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Does East Asia Move towards an Optimum Currency Area?

Evidence from the Multivariate Structural VAR Analysis

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Abstract

Focusing on the symmetry in structural shocks and employing a four-variable structural vector auto-regression model, this paper investigated the dynamic trend of the feasibility for East Asian economies to form a currency union. The analysis of correlations of external supply shocks, domestic supply shocks, real demand shocks and monetary shocks (nominal shocks) with a sample period from 1980 to 2010 suggests that it is not reasonable for East Asia to form a single currency union currently in the entire region. However, a viable approach for regional monetary integration would be to start with smaller currency areas: Northeast Asian sub-region cluster including Japan, Korea, Taiwan and Hong Kong, and Southeast sub-regional cluster including Indonesia, Malaysia, Singapore and Thailand, and other economies might be included later. We can reasonably expect that the integration of these sub-regional currency areas may lead to a single currency in East Asia when a sufficient degree of economic convergence is achieved.

Keywords: East Asia, Structural VAR, Optimum currency area

1. Introduction

Establishing a regional currency area within East Asia has attracted much attention after Asian financial crisis and the success of the Euro, and some steps, such as Chiang Mai Initiative, Asian Bond Markets Initiative, and the proposition of Asian Monetary Unit (AMU) (Ogawa, 2004; Ogawa & Shimizu, 2006) and Asian Currency Unit (ACU) (Kawai, 2009), have been taken. The global financial crisis triggered by "Subprime Crisis" has renewed calls for greater monetary integration within East Asia. The Optimum Currency Area (OCA) theory deals with the criteria as well as the costs and benefits from entering/forming a common currency area. Since Mundell (1961), a significant amount of economic works have been put forward to discuss five main criteria to evaluate the *ex-ante* monetary integration, i.e., the degree of factor mobility, the extent of intra-regional trade; the symmetry of economic shocks across countries and the responses to common shocks; the degree of economic openness, and the system of risk-sharing.

The symmetry of shocks is the core criteria and it captures the interaction between several OCA properties. OCA involves the costs from the sacrifice of monetary autonomy and the limits on the choice of fiscal policy, which are mainly related to the asymmetries of economic shocks. Only if the incidence of disturbances and "the speed with which the economy adjusts — taking into consideration also the policy responses to shocks—are similar across partner countries" (Bayoumi & Eichengreen, 1992, p.24), the costs from forgoing the control of macroeconomic policies are lower and the net benefits from participating in a common currency area would be higher.

Extending the bi-variable vector autoregressive (VAR) decomposition approach pioneered by Blanchard and Quah (1989) , Bayoumi and Eichengreen (1992) imposed an identifying restrictions that "aggregate demand disturbances have only a temporary impact on output but a permanent impact on prices, while aggregate supply disturbances permanently affect both prices and output" (Bayoumi & Eichengreen, 1992, pp.2-3) to extract the information on aggregate supply disturbances and aggregate demand disturbances for 11 European Currency members and compare their adjustment speeds to that of the United States. After that, the structural VAR decomposition has become a popular tool to assess the similarities of economic cycles. However, Bayoumi and

Eichengreen (1992) took real demand shocks and pure nominal shocks as aggregate demand shocks without separating them from each other. Also, they did not identify the ultimate source of the shocks. Especially, because of the long-run identification restriction, any shock that has a temporary effect on real output is interpreted as a demand shock without identifying the fluctuation of macroeconomic policies (Demertzis, Hallett & Rummel, 2000).

