Macroeconomic Integration in East Asia

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Abstract

This paper analyzes macroeconomic dependence among 10 Asian countries using data in the pre- and post-Asian crisis periods. In this connection, we decompose their macroeconomic activities (real GDP) into common and country-specific components using the Bai-Ng method (2004). Our results suggest first that both components are nonstationary. Second, we find the relative importance of common factors in all countries in terms of their contribution to variations in real GDP, particularly for South Korea and Singapore. But evidence is also obtained of country-specific effects increasingly important in countries like China in recent years. Therefore, if for example China is expected to grow at a fast pace in future, our findings imply that creation of a regional monetary union of these 10 countries needs to be held back until the Chinese economy has become more dominant in the region.

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1 Introduction

Economic and political cooperation has a long history in Asia. The Association of South-East Asian Nations (ASEAN), now consisting of 10 countries,[1] was established in 1967 to help achieve regional security, and socio-cultural and economic integration. Furthermore, the ASEAN Free Trade Area (FTA) agreement, which aimed to eliminate tariff and non-tariff barriers in the region, was signed in 1992 by six members (Brunei, Indonesia, Malaysia, Singapore, Thailand, and the Philippines) and later by the others. Such regional efforts seemed to have paid off. Some ASEAN members (Hong Kong (HK), South Korea, Singapore, and Taiwan) had exhibited outstanding economic performances for several decades and had been regarded as world-class economic success stories. However, history has shown that such success does not last forever. The 1997 Asian crisis erupted in Thailand came as a surprise to many economists and policy-makers, its adverse effects spilled over to neighboring countries, and consequently many countries experienced a sharp economic downturn. Mitigating this contagious effect to countries with relatively mature financial markets such as those in the ASEAN called for further regional cooperation. As a result, a more comprehensive group of Asian countries, the ASEAN Plus Three Countries (China, Japan, and Korea), was formed in 1997 to discuss regional economic and financial stability issues. This dialog led to the establishment of the Chiang Mai Initiative, a short-term credit arrangement among these countries to remedy pressure from lack of foreign reserves.

In this paper, we focus on regional economic dependence which has direct implications for assessing the scope for further economic and monetary union in this region. The theory of the optimal currency area emphasizes the importance of harmonization of the member countries. In Europe, economic convergence became mandatory for candidate countries intending to join the euro area. For example, in order to ensure a certain level of economic convergence before joining the currency union, the 1992 Maastricht Treaty was designed to clarify strict requirements such as a deficits-to-GDP ratio of less than three percent, a debt-to-GDP ratio of less than 60 percent, low inflation, and interest rates close to the EU average. With respect to Asia, there was a debate after the 1997 financial crisis about the introduction of a single currency like the euro. But many researchers cast doubt on this proposal and do not see this happening at least in the near future for both economic and political reasons.[2]

Against this background, we shall decompose macroeconomic activities into common and country-specific factors, then investigate their importance, and analyze the transmission channel which will create international economic dependence (i.e., synchronization) in the region. High dependence is regarded as indicating highly integrated economies.

[1] The ASEAN members are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand, the Philippines, and Vietnam.

[2] See Bayoumi, Eichengree and Mauro (2000) for discussion of a possible Asian monetary union.

In order for this, we use the factor model proposed by Bai and Ng (2004) which does not require a priori assumptions about the stationarity of common and country-specific factors. When common factors are found to be nonstatotionary, we can evaluate long-run implications of economic trends in a cointegrated system. This is probably for the first time for this approach to be used in this research field. Furthermore, long historical data including post-Asian crisis observations which have not been analyzed closely before enable us to conduct an analysis of common factor movements.

In short, we find evidence of more than one common factor and of both country-specific and common components being nonstationary. Furthermore, while we confirm the sizable contribution of common factors in explaining GDP variations, the country-specific effect seems increasingly important in some countries like China, HK and Singapore since the Asian crisis. Finally, this paper reports a strong relationship between common factors and international trade, confirming trade as the transmission channel.

2 Literature Review

Due to economic and political implications, a lot of research has been attempted to investigate economic integration, in particular, synchronization of business cycles across countries. For example, Selover (2004) studied interdependence between Korea and Japan, and found that Japanese business cycles have a moderate effect on Korean ones. Zhang, Sato and McAleer (2004) studied a group of 10 Asian countries plus the US, compared estimates from the EEC, and concluded that underlying structural shocks are less symmetrical in Asia. Germany, a leading country in Europe, shows a similar and significant correlation pattern of demand shocks with other core European countries. In contrast, Japan, a large economy in Asia, does not exhibit significant correlation with other Asian countries. Similarly, Moneta and Ruffer (2009) examined the output growth of 10 Asian countries from 1993 to 2005 using a dynamic common factor model, and reported a significant common factor shared by these countries except China and Japan.

However, the identification of synchronized countries is not an easy task. Unlike the abovementioned studies which found that China (mainland) and Japan are not synchronized with the rest of Asia, Sato and Zhang (2006) documented that Japan is one of the most synchronized countries in the region using the cointegration method. Out of 55 possible pairs of Asian countries, 10 pairs are found to be cointegrated with a positive cointegrating vector. Three pairs out of 10 are related with Japanese GDP (in levels), and interestingly China is strongly correlated only with HK.

There are more comprehensive studies in terms of country coverage. Using annual data from 106 countries from 1960 to 2005, Kose, Otrok, and Prasad (2008) reported evidence of convergence in business cycles within industrial countries and within emerging markets, but not between industrial and emerging markets. Furthermore, they found the

relative importance of country-specific factors in the post-1985 period by means of the variance decomposition method. Similarly, Kose, Otrok, and Whiteman (2008) studied business cycles by decomposing them into common and country-specific components using a Bayesian dynamic latent factor model. They confirmed the increasing importance of common factors in explaining variations in output, consumption and investment in the more recent period (1986:3-2003:4) compared with the Bretton Woods period (1960:1-1972:2).

