithm form. The superscripts e and $*$ denote expected future values and foreign variables respectively. Δ is the difference operator and $\Delta s^e_{t+k} \equiv s^e_{t+k} - s_t$ gives the expected nominal depreciation over the period t to $t+k$.

In the absence of transactions costs, arbitrage activities in the international goods market that lead to the convergence of national prices are represented by the relative purchasing power parity (RPPP):

$$\pi^e_{t+k} = \pi^{*e}_{t+k} + \Delta s^e_{t+k} \tag{2}$$

where π^e_{t+k} is the (annualized) inflation rate that is expected to prevail over the period t to $t+k$. It is defined as $\pi^e_{t+k} \equiv p^e_{t+k} - p_t$, where p^e_{t+k} and p^e_t are, respectively, the expected logged price level at $t+k$ and the current logged price level at t.

Substitute (2) into (1) yields:

$$i_{t,k} - \pi^e_{t+k} = i^*_{t,k} - \pi^{*e}_{t+k}$$

Using the Fisher equation, we obtain the real interest parity (RIP) condition:

$$r^e_{t,k} = r^{*e}_{t,k} \tag{3}$$

where $r^e_{t,k}$ is the expected k-period domestic real interest rate and $r^{*e}_{t,k}$ denotes the foreign counterpart. This condition states that when UIP and RPPP are satisfied, the combined forces of integration direct real capital flows to equalize real interest rates between countries.

The RIP condition in (3) is difficult to satisfy in reality because either UIP and/or

RPPP may break down, for example, because of the presence of capital controls, the rise in country risk premia, or trade policy that acts as a barrier which limits the strengths of market forces to drive national prices together (expressed in a common currency). However, as countries continue to liberalize their domestic markets and seek closer ties through economic co-operation, real capital flows become increasingly mobile which should lead to more synchronized movements in real interest rates across countries. Therefore greater synchronicity of movements between real interest rates can be used as a measure of increasing financial integration driven by enhanced real capital mobility.

While the theoretical relationships suggest that expected real interest rates should be used to test for financial integration, however, this is usually not empirically operational due to paucity of data on expectations. Instead, realized values of real interest rates are used, i.e., $r_{t,k}$ and $r^*_{t,k}$. This is based on the assumption that, under the rational expectations hypothesis, the *ex-post* realizations are unbiased predictors of their *ex-ante* counterparts.[1]

2.2. A FAVAR model for measuring financial integration

We estimate a FAVAR model to examine financial integration in the Asian region, which consists of a group of eleven countries. Real interest rate linkages are measured from two perspectives. First, the extent of *intra*-regional integration is assessed through the interaction between the individual real interest rates and a regional index (an unobservable factor to be estimated) that captures the common fluctuations of the real interest rates of the Asian countries. Second, we evaluate the interaction between the individual real rates and that of four anchor countries to the Asian countries (these are the observable factors), which captures the extent of *inter*-regional integration. The FAVAR model can be represented in state-space form where the measurement equation is

$$X_t = \Lambda^y Y_t + \Lambda^f F_t + v_t, \quad v_t \sim (0, R) \tag{4}$$

Write (4) in matrix form helps us to see how influences from the five factors on the movements of each individual Asian real interest rate are decomposed:[2]

[1] The *ex-ante* rate is related to the *ex-post* rate through $r^e_{t,k} = r_{t,k} + \xi_t$, where ξ_t represents the forecast error of inflation (Mishkin, 1984). Given the rationality of expectations and that the inflation error is unforecastable, the subjective market expectations of the real interest rate is equated with its conditional mathematical expectations, i.e., $r^e_{t,k} = E(r_{t,k}|I_t)$, where I_t is the information set.

[2] All real interest rates in the model are assumed to be of the same k-period rates. Hence the subscript k is dropped to simplify notations.

$$\begin{bmatrix} r_{1,t} \\ r_{2,t} \\ \vdots \\ \vdots \\ r_{11,t} \end{bmatrix} = \begin{bmatrix} \beta_1^{US} & \beta_1^{EU} & \beta_1^{JP} & \beta_1^{CN} \\ \beta_2^{US} & \beta_2^{EU} & \beta_2^{JP} & \beta_2^{CN} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \beta_{11}^{US} & \beta_{11}^{EU} & \beta_{11}^{JP} & \beta_{11}^{CN} \end{bmatrix} \begin{bmatrix} r_t^{US} \\ r_t^{EU} \\ r_t^{JP} \\ r_t^{CN} \end{bmatrix} + \begin{bmatrix} \beta_1^{RG} \\ \beta_2^{RG} \\ \vdots \\ \vdots \\ \beta_{11}^{RG} \end{bmatrix} \begin{bmatrix} f_t^{RG} \end{bmatrix} + \begin{bmatrix} v_{1,t} \\ v_{2,t} \\ \vdots \\ \vdots \\ v_{11,t} \end{bmatrix}$$

where $X_t = (r_{1,t}, \ldots, r_{11,t})'$ is the informational vector that contains the real interest rates of the eleven Asian countries. In the observable factor vector, Y_t, the real interest rates of the four anchor countries: United States (r_t^{US}), the European Union (r_t^{EU}), Japan (r_t^{JP}), and China (r_t^{CN}), represent the major external influences on the Asian countries. The reason for including China as one of the observable factors is that, given its rapid economic accession and increasing financial and trade activities with its neighbors, instead of placing China as one of the countries in the Asian region, the current setup allows us to examine the level of integration influence that China exerts on the Asian countries. The unobservable factor vector, F_t, contains the regional index (f_t^{RG}) that summarizes the commonality of the Asian real interest rate movements. The parameters β^{US}, β^{EU}, β^{JP}, β^{CN}, and β^{RG} are the factor loadings that measure the direction and intensity of co-movements between the individual real interest rates and their corresponding factors. The idiosyncratic shocks, v_t, are normally distributed with zero mean, and are serially uncorrelated with each other, $R = diag(\sigma_{v_1}^2, \ldots, \sigma_{v_{11}}^2)$.

The dynamics of the regional and anchor factors are described in the following transition equation:

$$\Phi_0 \begin{bmatrix} Y_t \\ F_t \end{bmatrix} = \Phi_1 \begin{bmatrix} Y_{t-1} \\ F_{t-1} \end{bmatrix} + w_t, \quad w_t \sim (0, Q) \tag{5}$$

We estimate two specifications for the transition equation (5). In the first specification, the interest rate factors are assumed to be connected to each other with a lag. Hence they evolve according to a VAR(1) process (where Φ_0 is an identity matrix) as follows:

$$\begin{bmatrix} r_t^{US} \\ r_t^{EU} \\ r_t^{JP} \\ r_t^{CN} \\ f_t^{RG} \end{bmatrix} = \begin{bmatrix} \phi_1^{US} & \phi_2^{US} & \phi_3^{US} & \phi_4^{US} & 0 \\ \phi_1^{EU} & \phi_2^{EU} & \phi_3^{EU} & \phi_4^{EU} & 0 \\ \phi_1^{JP} & \phi_2^{JP} & \phi_3^{JP} & \phi_4^{JP} & 0 \\ \phi_1^{CN} & \phi_2^{CN} & \phi_3^{CN} & \phi_4^{CN} & 0 \\ \phi_1^{RG} & \phi_2^{RG} & \phi_3^{RG} & \phi_4^{RG} & \phi_5^{RG} \end{bmatrix} \begin{bmatrix} r_{t-1}^{US} \\ r_{t-1}^{EU} \\ r_{t-1}^{JP} \\ r_{t-1}^{CN} \\ f_{t-1}^{RG} \end{bmatrix} + \begin{bmatrix} w_{1,t} \\ w_{2,t} \\ w_{3,t} \\ w_{4,t} \\ w_{5,t} \end{bmatrix}$$

where $\phi_5^{US} = \phi_5^{EU} = \phi_5^{JP} = \phi_5^{CN} = 0$ so that the regional factor does not feedback to the observable factors because it represents a group of small open economies.