Research was also conducted to try to identify the transmission channel of business cycles, and has frequently focused on international trade.[3] For example, this confluence of business cycles seems to be driven by strong trade (especially export) synchronization (Selover 1999, Moneta and Ruffer 2009), rather than by consumption or investment (Moneta and Ruffer 2009). Webber (2009) suggested that exports and investment are sources of common fluctuation in Asian business cycles. Furthermore, using data for over 100 countries on international trade, industrial structures, factor endowments, and currency union, among others, Baxter and Kouparitsas (2005) confirmed that international bilateral trade is the most important channel. However, some researchers argue against international trade as a transmission channel. For example, Imbs (2004) underscored specialization patterns which directly reflect differences in GDP per capita using data from 24 (relatively prosperous) countries.

3 Statistical Methods

Bai and Ng (2004) proposed a panel unit root test based on the factor model. Examination of the time-series properties of data such as stationarity has piqued the interest of many researchers over recent past decades. Initially, statistical tests (i.e., the unit root test) were proposed in the univariate context and then were extended to analyze the stationarity in panel data (Lin and Levin 1992). They were developed with an assumption of no cross-sectional correlation in the data. But this unlikely holds in actual economic and financial data, and a violation of this assumption biases test statistics (O'Connel 1998). Thus Bai and Ng (2004) proposed a procedure for estimating cross-sectional correlation (i.e., communal elements in the data) using a factor model. This paper will utilize these elements as a proxy for common movements across countries. Below we will explain briefly the concept of their statistical approach.

For the data X_{it} ($i = 1, \ldots, N$ and $t = 1, \ldots, T$), the factor model with individual effects (c_i) can be expressed as:

[3] There are studies examining financial market integration in Asia. For example, Park and Shin (2009) documented weak evidence of financial integration in East Asia. Nagayasu (2009) studied synchronization of financial markets using the forward premium in Asian countries, and showed a result indicative of the synchronization of the financial markets by finding the presence of multiple common factors in their financial markets.

$$X_{it} = c_i + \lambda_i' F_t + e_{it} \tag{1}$$

where F_t and e_{it} are common and country-specific elements respectively, and individuals (countries) and time are denoted as i and t. Since these elements are unobservable, an appropriate number of common factors (r) need to be determined by information criteria (e.g., Bai and Ng 2002). Given this information, both elements are estimated by a factor model, and we can carry on testing their stationarity. However, when e_{it} is nonstationary, the estimates of λ_i and e_{it} are no longer consistent, and therefore they proposed a differencing equation (1):

$$x_{it} = \lambda_i' f_t + z_{it} \tag{2}$$

where $x_{it} = \Delta X_{it}$, $f_t = \Delta F_t$, and $z_{it} = \Delta e_{it}$. Equation (2) suggests that f_t is common to all individuals, but λ_i makes a unique level of common factors $\lambda_i'\ f_t$ for each country. Thus, one can interpret λ_i as a parameter for capturing influence of f_t over the countries to a different degree. They are a reasonable proxy for common factors because for example some countries are more affected by oil shocks than others, and the extent to which the country is affected by this shock can be measured by λ_i. We call $\lambda_i'\ f_t$ as well as $\lambda_i'\ F_t$ common factors in the subsequent study, and thus our concept of the common factor may be slightly different from other studies that assume constant common factors across countries. Finally, e_{it} and F_t can be recovered by $e_{it} = \sum_{s=2}^{t} z_{is}$ and $F_t = \sum_{s=2}^{t} f_s$ where $t = 2, \ldots, T$.

Testing individually the stationarity of the country-specific component for country i is identical to the standard Augmented Dickey-Fuller (ADF) test based on equation (2).

$$\Delta\widehat{e}_{it} = d_{i0}\widehat{e}_{it-1} + d_{i1}\Delta\widehat{e}_{it-1} + \cdots + d_{ip}\Delta\widehat{e}_{it-p} + error \tag{3}$$

where estimates are denoted by "$\wedge$". Based on this test for individual countries, we can calculate the statistic for evaluating the stationarity of a group of country-specific components by pooling p-values ($p_e(i)$) obtained from the individual ADF test.

$$P_e = \frac{-2\sum_{i=1}^{N} ln(p_e(i)) - 2N}{\sqrt{4N}} \rightarrow N(0,1) \tag{4}$$

This statistic is shown to be asymptotically normally distributed, and its large positive value becomes evidence against the null of no cointegration.

With respect to common factors, testing their stationarity is identical to the standard ADF in the presence of a single common factor. If we assume that changes in common factors contain the constant, the test is based on the following equation.

$$\Delta \widehat{F}_t = c_0 + \delta_0 \widehat{F}_{t-1} + \delta_1 \Delta \widehat{F}_{t-1} + \cdots + \delta_p \Delta \widehat{F}_{t-p} + error \tag{5}$$

In this case, the statistic is referred to as ADF_f, and the critical value equals -2.86 at the five percent significance level. In the presence of multiple common factors, one can use the multivariate cointegration method to check if there is a long-run relationship between the common factors. In this paper, we use the Johansen test which is probably the most popular multivariate cointegration method.

4 Data

We consider 10 Asian countries: China (mainland), Hong Kong (HK), Indonesia, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, and the Philippines, five of which are ASEAN members. In addition, the US is included in our data set since it is an important trading partner of all these countries. Long historical data on the GDP for most Asian countries are not readily available, and therefore, we obtained quarterly real GDP data from Tilak Abeysinghe's homepage (http://www.fas.nus.edu.sg/ecs/esu/data.html) in order to evaluate common factor movements. We utilize all countries listed there and create a balanced panel data set spanning from 1975Q1 to 2007Q1 (base year = 1995).

These data are plotted in Figures 1 and 2, and their basic statistics are summarized in Table 1. Real GDP in Figure 1 shows that there is significant economic slowdown in 1997 at the time of the Asian crisis but there are signs of a prompt economic recovery. A similar trend in real GDP growth can be observed in Figure 2. Table 1 summarizes the basic statistics of real GDP (both in levels and differences). According to this table, the Chinese economy (GDP in levels) is very volatile as her standard deviation is far higher than others, and by contrast Japan, the Philippines and US experienced a very low volatility.

In addition, the correlation matrix is presented in Table 2. It shows that most pairs are positively correlated with each other regardless of the data being the level or growth of GDP. However, unlike other countries, the Chinese GDP growth is negatively correlated with other countries including Japan, Malaysia, South Korea, Taiwan, Thailand and the Philippines. This indicates that, as previous studies have suggested, the Chinese economy may be less integrated with the rest of Asia. We also note that all Asian countries except the Philippines are positively correlated (but insignificantly) with the US GDP growth.

With respect to trade data, two sources are used. Quarterly total import and export data are obtained from the IMF's International Finance Statistics (IFS). Their real values are calculated using the consumer price index (CPI) from the IFS. In addition, quarterly bilateral export and import data are obtained from the Direction of Trade (DOT) data set also from the IMF. But coverage is limited to China, HK, Indonesia, Japan, Malaysia,

Singapore, South Korea, Thailand, and the Philippines, and thus in order to supplement them total import and export data for Taiwan are downloaded from the homepage of the Central Bank of the Republic of China (Taiwan).

5 Empirical Results

5.1 PANIC estimates

The results on decomposition of real GDP to common and country-specific factors are summarized in Table 3. Different groupings of countries are considered to check the robustness of our findings. Our benchmark model consists of 10 Asian countries ($N = 10$). The group of 9 ($N = 9$) drops China from our benchmark, and that of 11 ($N = 11$) adds the US to the group of 10. First, we calculate the number of common factors (r) using information criteria, IC1, IC2, and IC3 (Bai and Ng 2002), and find that there is evidence of one and three common factors depending on the information criteria. A single common factor is supported by IC3, and three factors by IC1 and IC2. This result is generally robust to the composition of the panel of countries ($N = 9$, 10, or 11). One exception to this general observation is that the number of common factors increases from one to two according to IC3 when the US is included in the panel. This is indirect evidence of the significant influence on US economy on many Asian countries. As there are common factors, it appears essential for these Asian countries to consider economic conditions of the neighboring countries when forming economic stabilization policies. Our estimates of common ($\lambda_i' \ f_t$) and country-specific factors (z_{it}) are plotted in Figures 3 and 4 respectively. Figure 3 shows a sharp fall in the common factors around 1997, which suggests that the adverse effects of the Asian crisis were shared by these countries. Figure 4 shows that the country-specific effect is becoming increasingly important in China.

We also check the stationarity of these factors ($\lambda_i' \ f_t$ and e_{it}), and the results are reported in Table 3. Our statistic (P_e) in equation (4) shows that a group of country-specific factors is nonstationary, and similarly each common factor is found to be nonstationary. Since multiple common factors are found in our data, it is of interest to examine the stationarity of the group of common factors. We test this by means of the Johansen multivariate cointegration test using different compositions of common factors (i.e., $r = 2, 3$) and report evidence of non-cointegration in Table 4. The nonstationarity of both factors suggests that country-specific and common shocks are both permanent, and that both elements are important in determining their long-run economic performance. Therefore, this suggests that the nonstationarity of real GDP reported in previous studies (e.g., Sato and Zhang 2006) is attributable to the nonstationarity of both factors.[4]

[4]It follows that country-specific and common factors are not cointegrated.

5.2 The Relative Importance of Common and Country-Specific Factors

The relative importance of common factors is examined by calculating three ratios: 1) the ratio of the standard deviation of common factors to that of GDP, 2) the ratio of the standard deviation of country-specific factors to that of GDP, and 3) the ratio of country-specific factors to that of common factors. Where common factors are relatively important, the first ratio should approach one, and the second and the third ratios should be close to zero. On the other hand, if country-specific factors are dominant, the second ratio should approach one. While this is certainly a simplistic method, it helps us understand their relative importance.

Table 5 summarizes the results of these ratios with different assumptions about the number of common factors (r) and the composition of countries (N) in the panel. Our different assumptions are based on there being one, two or three common factors and a group of nine, ten or eleven countries, but such assumptions seem to barely alter the final results.[5] First, there is no doubt that common factors are important in all countries, and they seem to dominate GDP variations particularly in Singapore and South Korea. Their first ratio is close to one, and the second and third ratios measuring the contribution of country-specific effects are nominal. With respect to HK, the result is sensitive to the number of the common factors. When three, her first ratio is close to one. However, once the number of common factors drops to two or one, her first ratio increases from 1.0505 to 1.2652 and 1.2496 in our benchmark model ($N = 10$).

Second, unlike Singapore and South Korea, China and the Philippines on average exhibit a relatively high level of country-specific factors. This seems to underline that their economy is not closely associated with the rest of Asia during our sample period. The first ratio is around 0.7 in China, well below unity, while the second and third ratios are high compared with those of other countries. The Philippines' second and third ratios are similar to Chinese ratios. Thus, relatively speaking, these two countries are less integrated with other countries.

Given that these economies experienced a transition phase en route to industrialization, we also check if the relative importance of the factors has changed over time. Table 6 shows these ratios in two sub-sample periods when $r = 3$.[6] The breaking point of 1997Q2 is consistent with the economic disaster in Thailand, the first country hit by the Asian crisis. Generally, we can observe a similar pattern in these ratios to that from the full sample. However, there is evidence that country-specific effects become increasingly significant in the post-1997 period, particularly, in China, HK and Singapore. This general

[5] Since we found evidence of one and three common factors, two common factors are also considered here.

[6] The results with $r = 1$ and 2 are not reported here due to space constraint. But the results with a different size of r will not alter our general conclusion.

trend can also be seen in Figure 4, and is consistent with China being an important trade partner of HK and Singapore.