It is possible, however, that the transmission of interest rate fluctuations also takes place contemporaneously between the factors. Therefore in the second specification, we impose a recursive structure on Φ_0 using the ordering of $(r_t^{US}, r_t^{EU}, r_t^{JP}, r_t^{CN}, f_t^{RG})$ to identify the contemporaneous relationships. It is assumed that the US factor is the leader so that other factor rates do not have contemporaneous effects on the US. The Asian regional index factor is placed last so that it responds contemporaneously to fluctuations of the anchor factor rates. The matrix representation of this alternative identification scheme is

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\varphi_1 & 1 & 0 & 0 & 0 \\ -\varphi_2 & -\varphi_3 & 1 & 0 & 0 \\ -\varphi_4 & -\varphi_5 & -\varphi_6 & 1 & 0 \\ -\varphi_7 & -\varphi_8 & -\varphi_9 & -\varphi_{10} & 1 \end{bmatrix} \begin{bmatrix} r_t^{US} \\ r_t^{EU} \\ r_t^{JP} \\ r_t^{CN} \\ f_t^{RG} \end{bmatrix} = \begin{bmatrix} \phi_1^{US} & \phi_2^{US} & \phi_3^{US} & \phi_4^{US} & 0 \\ \phi_1^{EU} & \phi_2^{EU} & \phi_3^{EU} & \phi_4^{EU} & 0 \\ \phi_1^{JP} & \phi_2^{JP} & \phi_3^{JP} & \phi_4^{JP} & 0 \\ \phi_1^{CN} & \phi_2^{CN} & \phi_3^{CN} & \phi_4^{CN} & 0 \\ \phi_1^{RG} & \phi_2^{RG} & \phi_3^{RG} & \phi_4^{RG} & \phi_5^{RG} \end{bmatrix} \begin{bmatrix} r_{t-1}^{US} \\ r_{t-1}^{EU} \\ r_{t-1}^{JP} \\ r_{t-1}^{CN} \\ f_{t-1}^{RG} \end{bmatrix} + \begin{bmatrix} w_{1,t} \\ w_{2,t} \\ w_{3,t} \\ w_{4,t} \\ w_{5,t} \end{bmatrix}$$

The factor innovations, w_t, are normally distributed with zero mean, and are uncorrelated with each other, $Q = diag(\sigma_{US}^2, \sigma_{EU}^2, \sigma_{JP}^2, \sigma_{CN}^2, \sigma_f^2)$. In addition, the idiosyncratic shocks and the factor innovations are assumed to be orthogonal to each other, $E(v_{i,t} w_{j,t-s}) = 0$ for all i, j, and s.

There are two issues related to the scale and signs of the unobservable regional index factor and its associated factor loadings not being separately identified without additional restrictions. For example, multiplying the regional factor by -2 and its factor loadings by $-1/2$ would produce exactly the same model. To normalize the scale of the regional factor, we follow Sargent and Sims (1977) and Stock and Watson (1989, 1993) by calibrating the regional factor variance to a constant value. Specifically, the constant is chosen based on the scale of the data so that the regional factor variance is equal to the average variance of the idiosyncratic shocks of the Asian real interest rates. To normalize the signs of the regional factor and the associated loadings, we follow a strategy similar to Kose et al. (2003) and restrict the first loading on the regional factor (which is Australia) to be positive.[3]

3. Data

The data is monthly and spans from 1993M5 to 2012M12, where the starting month is dictated by data availability. All time series are extracted from Datastream and their original definitions and codes are detailed in the Data Appendix. The eleven Asian countries are selected from the member and observer states of ASEAN: Australia, Hong Kong, India, Indonesia, Korea, Malaysia, New Zealand, the Philippines, Singapore, Thailand,

[3] The estimation results are robust to alternative factor loading rotations.

and Taiwan.[4] The dataset also includes the four anchor economies: the United States, the European Union, Japan, and China. For each country we collect a 3-month nominal interest rate and compute the annualized 3-month inflation rates based on the CPI. The 3-month *ex-post* real interest rate for each country is computed using the exact formula, i.e., $r_{i,t} = ((1 + i_{i,t})/(1 + \pi_{i,t+3})) - 1$.[5] When referring to the interest rate series, we drop the term "real" to simplify the description hereafter.

Table 1 presents some descriptive statistics of the country interest rates. Starting with the G3 countries, the US interest rate has a lower mean but higher standard deviation, range (*maximum−minimum*), skewness, and kurtosis relative to the EU and Japan. Comparing between the anchor and Asian countries, the latter gives higher average values of the descriptive statistics.[6] Looking at the Asian countries, Indonesia leads the pack exhibiting the highest volatility followed by India. Even though China is positioned as an anchor country for the purpose of examining integration with its Asian neighbors, we note that its mean, standard deviation, range, and skewness (but not kurtosis) are similar to the high numbers that we observe from the Asian region. Australia and New Zealand are two Asian countries that have comparably low mean and standard deviation values with the G3 countries.

[Insert Table 1 about here]

All interest rates are standardized to have mean zero and unit standard deviation for estimation so that results are comparable across countries. We use dummy variable to adjust for two country-specific events that do not contribute to the overall co-movements of the interest rates. The first is the introduction of the goods and services tax (GST) in Australia that, because of the second-round effect of the new tax regime, temporarily raised the inflation rate from 2000M7 to 2001M6. The second is to remove the temporary inflation spike in Indonesia between 2005M7 and 2005M9 that was due to an exogenous supply shock to food prices. No such adjustment is carried out for the two financial crises covered in the sample period, i.e., the Asian financial crisis (AFC) in 1997-98 and the global financial crisis (GFC) in 2008-09. The reason is that each of these two crisis episodes represents a common adverse shock to a group of countries (where the effects of the AFC were more localized to the Asian region than that of the GFC) which should intensify the degree of synchronicity of interest rate movements between countries if they are integrated.

[4] Brunei, Cambodia, Myanmar, Laos, and Vietnam are not included because of short data span.

[5] The results are not qualitatively different when approximated real interest rates are used.

[6] These are mean: 2.292 (Asia) $>$ 1.726 (anchor); standard deviation: 5.148 (Asia) $>$ 3.887 (anchor); range: 36.062 (Asia) $>$ 25.623 (anchor); and kurtosis: 5.782 (Asia) $>$ 4.798 (anchor); but not for skewness: 0.368 (Asia) $<$ 0.466 (anchor).

[Insert Figures 1 and 2 about here]

The standardized series are graphed in Figures 1 and 2. Apart from the gap between the US and EU interest rates in the beginning of the sample period, the two series track each other closely. There are regular and in some cases large negative spikes of the Japanese interest rate in the second half of 1990s. These are mainly due to the exceedingly low nominal interest rate that is associated with the aggressive monetary expansion measures to revive the economy. In contrast, the Chinese interest rate is positive during this period because of strong economic performance. At the height of the GFC, the four anchor interest rates rise sharply in concert. The US interest rate reaches the highest point reflecting that it was the outbreak epicenter of the financial crisis. From the Asian countries, the interest rates increase in tandem in response to the AFC and GFC shocks respectively. There are noticeably large negative spikes from Indonesia and Malaysia which are the result of large swings in inflation during the crisis periods.

We also conduct unit root test to provide additional information on the time-series property of the interest rates. Given the low test power associated with the Dickey-Fuller procedure, we use a modified version proposed by Elliott et al. (1996) which is referred to as the ADF-GLS test and is shown to be approximately uniformly most powerful invariant. There are two types of the test with a unit root null hypothesis: the ADF-GLS$^{\mu}$ allows for an intercept and the ADF-GLS$^{\tau}$ test allows for a linear time trend. Table 2 presents the result of the ADF-GLS test. Combining the two test results, aside from Hong Kong and New Zealand, all country interest rates are found to be stationary.

[Insert Table 2 about here]

4. Empirical results

4.1. Estimated regional index factor

Figure 3 plots the regional index factor which is a Kalman smoothed estimate. The dynamic factor measures from the two FAVAR specifications (DF1 and DF2 respectively) are compared to the principal component (PC) which is a static measure. The DF index marks out two distinct periods of the collective interest rate response of the Asian region to the AFC and the GFC. Starting in 1994, the DF index rises above the zero mean reflecting strong regional economic performance and reaches a local peak followed by falling index rate before 1997. With the onset of the AFC, countries in the region faced massive capital outflows and devaluation pressure, this system-wide shock pushed the DF index to a maximum of 7.74% for DF1 and 8.40% for DF2 in March 1998 before it declines in value as the effects of the crisis subsided. The story from the PC index is qualitatively consistent with that of the DF index. However, the increase in the PC index rate during this period is smaller. The reaction to the AFC as told by the PC index is that the index rate initially rises, followed by a sharp fall towards zero, and then an equally sharp bounce back in the index rate reaching a maximum of 4.98% in June 1998.

All three index measures suggest a comparatively tranquil period between 2000 and 2006 where the index movements meander close to the zero line. One interesting turning point relates to the global slowdown associated with the dot-com bubble in 2000 and the ensuing deterioration in global economic conditions (which was exacerbated by the September 11 attack in 2001). The decrease in the index rate reflects the impact of this economic downturn on the Asian region, with the DF index suggesting a deeper regional trough (−2.82% for DF1 and −3.74% for DF2) than that by the PC index (−1.09%).

According to the PC index, the index rate plunges to the negative territory at the beginning of 2007 and bottoms out at −5.47% in April 2008. During the height of the GFC in 2008, the default risk shot up as international capital markets froze. The effect of the credit crunch that originated in the US were systemically transmitted and afflicted countries around the world. The Asian countries were certainly not immune from the acute rise in risk premium as the index rate increases dramatically from the low point in April to peak at 3.70% in October 2008. Although swift and unprecedented government policy co-ordination helped to calm the financial markets, the initial damages quickly transformed and spilled over to the real side of the global economy as witnessed by the dramatic reduction in international trade volume. With policy rooms to operate against a weak global economic environment, export-reliant economies in Asia hoped to resuscitate export activities through monetary expansion as indicated by the negative index rates after 2009. In contrast, the DF index suggests a much deeper regional slowdown than the picture painted by the PC index. After rising slightly in 2008, the DF1 index slides along a steep descending path and arrives at a trough of −11.58% in March 2011. On the other hand, similar to the PC index, the DF2 index rate rises in response to the credit market freeze in 2008. Thereafter the two DF indices follow each other closely but with the following differences: the DF2 index rates are more negative throughout 2009-10; the trough point for the DF2 index is −12.94% in February 2011; and the subsequent rise in the DF2 index rate associated with the recovery of the regional economy is more volatile than that suggested by the DF1 index.