5.3 The Transmission Channel

While many other transmission channels can be considered (see Section 2), this sub-section focuses on the trade channel and looks at whether there is a positive and cointegrated relationship between common factors ($\lambda_i' \ f_t$) and international trade in the panel data context. The presence of cointegration ensures that there is a linear combination between them and becomes evidence of a long-run relationship. We would expect that common factors and trade related data are positively correlated and also cointegrated since many Asian countries have adopted an open market policy and international trade has been regarded as an engine of economic developments. But as discussed, some previous studies (e.g., Imbs 2004, Shin and Wang 2004) question the role of international trade as a transmission channel, and argue that it is other characteristics of a country such as the intra-industry trade and industry structure which synchronize business cycles.

Here we use two types of trade data. One is the real value of total import and export data, and the other is trade concentration measures which are also created separately for imports and exports.

$$\frac{Imp_{ijt}}{Imp_{it}} \quad \text{for} \quad \text{imports} \quad \text{and} \quad \frac{Exp_{ijt}}{Exp_{it}} \quad \text{for} \quad \text{exports}$$

where Imp and Exp refer to imports and exports respectively. The subscripts (i and j) represent home country (i) and the rest of Asia (j), and t is time. Thus Exp_{ijt}/Exp_{it} shows the exports of country i to the rest of Asia divided by the total exports of country i, and Imp_{ijt}/Imp_{it} indicates the proportion of imports to country i from Asia to the total imports to that country. Here, we use the benchmark model, and thus Asia is defined as the 10 Asian countries used in this study.[7] Since high ratios indicate high concentration of regional trade, one might expect that a high concentration ratio would be closely and positively associated with common factors.

Table 7 summarizes the trade data and shows that regional trade within ASEAN is high; the trade concentration measure of most ASEAN countries is around 50 percent. The non-ASEANs like Japan and Korea exhibited a slightly lower level of regional trade, but interestingly, mainland China shows a high concentration of international trade with other Asian countries.[8]

Table 8 reports the estimated relationship, based on $r = 3$ and $N = 10$, between the

[7] A similar definition of concentration ratios was used previously (e.g., Frankel and Rose 1998; Shin and Wang 2004) and are calculated for each country and each time period.

[8] This table also shows that the US is an important trade partner for all countries, especially for Japan, Korea and the Philippines.

common factor and trade related data.[9] We use several panel data estimation methods (OLS, Adjusted (Adj.) OLS, and Fully Modified (FM) OLS).[10] Generally, when total trade data is employed, a positive and significant relationship is obtained for both import and export, and there is cointegration between the trade value and common factors. However, when the trade concentration is considered, evidence to support their relationship with common factors (in levels) becomes very weak; there is no evidence of cointegration between them using the panel cointegration method (Kao 1999). There is a possibility that structural breaks may destroy the relationship, but our result is also confirmed by the Westerlund test (2006) which takes account of multiple and unknown structural breaks in the panel data.[11]

Therefore, we conclude that trade is one important transmission channel for international economic dependence, and the concentration of trade partners (i.e., ASEAN or otherwise) seems a secondary issue. This result implies that our common factors are also influenced by economic developments elsewhere such as the US and Europe. Furthermore, China which exhibits high trade concentration with other Asian countries (Tables 7) shows a low correlation with common factors (Tables 5 and 6). This implies the significance of her domestic market, and therefore one may conclude that international trade is less important for her compared with other Asian countries. In general, our results strongly support the role of international trade, and in particular, both import and export are found to be a driving force of common factor movements. This point was controversial in previous studies, but a statistically more sensible approach seems to yield our rather clear-cut result.

6 Summary

We studied economic dependence in macroeconomic activity among East Asian countries. Monitoring their level of regional integration is important not only when considering further economic and financial integration but also when forming economic policy to stabilize their own economies. When a country is largely dependent on other members, a shock in one member country will directly and possibly quickly influence its own countries.

One distinguishing feature of this paper is its decomposition of the GDP into common and country-specific components using the statistical method proposed by Bai and Ng (2004) that has not been used hitherto in this research field. Like previous studies, we analyze the importance of common factors. But since the Bai-Ng approach utilizes a

[9] Previous studies (e.g., Wu, Chen and Lee 2001) often showed that export and import data are nonstationary.

[10] See Kao and Chiang (2000).

[11] In order to check this weak relationship between the concentration ratio and common factors, we also employ the growth (rather than the level) of the common factors. The results are not shown in the paper due to limited space. But, the parameter sign remains generally unchanged although the relationship with the growth of the common factors is now found to be cointegrated.

factor model and was developed as a panel unit root test, we study the persistence of the common and country-specific factors also. Furthermore, we employ long historical data which are not readily available from conventional statistical databases and which allow us to analyze the transmission channel, creating international dependence, in a cointegrated system.

Our results are as follows. Using real GDP data, we find at least one common factor among Asian countries. Furthermore, common factors dominate variations in GDP in each country, confirming their open economic policy, i.e., international trade, is a driving force of the common factors. In addition, while their size may be inconsequential, country-specific factors are increasingly significant in recent years and indeed have a permanent effect on macroeconomic activities (i.e, they are nonstationary), and in particular country-specific effects are becoming more important in China, HK and Singapore. We think that this result is attributable to the recent economic and financial developments within mainland China which has a huge domestic market and with which HK and Singapore have been increasingly integrated. Therefore, one could conclude that an expansion in the Chinese economy has made it difficult for the 10 Asian countries to form economic and monetary union in the post-Asian crisis period. However, this does not rule out this possibility in the future—far from it. Simply, the time is not yet ripe for this to take place. Once the Chinese economy increases and dominates this region, and if common factors are largely explained by its economy, one could consider creating a more comprehensive coverage of an economic union and even a monetary union in this region.

Finally, while our analysis is statistically solid, there are many issues that one could investigate in the future. For example, we focused on international trade as a transmission channel of business cycles. However, there are many other channels through which stocks are transmitted across countries (See Section 2). We believe that the understanding and identification of the exact nature of transmission mechanisms will help propose a more concrete approach for further economic integration.

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Tables

Table 1. Basic Statistics of Real GDP (log)

Levels	Mean	Standard Deviation	Max	Min
China	4.1446	0.8519	5.5947	2.8382
HK	4.2714	0.5270	5.0802	3.1079
Indonesia	4.2415	0.4734	4.9659	3.3247
Japan	4.4364	0.2572	4.7808	3.8948
Malaysia	4.2199	0.5920	5.1580	3.1241
Singapore	4.2009	0.6440	5.2214	3.0604
S. Korea	4.1487	0.6277	5.0757	2.9977
Taiwan	4.2186	0.6344	5.1209	2.9403
Thailand	4.1148	0.5795	4.9471	3.0364
Philippines	4.5348	0.2702	5.1258	4.0057
USA	4.4885	0.2892	4.9693	3.9658
Differences				
China	0.0211	0.0135	0.0629	-0.0348
HK	0.0154	0.0222	0.1096	-0.0416
Indonesia	0.0128	0.0167	0.0569	-0.0969
Japan	0.0069	0.0116	0.0402	-0.0412
Malaysia	0.0159	0.0161	0.0550	-0.0665
Singapore	0.0169	0.0158	0.0553	-0.0281
S. Korea	0.0162	0.0225	0.0779	-0.0722
Taiwan	0.0170	0.0130	0.0639	-0.0194
Thailand	0.0149	0.0177	0.0574	-0.0499
Philippines	0.0088	0.0188	0.0678	-0.0690
USA	0.0078	0.0076	0.0386	-0.0204

Note: Full sample.

Table 2. Correlation Matrix (log GDP, Full Sample)

	China	HK	Indonesia	Japan	Malaysia	Singapore	SKorea	Taiwan	Thailand	Philippines
China	1.0000									Levels
HK	0.9792	1.0000								
Indonesia	0.9846	0.9939	1.0000							
Japan	0.9683	0.9928	0.9889	1.0000						
Malaysia	0.9931	0.9836	0.9929	0.9742	1.0000					
Singapore	0.9946	0.9880	0.9935	0.9801	0.9984	1.0000				
S. Korea	0.9928	0.9907	0.9932	0.9871	0.9930	0.9952	1.0000			
Taiwan	0.9902	0.9951	0.9941	0.9910	0.9919	0.9952	0.9974	1.0000		
Thailand	0.9834	0.9887	0.9959	0.9895	0.9905	0.9917	0.9949	0.9929	1.0000	
Philippines	0.9590	0.9379	0.9437	0.9107	0.9650	0.9601	0.9434	0.9437	0.9329	1.0000
USA	0.9963	0.9793	0.9798	0.9671	0.9899	0.9914	0.9905	0.9899	0.9778	0.9653
China	1.0000									Differences
HK	0.0541	1.0000								
Indonesia	0.0244	0.2615	1.0000							
Japan	-0.0180	0.0971	0.0841	1.0000						
Malaysia	-0.2179	0.1535	0.4674	0.1783	1.0000					
Singapore	0.0478	0.3216	0.2914	0.0233	0.4287	1.0000				
S. Korea	-0.0832	0.2408	0.1490	0.2645	0.3024	0.0755	1.0000			
Taiwan	-0.1246	0.2800	0.0778	0.0900	0.2236	0.3190	0.1608	1.0000		
Thailand	-0.0114	0.1221	0.4094	0.0645	0.3871	0.3003	0.2024	0.1131	1.0000	
Philippines	-0.1945	0.2383	0.0940	0.0201	0.1664	0.1340	0.0645	0.0860	0.0280	1.0000
USA	0.0017	0.0401	0.0332	0.0511	0.1502	0.1424	0.0920	0.2288	0.1429	-0.0576

Table 3. PANIC Test Results

	Country-specific factor	Common factor	Information Criteria		
Full Sample	P_e	ADF_f	IC1	IC2	IC3
N =10	-1.370	-2.184 , -1.074 , -0.768	3	3	1
N =9	-0.453	-2.311 , -1.304 , -1.275	3	3	1
N =11	-1.417	-2.203 , -0.875 , -0.712	3	3	2

Note: Full sample. The PANIC test and information criteria are based on Bai and Ng (2004) and Bai and Ng (2002) respectively. The statistic (pe) for evaluating the stationarity of country-specific factors is normally distributed and thus its 5% critical value is 1.64. When there is only one common factor, the factor unit root test (ADFf) has a 5% critical value of -2.86 (the constant only). A maximum of 4 common factors are considered when deciding the true number of common factors in the information criteria. "$N = 10$" refers to all 10 Asian countries, and "$N = 9$" to 9 when China is not included. "$N = 11$" is the panel of 10 Asian countries and the US.

Table 4. Cointegration among Common Factors by Johansen Test

	$N = 10$	$N = 9$	$N = 11$
	Trace statistics (p-value)	Trace statistics (p-value)	Trace statistics (p-value)
Factors 1, 2			
r =0	9.077 (0.358)	7.473 (0.523)	9.768 (0.299)
r =1	2.274 (0.131)	3.457 (0.063)	2.197 (0.138)
Factors 1, 2, 3			
r =0	22.751 (0.259)	18.837 (0.505)	24.032 (0.199)
r =1	8.178 (0.447)	9.376 (0.332)	8.156 (0.449)
r =2	2.452 (0.117)	3.520 (0.061)	2.571 (0.109)

Note: Full sample. The "r" is the number of common factors, and "N" is that of countries. The lag length of four is used for this test.