[Insert Figure 3 about here]

4.2. Parameter estimates

Tables 3 and 4 present the parameter estimates of the FAVAR model for the two specifications. Apart from Indonesia and Malaysia, the impact coefficients of the regional factor are positive and significant indicating positive co-movements between individual interest rates and regional index fluctuations. From the G3 factors, different combinations of the

US, EU, and Japan factor loadings are significantly related to the country interest rates. However, we observe in the first specification that Japan is the only significant influence from the G3 factors for Australia, India, Indonesia, New Zealand, and Singapore. When contemporaneous relationships are added in the second specification, the US factor loadings become significant for Australia (at 10%) and New Zealand (at 1% and the sign turns to negative), and the EU factor becomes significant for India (at 10%). As an emerging economic powerhouse to the region, the estimated factor loadings indicate that China is positively related to Australia, Korea, the Philippines, and Taiwan but negatively related to Hong Kong.[7]

Inspecting the autoregressive parameter estimates in the transition equation, all factors other than Japan exhibit high level of persistence, i.e., the average value of the two specifications are regional index (0.957), EU (0.934), US (0.831), and China (0.825); the level of autocorrelation for Japan (0.573) is substantially lower than the rest of the group. The estimated coefficients from specification 2 show that there are siginficant contemporaneous feedback between the factors. Specifically the US factor impacts significantly on the EU, Japan, and China while the EU has contemporaneous effect on Japan. The regional factor responds to fluctuations from the US, EU, and China factors but not Japan.

Many of the estimated coefficients indicate a negative relationship between interest rates. On first glance this may seem to suggest a weakening rather than a strengthening of financial integration through interest arbitrage. If one incorporates shocks to risk premium (through UIP) and/or inflation (through RPPP), countries are prompted to make adjustment in response to these disparity shocks in the short run in order to return to the long-run equilibrium path. There is likely to be asymmetry in the speed of adjustment between countries because the transmission speed of a small economy shock is faster than that of a large economy shock. If the adjustment on the part of the small economy is sufficiently faster, interest rates may become negatively correlated reflecting changes in the interest differentials. Notwithstanding the presence of these imperfections, the efficiency and integration of capital markets are still maintained as long as the interest rate paths are convergent towards each other.

[Insert Tables 3 and 4 about here]

4.3. Impulse response functions

To derive the impulse response functions (IRF) of the Asian interest rates, we first obtain the vector moving average (VMA) representation of the transition equation (5):

[7] The impact coefficient for New Zealand changes from 0.007 in the first specification to −0.019 in the second specification but remains insignificant.

$$\begin{aligned}\begin{bmatrix} Y_t \\ F_t \end{bmatrix} &= (I - \Phi_0^{-1}\Phi_1 L)^{-1} + \Phi_0^{-1} w_t \\ &= \Gamma(L)\epsilon_t \end{aligned} \tag{6}$$

where $\epsilon_t = \Phi_0^{-1} w_t$ is the vector of structural factor shocks, $\Gamma = \Phi_0^{-1}\Phi_1$ is the MA coefficient matrix, and $\Gamma(L) = I + \Gamma L + \Gamma^2 L^2 + \cdots$ is the matrix of polynomials in the lag operator L.

Substitute the VMA representation (6) into the measurement equation (4) and isolate out the dynamic responses of the informational variables, X_t^{IRF}:

$$\begin{aligned} X_t^{IRF} &= \begin{bmatrix} \Lambda^y & \Lambda^f \end{bmatrix} \begin{bmatrix} Y_t \\ F_t \end{bmatrix} \\ &= \begin{bmatrix} \Lambda^y & \Lambda^f \end{bmatrix} \Gamma(L)\epsilon_t \end{aligned} \tag{7}$$

Figures 4 to 8 report the impulse response functions (7) of the Asian interest rates to one-standard-deviation factor shocks. The dynamic responses to each factor shock are consistent with the sign of the associated factor loading estimates. All impulse response functions are mean-reverting showing that after each country deals with the disparity shocks in the short run, the country interest rates move on convergent paths with the factor interest rates. In comparing the dynamic responses to the anchor factor shocks, for some Asian countries, specification 2 yields responses that have higher amplitudes in the short run. However, for the dynamic responses to the China factor shock, the impulse response functions show little difference between the two specification which may be due to the lack of contemporaneous relationships between China and the other anchor countries.

[Insert Figures 4 to 8 about here]

4.4. Forecast error variance decomposition

We can compute forecast error variance decomposition (FEVD) by using information in the moving average coefficients related to the interest rate variables in X_t that is explained by the factors, Y_t and F_t. This gives us a measure of the degree of financial integration as the forecast error variance of each Asian interest rate is decomposed into the fraction variance contributions from the regional, US, EU, Japan, and China factors. The FEVD can be expressed as:

$$\frac{Var(X_{t+h} - \widehat{X}_{t+h|t} | \epsilon_t)}{Var(X_{t+h} - \widehat{X}_{t+h|t})}$$

Tables 5 and 6 present the FEVD results from the two FAVAR model specifications and track the variance contributions for the Asian interest rates from each factor over a

60-month (or 5 years) horizon. This also represents a projection path of how the synchronicity of interest rate movements changes over time. We will begin with the results of specification 2 in Table 6 and focus on the long-run integration picture at horizon 60. Although the US and EU factors account for more than 50% of the interest rate fluctuations for all Asian countries (except Indonesia), further refinement can be made in classifying how each country is integrated with the factors. For Korea, Malaysia, the Philippines, Singapore, and Thailand, the dominant integration forces in the long run are the US and EU factors. The regional factor provides a third source of integration for Australia, Hong Kong, and New Zealand. As for India and Taiwan, Japan is the third integration factor behind the US and EU in terms of explanatory power. In contrast, Indonesia is most closely integrated with Japan (that surpasses the US and EU) in the long run.

So far the long-run story seems to suggest limited intra-regional integration between the Asian countries. However, the regional factor plays a larger role if the focus is shifted to the short-run horizon. At horizon 6, for example, the regional factor becomes the largest contributor to explaining the interest rate variability for Australia and New Zealand. It also accounts for 30.61% of the variability for Hong Kong, 22.84% for Singapore, and a more modest 10.06% for Korea.

Despite its remarkable economic growth and rapid accession to the world stage, the FEVD for the China factor reveals disappointingly low degree of integration with its Asian neighbors. The pattern of integration for China is similar to that shown by the regional factor, where the impact of integration is relatively small and concentrated in the short run with a few of the Asian countries. For example, if we arbitrarily use an explantory power of 10% as a standard for integration, then China is integrated with Hong Kong (at 10.64%), India (at 19.95%), Korea (at 11.73%), and the Philippines (at 11.36%) at the six-month horizon.

The FEVD story from specification 1 is qualitatively similar with the following differences: First, the explanatory power of the US factor decreases dramatically for Australia, New Zealand, and Singapore; and Korea experiences a smaller decrease. As a result, the EU factor becomes the most dominant driver of the integration process and the regional factor enjoys a slight increase in its explanatory power with these Asian countries. Second, in the case of Taiwan, the variance contributions from the US and Japan factors are more equalized with the EU factor still accounts for the largest share of interest rate variability.

[Insert Tables 5 and 6 about here]

4.5. Sub-sample estimation

With an acceleration of market reform measures after the AFC and China joining the WTO in December 2001 that represents a commitment to abide by international norms in trade in goods and services, it may be possible to uncover stronger evidence of financial integration in Asia driven by the regional and China factors by focusing on the post-2002period. Hence we estimate the FAVAR model over two sub-sample periods: 1993M5–2002M12 (period 1) and 2003M1–2012M12 (period 2). Tables 7 and 8 report the FEVD results at horizons 6 and 60 for both specifications so we can compare the short- and long-run changes.

In the long run we observe a general increase in the integration power coming from China in period 2. Although the size of the increase is mostly small and the explanatory power remains modest. However, there are particularly large increases for India and Taiwan (in specification 1) in that China becomes a more significant driving force of integration with these two countries. On the other hand, the Philippines experienced large decline in synchoronicty with China after 2002. For the regional factor, we similarly observe (mostly modest) increases in the strength of intra-regional integration with most of the Asian countries in the long run. Interestingly, those countries that experience falling regional factor contributions see their integration becoming more intensified with China, and vice versa. Indonesia presents an interesting individual case. Over the full sample, its integration intensity is the highest with Japan. When split over the two periods, however, the Japan effect disappears and is replaced by the EU factor being the most dominant driver of financial integration followed by an increase in convergence with the regional factor.