Table 5. The Relative Importance of Common Factors (Full Sample)

	$Std(\lambda F)/Std(X)$			$Std(e)/Std(X)$			$Std(e)/Std(\lambda F)$		
$N =$	10	9	11	10	9	11	10	9	11
$r = 3$									
China	0.7786	–	0.7884	0.2312	–	0.2209	0.2969	–	0.2801
HK	1.0505	1.0377	1.0425	0.1159	0.0995	0.1109	0.1103	0.0959	0.1064
Indonesia	1.1763	1.0854	1.1729	0.2111	0.1200	0.2096	0.1794	0.1106	0.1787
Japan	0.9224	0.8823	0.9270	0.1615	0.1705	0.1615	0.1751	0.1933	0.1742
Malaysia	1.0854	1.0419	1.0868	0.1241	0.0932	0.1253	0.1143	0.0895	0.1152
Singapore	1.0240	0.9235	1.0280	0.0539	0.0846	0.0565	0.0526	0.0916	0.0550
S. Korea	0.9458	1.0042	0.9446	0.0541	0.0296	0.0549	0.0572	0.0295	0.0581
Taiwan	0.8959	0.8237	0.9045	0.1104	0.1734	0.1037	0.1232	0.2105	0.1147
Thailand	1.1170	1.0243	1.1202	0.1583	0.0778	0.1636	0.1417	0.0759	0.1461
Philippines	0.9638	1.0381	0.9470	0.2549	0.2710	0.2550	0.2645	0.2611	0.2693
US	–	–	0.9064	–	–	0.1481	–	–	0.1634
$r = 2$									
China	0.7225	–	0.7300	0.2849	–	0.2772	0.3943	–	0.3797
HK	1.2652	1.1185	1.2676	0.3110	0.1704	0.3140	0.2458	0.1523	0.2477
Indonesia	1.0917	1.0232	1.0946	0.1372	0.0814	0.1412	0.1257	0.0795	0.1290
Japan	0.9230	0.9049	0.9237	0.1614	0.1634	0.1621	0.1748	0.1805	0.1755
Malaysia	1.0226	0.9981	1.0258	0.0885	0.0879	0.0894	0.0865	0.0880	0.0871
Singapore	0.9845	0.8874	0.9917	0.0465	0.1182	0.0458	0.0473	0.1332	0.0462
S. Korea	1.0142	1.0823	1.0061	0.0404	0.1028	0.0340	0.0398	0.0950	0.0338
Taiwan	0.8957	0.8218	0.9032	0.1106	0.1749	0.1047	0.1235	0.2129	0.1159
Thailand	0.9896	0.9546	0.9939	0.0986	0.0854	0.1018	0.0997	0.0894	0.1024
Philippines	1.2508	1.0957	1.2531	0.4073	0.2914	0.4097	0.3256	0.2659	0.3269
US	–	–	0.8521	–	–	0.1804	–	–	0.2117
$r = 1$									
China	0.7155	–	0.7206	0.2925	–	0.2871	0.4088	–	0.3984
HK	1.2496	1.1854	1.2495	0.2955	0.2318	0.2960	0.2365	0.1955	0.2369
Indonesia	1.0864	1.0258	1.0875	0.1322	0.0827	0.1347	0.1217	0.0806	0.1239
Japan	0.9363	0.8722	0.9406	0.1684	0.1829	0.1690	0.1798	0.2096	0.1797
Malaysia	1.0264	0.9838	1.0302	0.0872	0.0843	0.0888	0.0850	0.0857	0.0862
Singapore	0.9732	0.9077	0.9772	0.0556	0.1020	0.0542	0.0571	0.1124	0.0555
S. Korea	1.0489	1.0051	1.0511	0.0852	0.0660	0.0867	0.0812	0.0657	0.0825
Taiwan	0.8919	0.8300	0.8983	0.1122	0.1668	0.1069	0.1258	0.2009	0.1190
Thailand	0.9912	0.9340	0.9951	0.1007	0.1041	0.1031	0.1016	0.1114	0.1036
Philippines	1.2274	1.1977	1.2259	0.4121	0.3986	0.4098	0.3357	0.3328	0.3343
US	–	–	0.8506	–	–	0.1820	–	–	0.2140

Note: Includes the constant term. "X" is real GDP.

Table 6. The Relative Importance of Common Factors (Different Sample Periods)

$r=3, N=10$	1970Q2-1997:Q2			1997Q3-2007Q1		
	$\frac{Std(\lambda F)}{Std(X)}$	$\frac{Std(e)}{Std(X)}$	$\frac{Std(e)}{Std(\lambda F)}$	$\frac{Std(\lambda F)}{Std(X)}$	$\frac{Std(e)}{Std(X)}$	$\frac{Std(e}{Std(\lambda F)})$
China	0.9051	0.1067	0.1179	0.6970	0.2941	0.4220
HK	1.0116	0.0502	0.0496	1.2394	0.2748	0.2217
Indonesia	1.0005	0.0663	0.0663	0.9153	0.1136	0.1241
Japan	0.8891	0.1676	0.1885	1.1037	0.4421	0.4006
Malaysia	1.0587	0.0946	0.0893	1.0450	0.0687	0.0657
Singapore	1.0025	0.0480	0.0478	1.3126	0.3508	0.2672
S. Korea	1.0124	0.0700	0.0692	0.9885	0.0529	0.0536
Taiwan	0.9596	0.0772	0.0804	1.0523	0.1338	0.1272
Thailand	1.0174	0.0703	0.0691	0.8472	0.1878	0.2217
Philippines	0.8602	0.2008	0.2334	0.8803	0.1267	0.1439
$r=3, N=9$						
HK	0.9796	0.0321	0.0328	1.0931	0.1348	0.1233
Indonesia	0.9342	0.0744	0.0796	1.0775	0.0878	0.0814
Japan	0.8522	0.1860	0.2183	1.0185	0.4257	0.4180
Malaysia	1.0692	0.1048	0.0980	1.0410	0.0645	0.0620
Singapore	0.9620	0.0520	0.0541	1.1204	0.1496	0.1336
S. Korea	1.0242	0.0614	0.0600	1.0099	0.0596	0.0591
Taiwan	0.9330	0.0903	0.0968	0.8092	0.2040	0.2521
Thailand	0.9971	0.0553	0.0555	0.8414	0.1915	0.2276
Philippines	1.0411	0.1545	0.1484	0.7147	0.2875	0.4023
$r=3, N=11$						
China	0.9000	0.1110	0.1233	0.7191	0.2728	0.3794
HK	1.0118	0.0500	0.0495	1.2420	0.2780	0.2238
Indonesia	0.9980	0.0666	0.0667	0.9008	0.1269	0.1408
Japan	0.8870	0.1677	0.1891	1.1125	0.4457	0.4006
Malaysia	1.0564	0.0940	0.0890	1.0407	0.0656	0.0630
Singapore	0.9979	0.0485	0.0486	1.3221	0.3604	0.2726
S. Korea	1.0133	0.0705	0.0695	0.9863	0.0527	0.0535
Taiwan	0.9597	0.0754	0.0786	1.0698	0.1455	0.1360
Thailand	1.0135	0.0689	0.0680	0.8468	0.1885	0.2226
Philippines	0.8604	0.2011	0.2337	0.8918	0.1172	0.1315
US	1.0797	0.1589	0.1472	0.7545	0.2253	0.2986

Note: See table 5.