[Insert Tables 7 and 8 about here]

5. Conclusions

During the past four decades, financial institutions and markets around the world have undergone major transformation including structural reforms to enhance efficiency and interdependence of financial and economic systems. Capital markets in Asia have similarly gone through periods of deregulation reforms in the hope of strengthening financial ties. Even after the Asian financial crisis the pace of reforms continued as countries in Asia looked to shore up financial stability through greater integration. In addition with China's accession to the WTO, the current status of financial integration in Asia is in need of a systematic investigation.

We study this issue with a group of eleven Asian countries and assume that the forces of integration are driven by one unobservable regional index factor that measures intra-regional integration within the Asian countries, and four observable country factors that measures inter-regional integration with the Asian region. A FAVAR model is estimated where the unobservable regional index factor is extracted by Kalman filter. We performed forecast error variance decomposition to examine the sources of integration forces with the Asian interest rates. The main findings are that the majority of the interest rate commonality is driven by inter-regional integration where the US and EU are the two dominant factors that explain over half of all interest rate variability. For Indonesia, however, Japan is the largest contributor to explaining its interest rate variability. There is limited intra-regional integration as indicated by the contribution from the regional factor and China also accounts for a rather small share of interest rate movements. When we focus on the post-2002 period, the contributions from the regional and China factors become increasingly important. Although the increase is small and the explanatory power remains modest.

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Data Appendix

Country	Data Definition and Code
United States	Treasury bill rate (USI60C) CPI (USI64...F)
European Union	Euro interbank offer rate (EMINTER3) CPI (EMEBCPALE)
Japan	Uncollaterized money interest rate: 3 month (JPCR3MTA) CPI (JPI64...F)
China	Time deposit rate: 3 month (CHSRW3M) CPI (CHCONPRCF)
Australia	90-day bank bill rate (RBA) Monthly inflation (AUCPANNL)
Hong Kong	Treasury bill rate: 3 month (HKGBILL3) CPI (HKI64...F)
India	Treasury bill yield: 91 day auction (INGBILL3) CPI (INI64...F)
Indonesia	Interbank 3 month rate (IDIBK3M) CPI (IDI64...F)
Korea	91-day CDs yield (KOMIR076R) CPI (KOCONPRCF)
Malaysia	Treasury bill discount rate: 3 month (MYGBILL3) CPI (MYCONPRCF)
New Zealand	Treasury bill rate (NZI60C) Monthly inflation (NZCPANNL)
Philippines	Treasury bill rate: 91 day (PHTBL3M) CPI (PHI64...F)
Singapore	Interbank 3-month rate (SGIBK3M) CPI (SPCONPRCF)
Thailand	Interbank 3-month rate (THBBIB3) CPI (THI64...F)
Taiwan	Money market rate: 90 day (TWMONEY3) CPI (TWCONPRCF)

Table 1: Descriptive statistics for country real interest rates, 1993M5-2012M9

Country	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis
US	0.676	3.602	20.376	−7.737	0.862	7.578
EU	1.533	2.186	9.095	−3.236	0.247	2.830
Japan	0.706	2.408	8.936	−8.193	−0.257	4.419
China	3.988	7.352	32.144	−12.773	1.011	4.365
Australia	2.702	1.373	6.519	−1.606	0.051	3.620
Hong Kong	1.263	6.360	22.320	−13.575	0.297	3.391
India	0.565	7.385	38.535	−20.002	0.823	6.606
Indonesia	4.426	11.077	50.026	−39.922	0.783	9.134
Korea	3.651	5.221	25.437	−9.885	1.106	5.490
Malaysia	1.228	3.166	15.022	−16.613	−0.989	13.535
New Zealand	3.490	2.073	7.561	−2.659	−0.473	3.396
Philippines	2.528	4.896	23.996	−12.122	0.832	6.689
Singapore	0.334	3.470	12.216	−7.421	0.195	3.452
Thailand	2.647	6.032	23.740	−14.306	0.890	4.752
Taiwan	2.377	5.575	20.282	−12.922	0.535	3.538

Table 2: Unit root tests

Country	ADF-GLS$^{\mu}$	Lags	ADF-GLS$^{\tau}$	Lags
US	−2.087**	11	−2.628	11
EU	−0.571	6	−2.975**	6
Japan	−2.123**	9	−2.794*	9
China	−1.747*	12	−2.201	12
Australia	−2.461**	0	−2.723*	0
Hong Kong	−1.341	9	−1.468	9
India	−1.641*	9	−2.081	9
Indonesia	−4.972***	5	−5.193***	5
Korea	−0.956	9	−2.721*	9
Malaysia	−1.706*	9	−5.572***	3
New Zealand	−1.426	0	−2.612	0
Philippines	−2.326**	6	−2.563	6
Singapore	−2.070**	9	−3.005**	9
Thailand	−3.658***	3	−4.473***	3
Taiwan	−1.030	9	−3.660***	9

Note: *** 1% significance, ** 5% significance, and * 10% significance. The Schwarz information criterion is used to select the lag order with maximum lag of 12.

Table 3: FAVAR model parameter estimates
(no contemporaneous relationships)

	β^{RG}	β^{US}	β^{EU}	β^{JP}	β^{CN}	σ_v
Australia	0.164***	−0.003	−0.025	−0.099**	0.118**	0.719***
Hong Kong	0.074***	0.210**	−0.168*	0.050	−0.112*	0.943***
India	0.032**	0.036	−0.096	0.174***	0.091	0.975***
Indonesia	0.002	0.079	0.028	−0.136**	0.004	0.988***
Korea	0.081***	0.233***	0.139**	0.014	0.140***	0.760***
Malaysia	−0.008	0.360***	0.153***	−0.033	0.022	0.886***
New Zealand	0.234***	0.052	0.045	−0.040**	0.007	0.115***
Philippines	0.054***	0.192***	0.186***	0.025	−0.177***	0.881***
Singapore	0.099***	0.099	0.108	0.116**	0.044	0.825***
Thailand	0.031***	0.475***	0.247***	−0.019	0.045	0.656***
Taiwan	0.027*	0.078	0.176***	0.233***	0.098*	0.880***
	ϕ_1^{US}	0.831***	ϕ_1^{CN}	0.020	σ_{US}	0.533***
	ϕ_2^{US}	0.078**	ϕ_2^{CN}	0.076**	σ_{EU}	0.377***
	ϕ_3^{US}	−0.242***	ϕ_3^{CN}	−0.062*	σ_{JP}	0.733***
	ϕ_4^{US}	0.040	ϕ_4^{CN}	0.824***	σ_{CN}	0.504***
	ϕ_1^{EU}	−0.025	ϕ_1^{RG}	0.038		
	ϕ_2^{EU}	0.949***	ϕ_2^{RG}	0.095*		
	ϕ_3^{EU}	−0.090***	ϕ_3^{RG}	−0.088		
	ϕ_4^{EU}	0.029	ϕ_4^{RG}	0.053		
			ϕ_5^{RG}	0.957***		
	ϕ_1^{JP}	0.298***				
	ϕ_2^{JP}	−0.050				
	ϕ_3^{JP}	0.528***				
	ϕ_4^{JP}	0.043				

Note: *** 1% significance, ** 5% significance, and * 10% significance.

Table 4: FAVAR model parameter estimates
(recursive contemporaneous relationships)

	β^{RG}	β^{US}	β^{EU}	β^{JP}	β^{CN}	σ_v
Australia	0.164***	−0.107*	−0.073	−0.096**	0.099**	0.719***
Hong Kong	0.074***	0.163**	−0.189**	0.052	−0.120*	0.943***
India	0.032**	0.016	−0.105*	0.174***	0.087	0.975***
Indonesia	0.002	0.078	0.028	−0.136**	0.004	0.988***
Korea	0.081***	0.181***	0.116*	0.015	0.131***	0.760***
Malaysia	−0.008	0.365***	0.156***	−0.033	0.023	0.886***
New Zealand	0.234***	−0.097***	−0.024	−0.036**	−0.019	0.115***
Philippines	0.054***	0.158***	0.170***	0.026	−0.183***	0.881***
Singapore	0.099***	0.036	0.079	0.118**	0.033	0.825***
Thailand	0.031***	0.455***	0.238***	−0.018	0.042	0.656***
Taiwan	0.027**	0.061	0.169***	0.234***	0.095*	0.880***
	φ_1	0.479***	ϕ_1^{EU}	−0.428***	ϕ_1^{RG}	−0.573***
	φ_2	0.426***	ϕ_2^{EU}	0.918***	ϕ_2^{RG}	−0.183***
	φ_3	−0.187***	ϕ_3^{EU}	0.029	ϕ_3^{RG}	−0.068
	φ_4	−0.161**	ϕ_4^{EU}	0.011	ϕ_4^{RG}	−0.056
	φ_5	0.168			ϕ_5^{RG}	0.957***
	φ_6	−0.033	ϕ_1^{JP}	−0.063		
	φ_7	0.638***	ϕ_2^{JP}	0.097*	σ_{US}	0.533***
	φ_8	0.292***	ϕ_3^{JP}	0.617***	σ_{EU}	0.278***
	φ_9	−0.019	ϕ_4^{JP}	0.032	σ_{JP}	0.710***
	φ_{10}	0.114**			σ_{CN}	0.499***
			ϕ_1^{CN}	0.166**		
	ϕ_1^{US}	0.830***	ϕ_2^{CN}	−0.070		
	ϕ_2^{US}	0.082**	ϕ_3^{CN}	−0.073**		
	ϕ_3^{US}	−0.242***	ϕ_4^{CN}	0.826***		
	ϕ_4^{US}	0.038				

Note: *** 1% significance, ** 5% significance, and * 10% significance.

Table 5a: Forecast error variance decomposition
(no contemporaneous relationships)

	Horizon	RG factor	US factor	EU factor	JP factor	CN factor
Australia	6	68.48	2.49	7.84	9.83	11.36
	12	56.64	3.18	24.55	6.60	9.04
	24	38.29	4.60	46.04	4.42	6.64
	36	30.88	5.39	54.36	3.63	5.75
	48	27.90	5.73	57.66	3.32	5.40
	60	26.67	5.87	59.01	3.19	5.26
Hong Kong	6	21.42	52.16	11.50	7.34	7.59
	12	28.55	44.24	12.12	8.67	6.42
	24	29.37	34.89	22.87	7.24	5.64
	36	26.64	30.18	31.62	6.30	5.26
	48	24.92	28.14	36.06	5.83	5.05
	60	24.09	27.29	38.04	5.62	4.96
India	6	5.68	30.40	6.11	40.36	17.45
	12	7.40	26.23	11.69	36.83	17.85
	24	8.03	22.72	24.00	29.88	15.36
	36	7.92	21.30	29.52	27.09	14.17
	48	7.80	20.74	31.84	25.95	13.67
	60	7.73	20.52	32.79	25.49	13.47
Indonesia	6	0.04	17.80	9.08	72.84	0.25
	12	0.06	20.15	10.37	69.04	0.38
	24	0.08	20.07	10.76	68.70	0.38
	36	0.09	20.05	10.91	68.56	0.38
	48	0.09	20.04	10.97	68.51	0.39
	60	0.09	20.04	10.99	68.49	0.39
Korea	6	13.01	23.98	36.08	12.05	14.88
	12	11.01	15.69	54.13	8.62	10.55
	24	9.39	13.11	63.84	5.80	7.86
	36	8.76	12.43	66.60	5.09	7.11
	48	8.50	12.21	67.60	4.84	6.85
	60	8.39	12.13	67.98	4.75	6.75
Malaysia	6	0.15	52.77	30.03	15.92	1.13
	12	0.17	41.58	44.25	12.89	1.11
	24	0.21	38.04	49.33	11.34	1.08
	36	0.22	37.58	49.97	11.15	1.08
	48	0.23	37.52	50.05	11.13	1.08
	60	0.23	37.51	50.06	11.12	1.08

Table 5b: Forecast error variance decomposition
(no contemporaneous relationships)

	Horizon	RG factor	US factor	EU factor	JP factor	CN factor
New Zealand	6	78.20	0.82	14.03	5.41	1.55
	12	58.20	2.19	32.21	4.68	2.71
	24	37.94	4.31	51.18	3.36	3.22
	36	30.50	5.18	58.28	2.83	3.22
	48	27.55	5.55	61.11	2.61	3.17
	60	26.35	5.70	62.27	2.52	3.15
Philippines	6	9.53	27.41	37.91	7.63	17.51
	12	10.10	20.14	51.41	6.59	11.76
	24	9.81	16.83	59.45	5.01	8.90
	36	9.39	15.76	62.19	4.52	8.14
	48	9.15	15.37	63.30	4.33	7.85
	60	9.04	15.22	63.75	4.25	7.73
Singapore	6	31.12	17.52	29.75	15.21	6.40
	12	23.79	10.47	49.54	10.61	5.59
	24	17.88	9.34	61.67	6.52	4.58
	36	15.74	9.10	65.43	5.47	4.26
	48	14.86	9.05	66.87	5.09	4.13
	60	14.50	9.03	67.44	4.95	4.08
Thailand	6	0.98	45.39	36.78	14.77	2.08
	12	1.03	32.74	52.92	11.26	2.05
	24	1.09	27.97	60.02	8.91	2.01
	36	1.12	26.85	61.61	8.40	2.02
	48	1.13	26.52	62.06	8.26	2.02
	60	1.14	26.42	62.21	8.21	2.02
Taiwan	6	1.80	23.00	30.13	32.99	12.08
	12	1.76	15.77	49.24	23.30	9.93
	24	1.74	14.29	58.90	17.10	7.98
	36	1.75	13.88	61.05	15.79	7.53
	48	1.75	13.76	61.68	15.41	7.40
	60	1.76	13.73	61.88	15.29	7.35

Table 6a: Forecast error variance decomposition
(recursive contemporaneous relationships)

	Horizon	RG factor	US factor	EU factor	JP factor	CN factor
Australia	6	46.38	20.28	13.56	11.98	7.80
	12	34.01	25.92	28.05	6.81	5.21
	24	23.53	25.44	43.19	4.10	3.74
	36	19.50	24.36	49.52	3.32	3.30
	48	17.82	23.76	52.27	3.02	3.13
	60	17.11	23.46	53.46	2.90	3.06
Hong Kong	6	30.61	34.26	10.75	13.74	10.64
	12	33.75	31.68	14.03	13.11	7.43
	24	28.33	30.76	27.07	8.71	5.13
	36	24.09	28.97	35.51	7.01	4.42
	48	21.98	27.94	39.64	6.30	4.13
	60	21.03	27.44	41.53	6.00	4.00
India	6	6.61	25.44	5.08	42.93	19.95
	12	7.73	21.70	16.38	36.12	18.09
	24	7.40	21.96	31.08	25.87	13.68
	36	7.03	21.57	36.66	22.60	12.15
	48	6.82	21.35	38.93	21.34	11.56
	60	6.73	21.25	39.86	20.84	11.33
Indonesia	6	0.04	19.36	10.91	69.36	0.33
	12	0.06	22.06	11.64	65.77	0.47
	24	0.09	22.01	11.94	65.50	0.47
	36	0.09	22.00	12.08	65.35	0.47
	48	0.10	22.00	12.14	65.29	0.47
	60	0.10	22.00	12.17	65.26	0.47
Korea	6	10.06	25.45	35.22	17.54	11.73
	12	7.90	21.65	52.04	10.85	7.56
	24	6.58	20.97	60.12	6.90	5.43
	36	6.11	20.49	62.56	5.96	4.89
	48	5.91	20.29	63.48	5.63	4.70
	60	5.82	20.19	63.86	5.50	4.62
Malaysia	6	0.12	60.53	22.73	15.67	0.95
	12	0.15	48.10	37.72	13.07	0.97
	24	0.17	43.51	43.86	11.50	0.96
	36	0.18	42.78	44.81	11.27	0.96
	48	0.19	42.66	44.96	11.23	0.96
	60	0.19	42.64	44.98	11.23	0.96

Table 6b: Forecast error variance decomposition
(recursive contemporaneous relationships)

	Horizon	RG factor	US factor	EU factor	JP factor	CN factor
New Zealand	6	56.46	9.08	19.99	13.15	1.31
	12	35.76	20.47	34.88	7.34	1.55
	24	23.58	22.72	47.78	4.18	1.73
	36	19.43	22.26	53.18	3.36	1.77
	48	17.73	21.88	55.55	3.06	1.77
	60	17.02	21.68	56.60	2.93	1.77
Philippines	6	6.69	45.22	22.65	14.08	11.36
	12	6.94	35.65	38.72	11.22	7.47
	24	6.68	31.62	47.99	8.13	5.58
	36	6.39	30.03	51.26	7.21	5.11
	48	6.23	29.37	52.61	6.86	4.93
	60	6.15	29.10	53.18	6.71	4.86
Singapore	6	22.84	22.43	29.25	20.29	5.20
	12	15.81	20.29	47.91	12.19	3.80
	24	11.75	21.04	57.22	7.05	2.94
	36	10.40	20.66	60.37	5.84	2.73
	48	9.84	20.43	61.67	5.41	2.65
	60	9.60	20.32	62.22	5.25	2.62
Thailand	1	0.58	93.70	5.02	0.20	0.50
	12	0.80	38.86	45.92	12.77	1.65
	24	0.84	33.69	53.94	9.95	1.59
	36	0.85	32.39	55.86	9.30	1.59
	48	0.86	32.00	56.44	9.11	1.59
	60	0.86	31.87	56.63	9.04	1.59
Taiwan	6	1.28	42.48	21.52	25.59	9.13
	12	1.26	29.48	42.84	19.01	7.41
	24	1.23	25.80	53.26	13.81	5.89
	36	1.23	24.86	55.69	12.68	5.53
	48	1.23	24.58	56.44	12.33	5.42
	60	1.23	24.48	56.68	12.22	5.39