Table 7. Trade Concentration (Average)

	Imports		Exports	
	Within Asia	With the US	Within Asia	With the US
China	0.428	0.115	0.505	0.145
HK	0.661	0.077	0.442	0.232
Indonesia	0.465	0.115	0.576	0.149
Japan	0.278	0.194	0.292	0.289
Malaysia	0.531	0.158	0.515	0.176
Singapore	0.485	0.149	0.458	0.171
S. Korea	0.378	0.195	0.353	0.238
Taiwan	–	–	–	–
Thailand	0.476	0.113	0.407	0.180
Philippines	0.433	0.202	0.403	0.307

Note: The data are from the IMF's Direction of Trade, and statistics are computed as trade to/from each partner country divided by the total trade of the home country. The sample period is 1981Q1 to 2008Q4.

Table 8. The Long-Run Relationship between Trade and Common Factors

		Total trade (p-value)		Trade within Asia (p-value)		Trade concentration (p-value)	
		Import	Export	Import	Export	Import	Export
OLS		0.539 (0.000)	0.470 (0.000)	0.396 (0.000)	0.378 (0.000)	0.018 (0.000)	0.012 (0.000)
Adj OLS		0.612 (0.000)	0.536 (0.000)	0.457 (0.000)	0.438 (0.000)	0.021 (0.000)	0.014 (0.000)
FMOLS		0.262 (0.000)	0.257 (0.000)	0.546 (0.000)	0.564 (0.000)	0.031 (0.000)	0.034 (0.000)
Panel cointegration	DF_ρ^*	-10.044 (0.000)	-9.707 (0.000)	-8.643 (0.000)	-4.641 (0.000)	-1.005 (0.157)	-0.514 (0.304)
test	DF_t^*	-2.559 (0.000)	-2.490 (0.000)	-2.476 (0.000)	-1.144 (0.126)	-1.070 (0.142)	-0.435 (0.435)
Panel cointegration							
test with breaks	LM	–	–	–	–	118.400 (0.000)	5.200 (0.000)

Note: The panel cointegration test is based on Kao (1999), and the lag length of four is determined by the Akaike Information Criterion. The panel cointegration test with structural breaks is based on Westerlund (2006), and breaks are considered in the constant and time trend. The maximum number of breaks is three. Figures in parentheses are p-values. Due to data availability, the analysis using total trade data is based on 10 Asian countries, while that for trade concentration is based on 9 countries (i.e., excluding Taiwan). The sample period is 1981Q1 to 2008Q4.

Figures

Figure 1. Standardized Real GDP of Asian Countries (in natural log)

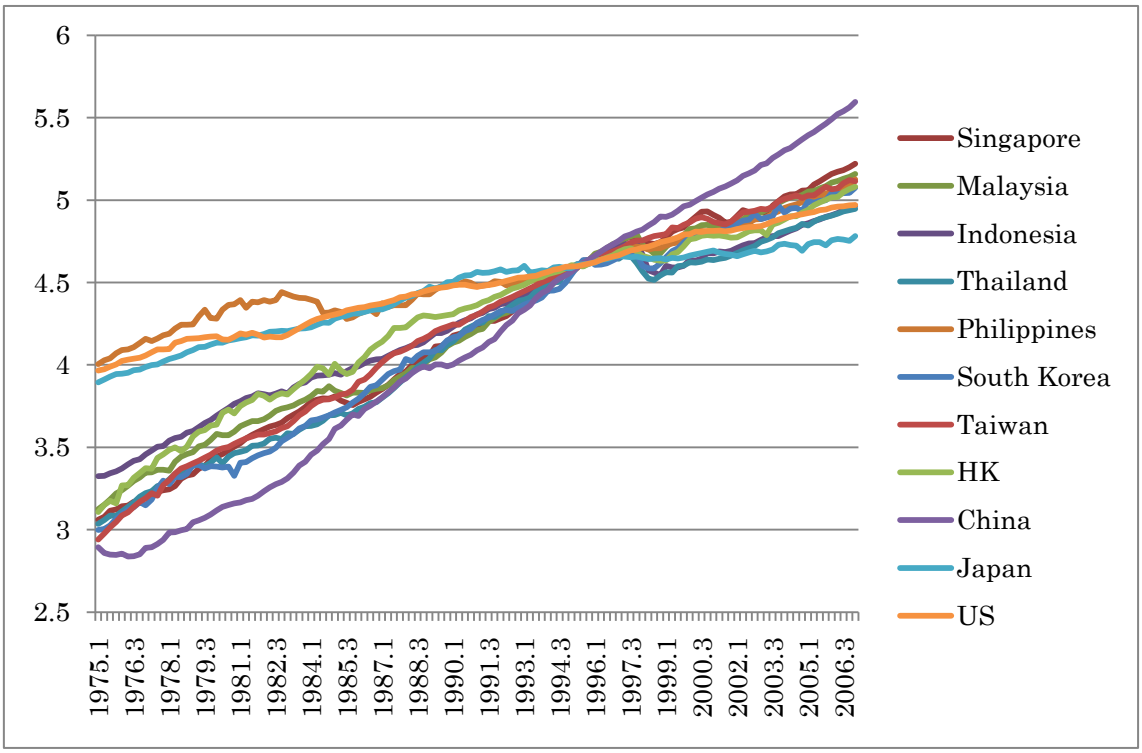

Figure 2. Real GDP Growth (log difference)