Table 7: Subsample forecast error variance decomposition
(no contemporaneous relationships)

	Horizon	Subsample Period	RG	US	EU	JP	CN
Australia	6	*1993M5-2002M12*	34.24	49.42	3.18	3.59	9.58
		2003M1-2012M9	14.09	7.81	65.41	9.85	2.84
	60	*1993M5-2002M12*	10.20	25.90	56.83	0.50	6.56
		2003M1-2012M9	14.41	9.95	63.27	9.59	2.78
Hong Kong	6	*1993M5-2002M12*	0.60	66.16	22.60	2.14	8.50
		2003M1-2012M9	13.29	21.72	61.28	1.22	2.49
	60	*1993M5-2002M12*	1.24	62.50	25.26	2.49	8.50
		2003M1-2012M9	7.91	13.79	68.08	3.73	6.48
India	6	*1993M5-2002M12*	2.70	56.83	0.62	37.67	2.19
		2003M1-2012M9	23.27	7.30	15.40	18.69	35.34
	60	*1993M5-2002M12*	4.74	53.73	8.35	30.40	2.79
		2003M1-2012M9	12.44	6.59	46.15	12.75	22.06
Indonesia	6	*1993M5-2002M12*	0.10	12.58	38.40	44.84	4.07
		2003M1-2012M9	39.81	4.61	45.48	7.59	2.51
	60	*1993M5-2002M12*	0.15	9.67	57.52	29.60	3.07
		2003M1-2012M9	19.31	4.70	62.90	7.18	5.91
Korea	6	*1993M5-2002M12*	17.06	13.37	56.85	2.79	9.92
		2003M1-2012M9	10.90	21.07	32.79	30.42	4.81
	60	*1993M5-2002M12*	4.79	16.59	73.81	0.46	4.35
		2003M1-2012M9	6.03	14.40	56.28	18.20	5.09
Malaysia	6	*1993M5-2002M12*	6.51	41.58	2.56	42.41	6.94
		2003M1-2012M9	24.42	36.01	10.91	25.52	3.13
	60	*1993M5-2002M12*	6.44	34.06	34.15	18.93	6.43
		2003M1-2012M9	13.15	20.43	44.50	17.89	4.03
New Zealand	6	*1993M5-2002M12*	41.48	22.17	26.16	2.45	7.74
		2003M1-2012M9	1.87	7.98	73.07	14.12	2.96
	60	*1993M5-2002M12*	8.34	20.68	65.88	0.26	4.84
		2003M1-2012M9	1.42	8.33	75.87	10.47	3.91
Philippines	6	*1993M5-2002M12*	22.89	8.03	5.83	0.25	63.01
		2003M1-2012M9	51.83	5.13	25.53	15.81	1.70
	60	*1993M5-2002M12*	11.00	20.57	52.29	0.07	16.07
		2003M1-2012M9	22.59	5.10	56.33	10.81	5.17
Singapore	6	*1993M5-2002M12*	32.57	31.58	22.66	6.28	6.90
		2003M1-2012M9	25.18	2.32	54.05	9.03	9.42
	60	*1993M5-2002M12*	7.45	20.67	66.32	0.77	4.80
		2003M1-2012M9	10.47	4.35	67.68	8.75	8.74
Thailand	6	*1993M5-2002M12*	35.15	19.91	35.16	3.28	6.50
		2003M1-2012M9	1.86	33.68	26.67	32.82	4.97
	60	*1993M5-2002M12*	7.66	19.88	68.15	0.40	3.91
		2003M1-2012M9	1.22	23.99	48.32	22.09	4.38
Taiwan	6	*1993M5-2002M12*	7.92	31.30	20.28	36.69	3.80
		2003M1-2012M9	4.16	8.80	33.62	29.56	23.85
	60	*1993M5-2002M12*	3.69	17.95	66.55	8.00	3.81
		2003M1-2012M9	2.20	7.89	55.20	19.63	15.08

Table 8: Subsample forecast error variance decomposition
(recursive contemporaneous relationships)

	Horizon	Subsample Period	RG	US	EU	JP	CN
Australia	6	*1993M5-2002M12*	28.27	57.60	4.49	2.87	6.77
		2003M1-2012M9	19.25	15.49	41.96	17.23	6.07
	60	*1993M5-2002M12*	8.46	29.62	57.37	0.44	4.10
		2003M1-2012M9	18.66	15.08	42.11	16.70	7.45
Hong Kong	6	*1993M5-2002M12*	0.71	55.02	32.25	1.72	10.30
		2003M1-2012M9	14.69	2.94	65.52	14.98	1.87
	60	*1993M5-2002M12*	1.41	50.10	36.83	1.97	9.69
		2003M1-2012M9	5.47	8.30	73.81	7.92	4.50
India	6	*1993M5-2002M12*	2.52	59.84	1.09	34.50	2.05
		2003M1-2012M9	21.24	2.31	23.76	19.83	32.87
	60	*1993M5-2002M12*	4.34	56.86	9.29	27.22	2.29
		2003M1-2012M9	8.35	7.91	56.76	10.13	16.86
Indonesia	6	*1993M5-2002M12*	0.10	32.37	24.01	40.40	3.12
		2003M1-2012M9	28.81	3.23	46.26	20.27	1.42
	60	*1993M5-2002M12*	0.14	23.02	47.62	26.97	2.25
		2003M1-2012M9	10.07	8.67	67.53	9.46	4.28
Korea	6	*1993M5-2002M12*	14.70	17.82	56.00	3.18	8.30
		2003M1-2012M9	8.46	19.58	30.92	37.08	3.95
	60	*1993M5-2002M12*	3.98	18.51	73.96	0.52	3.03
		2003M1-2012M9	3.93	15.53	58.28	18.08	4.18
Malaysia	6	*1993M5-2002M12*	5.52	46.87	6.98	35.31	5.32
		2003M1-2012M9	15.99	29.29	15.85	36.23	2.64
	60	*1993M5-2002M12*	5.14	37.06	38.89	14.85	4.07
		2003M1-2012M9	7.02	18.60	52.32	18.62	3.44
New Zealand	6	*1993M5-2002M12*	36.56	25.55	29.27	2.51	6.10
		2003M1-2012M9	1.94	7.83	59.74	27.61	2.89
	60	*1993M5-2002M12*	6.96	23.07	66.58	0.29	3.09
		2003M1-2012M9	1.17	10.54	69.21	15.84	3.24
Philippines	6	*1993M5-2002M12*	23.47	11.10	2.54	0.55	62.33
		2003M1-2012M9	34.36	3.89	33.42	26.61	1.72
	60	*1993M5-2002M12*	10.00	23.79	52.54	0.17	13.51
		2003M1-2012M9	11.36	9.07	63.69	11.45	4.42
Singapore	6	*1993M5-2002M12*	31.20	31.08	25.77	6.22	5.74
		2003M1-2012M9	15.58	8.61	40.79	29.60	5.42
	60	*1993M5-2002M12*	6.40	22.63	67.12	0.71	3.14
		2003M1-2012M9	5.51	10.38	65.60	13.49	5.02
Thailand	6	*1993M5-2002M12*	32.34	24.64	33.53	3.79	5.70
		2003M1-2012M9	1.45	37.02	20.86	36.87	3.80
	60	*1993M5-2002M12*	6.54	22.27	68.15	0.46	2.59
		2003M1-2012M9	0.90	26.52	46.41	22.71	3.46
Taiwan	6	*1993M5-2002M12*	7.49	37.79	17.52	33.72	3.49
		2003M1-2012M9	2.50	27.78	20.49	36.30	12.93
	60	*1993M5-2002M12*	3.31	20.42	66.34	7.01	2.91
		2003M1-2012M9	1.29	19.06	50.38	21.26	8.02

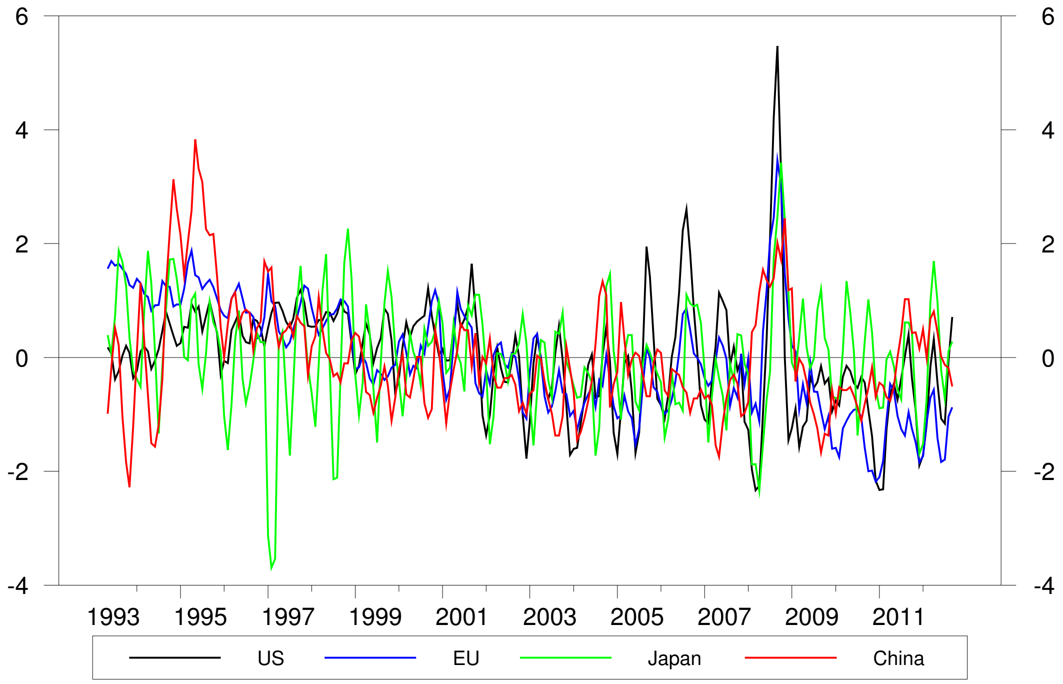

Figure 1: Standardized real interest rates of the anchor countries

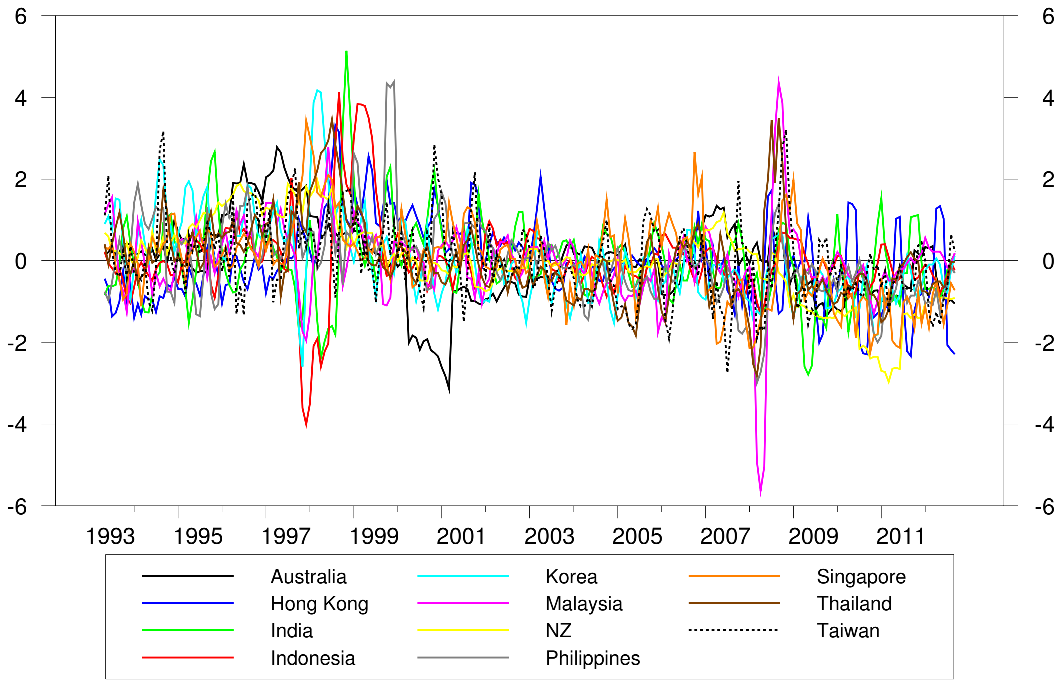

Figure 2: Standardized real interest rates of the Asian countries

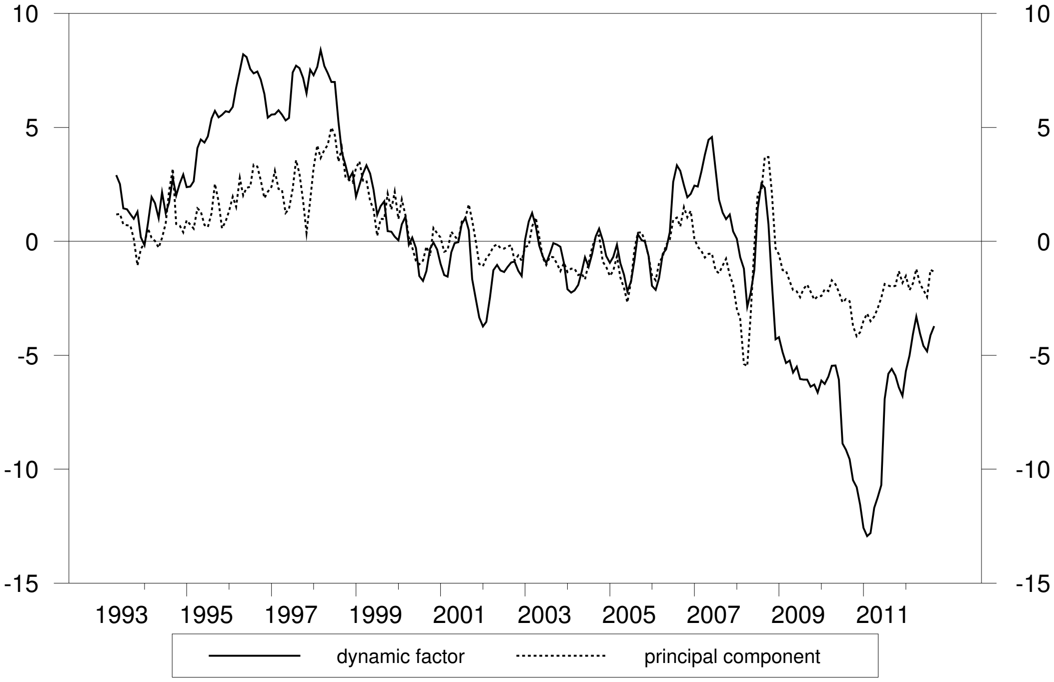

Figure 3: Unobservable regional index factor

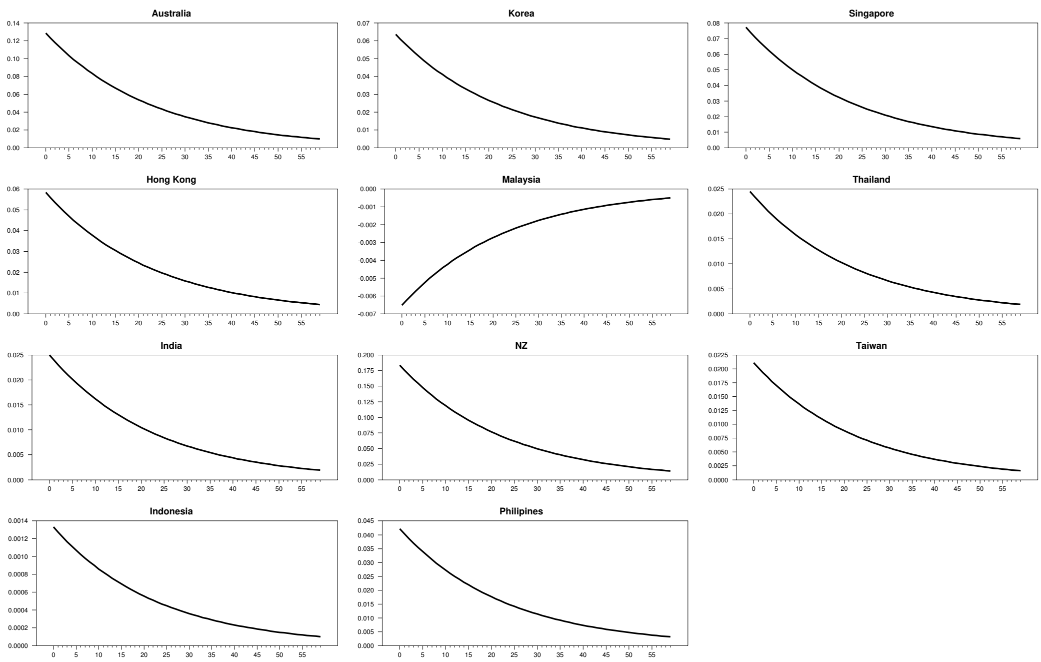

Figure 4: Dynamic responses of real interest rates to 1 s.d. regional shock
—— (no recursive); - - - (recursive)