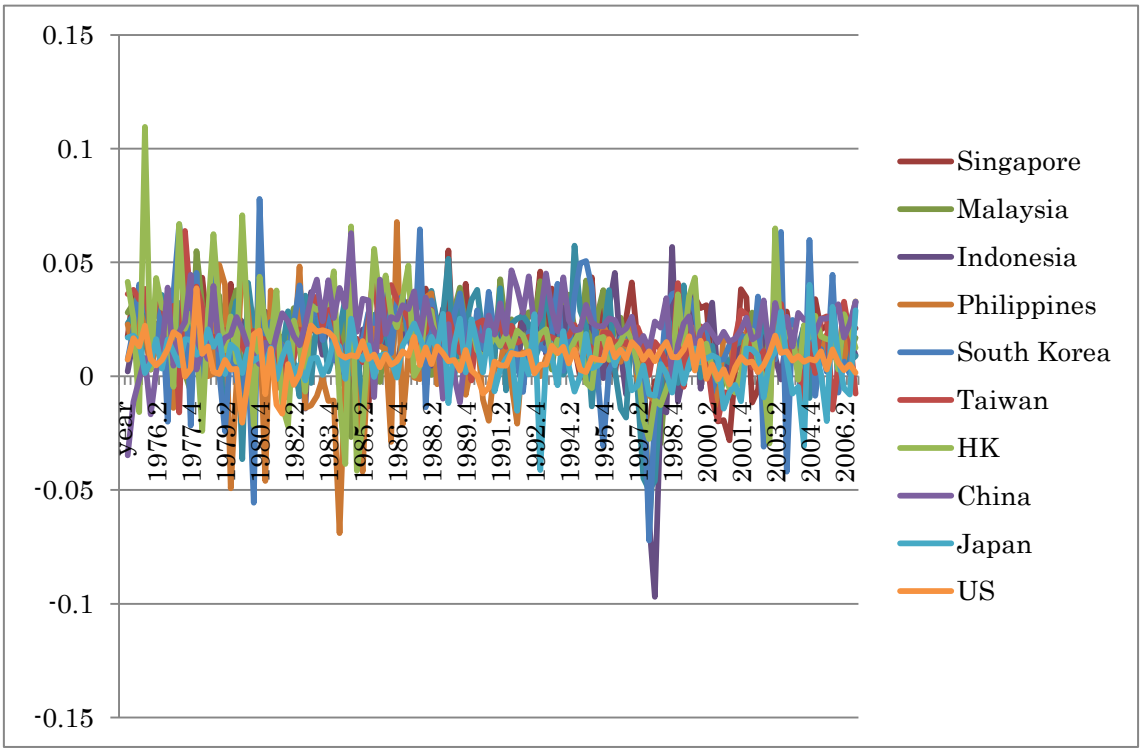

Figure 3. Common Components of Real GDP Growth (in natural log)

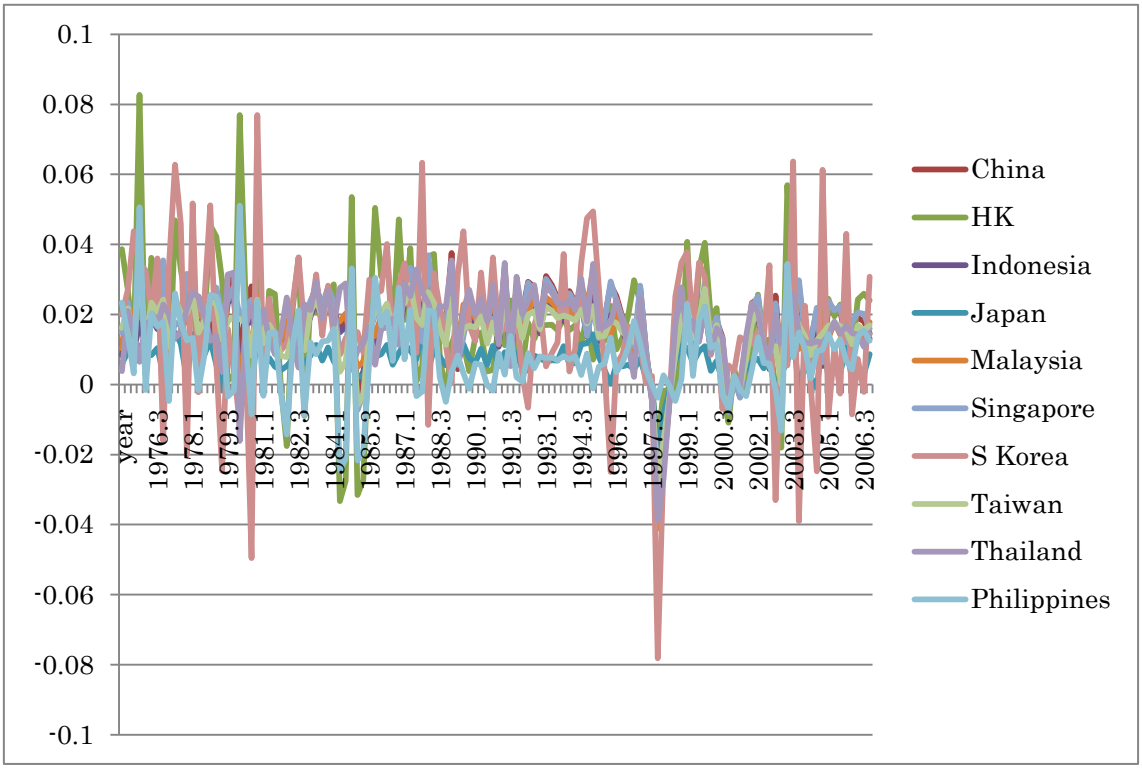

Figure 4. Country-specific Components