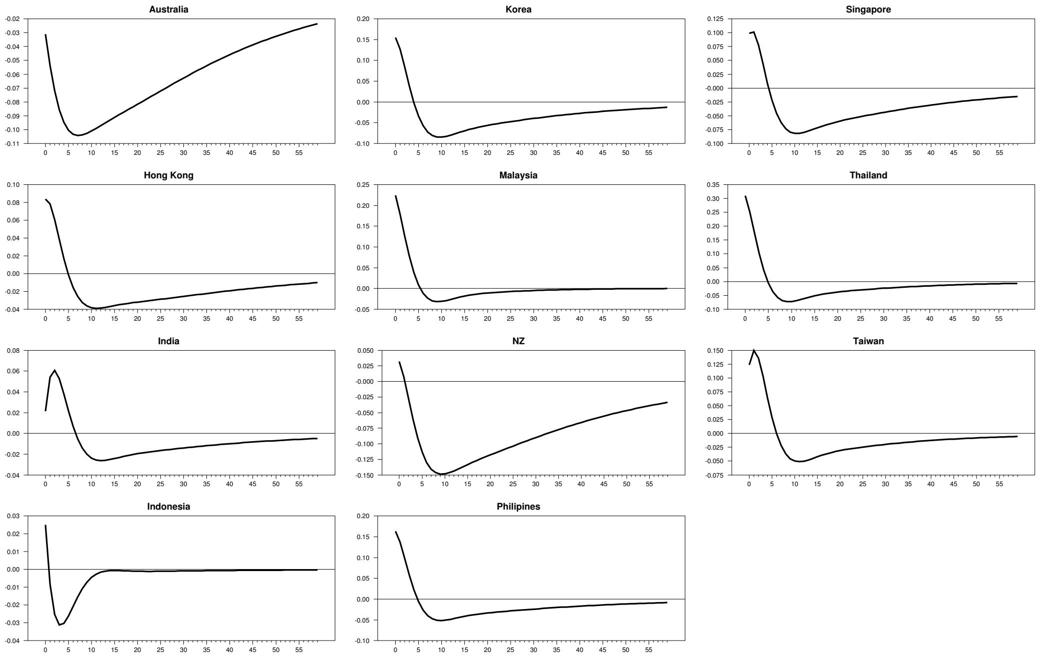

Figure 5: Dynamic responses of real interest rates to 1 s.d. US shock
—— (no recursive); - - - (recursive)

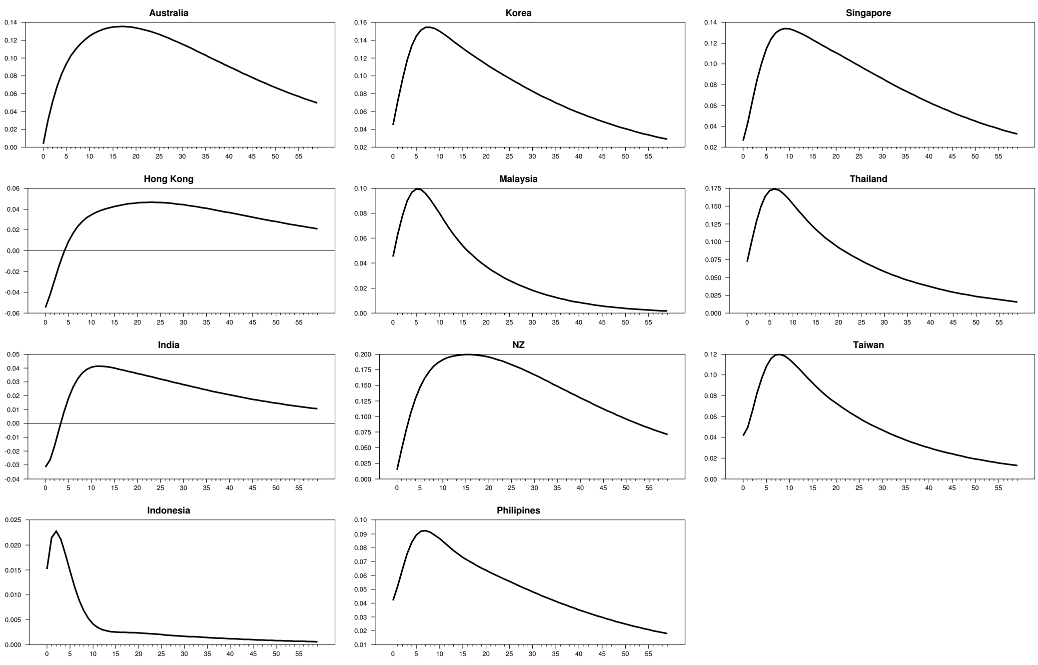

Figure 6: Dynamic responses of real interest rates to 1 s.d. EU shock
—— (no recursive); - - - (recursive)

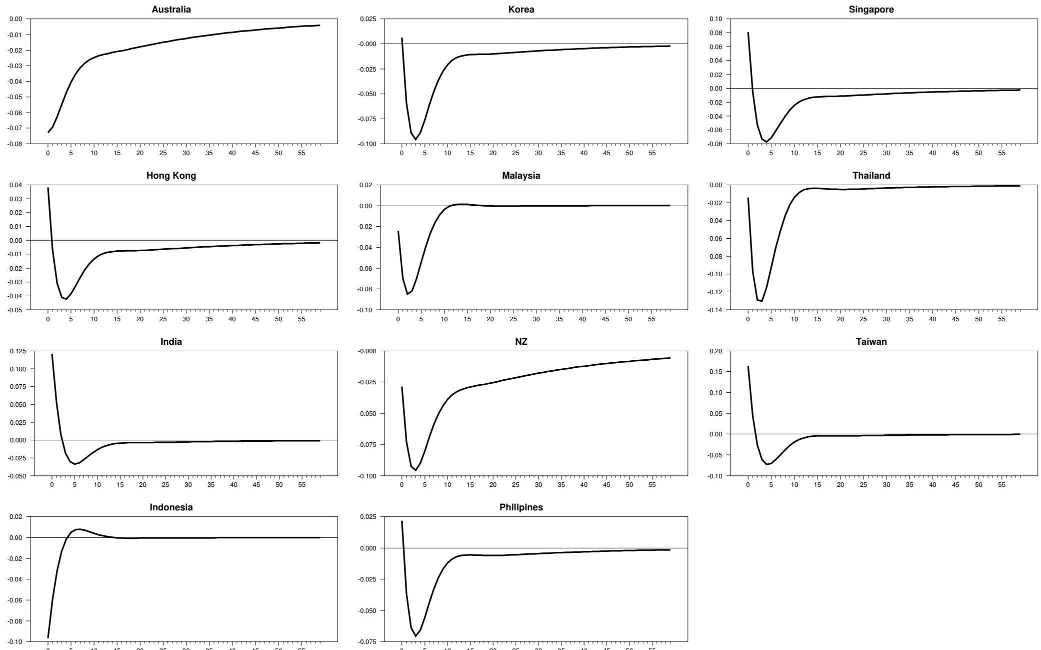

Figure 7: Dynamic responses of real interest rates to 1 s.d. Japan shock
—— (no recursive); - - - (recursive)

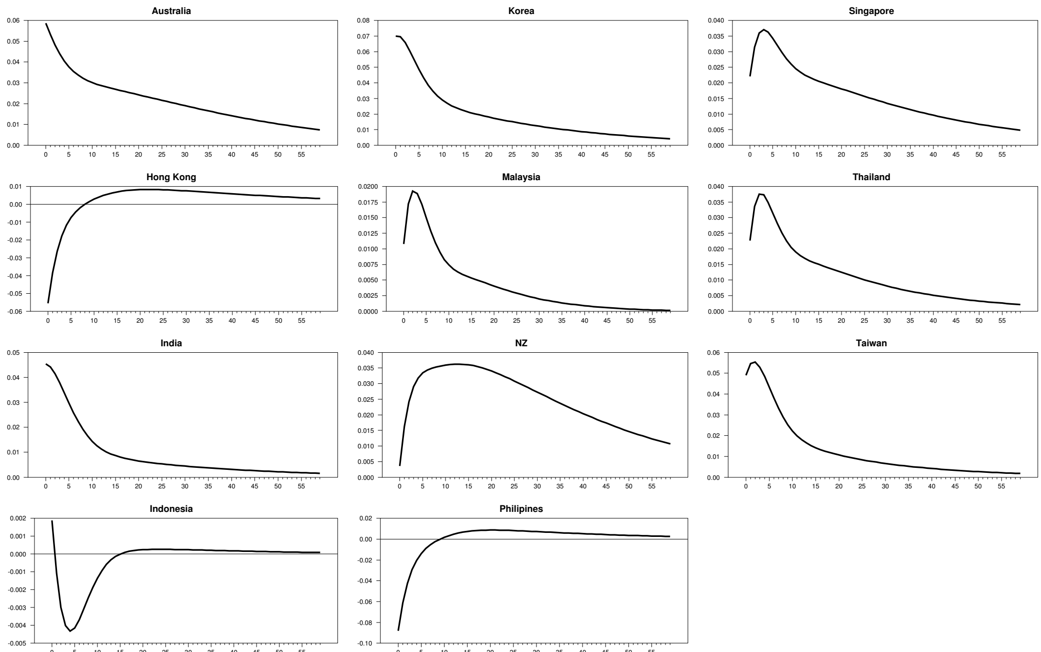

Figure 8: Dynamic responses of real interest rates to 1 s.d. China shock
—— (no recursive); - - - (recursive)