Shioji (2000) emphasized that it is important to distinguish economic structural shocks coming from the IS side and the LM side of the macroeconomic equilibrium model. By presenting a stochastic version of the two countries, rational expectations open macroeconomic model developed by Obstfeld, Cooper, and Krugman (1985), Clarida and Gall (1994) exhibited not only the standard Mundell-Fleming-Dornbusch results in the short-run when prices adjust sluggishly to structural shocks, but also the "longer run" properties that characterize macroeconomic equilibrium in the open economy once prices adjust fully to all shocks. Further, Clarida and Gall (1994) analyzed the real exchange rate changes and identified three structural shocks that drive the system: monetary shocks, demand shocks, and supply shocks, which are represented by relative price level, real exchange rate and relative home output respectively. Chamie, DeSerres and Lalonde (1994) extended the method of Blanchard and Quah (1989) to a trivariate VAR composed of real supply, real demand and nominal shocks, and introduced the state-space model to identify the common and specific components of these shocks, and they obtained results contrary to those of Bayoumi and Eichengreen (1992). Using long-term restrictions on a simple VAR model, Demertzis, et al. (2000) identified the fundamental demand, supply and monetary shocks that drive output, prices and competitiveness, and concluded that there might have been increasing convergence in the optimum currency area criteria in EU; however, the convergence is mainly due to policy interventions rather than to any natural convergence in the shocks or structures.

East Asia is one of the most dynamic regions in terms of economic integration. A rather abundant literature has assessed monetary integration in East Asian economies according to various OCA criteria, among which the symmetry of economic shocks is also a focus. The existing empirical studies have yielded mixed results. Conducting structural VAR studies, Bayoumi and Eichengreen (1994), Ling and Yuen (2001), Zhang, Sato and McAleer (2001 & 2003), Sato, Zhang and McAleer (2003), Kwack (2004), Ahn, Kim and Chang (2006), Huang and Guo (2006), Lee and Azali (2009), and Quah (2012) generally suggested that certain sub-regional groups might form a currency union ahead of the other subgroups and the entire region, although the member economies of certain sub-regional group in those studies vary more or less. In contrast, Chow and Kim (2003), Joen and Zhang (2007), and Kim (2007) argued that it is not yet ready for East Asia to form a currency union. Hsu (2010) concluded that a common currency area may become viable through deepening regional integration in East Asia, although the empirical results do not provide strong support for forming a common currency area because the symmetric "prevalent shock" cannot be defined.

The rapid economic development, the efforts on seeking to deepen monetary cooperation, the following policy measures and the international events may result in significant structural and institutional changes in East Asia. Hence, the conclusions of previous studies may quickly become obsolete, and the arguments for and against are subject to continual modification. Focusing on the symmetry in structural shocks, this paper aims to investigate the dynamic trend of the feasibility to form a potential currency union in East Asia. Taking the global financial crisis into consideration, this paper employs four-variables structural VAR decomposition to identify four macroeconomic disturbances, i.e., external supply shocks, domestic supply shocks, real demand shocks and monetary shocks (nominal shocks), and the responses of macroeconomic variables to structural shocks with a sample period up to the year of 2010. Especially, this paper investigates how the global financial crisis influences the symmetry and asymmetry of macroeconomic shocks in East Asia economies compared to the Asian financial crisis during 1997-1998. The results suggest that it is not reasonable for East Asia to form a single currency union currently, but a viable approach for regional monetary integration would be to start with Northeast Asian sub-region cluster including Japan, Korea, Taiwan and Hong Kong, and Southeast sub-regional cluster including Indonesia, Malaysia, Singapore and Thailand, in which the member economies vary more or less from those suggested by previous studies.

The remaining of this paper is organized as follows: Section 2 presents the empirical model of structural VAR. Section 3 describes the data of macroeconomic variables, takes the stationarity test, and analyzes correlations and variability of the variables. Section 4 reports the empirical results. Section 5 concludes.

2. The Empirical Model

Based on Bayoumi and Eichengreen (1992), we divide the total demand shocks into real shocks and nominal shocks respectively. Taking East Asia's export-oriented economic structure and its high dependence on the world

economy into consideration, we set up an open economy macroeconomic framework incorporating the external shocks. We use growth rate of world GDP, growth rate of domestic GDP, real effective exchange rate, and CPI index to identify external shocks, real demand shocks, supply shocks and nominal shocks (or monetary shocks) respectively. It is assumed that the economy has achieved domestic and external equilibrium at initial. Only supply shocks are expected to influence the aggregate output level in the long run and demand shocks and monetary shocks have only temporary effects. Supply shocks, real demand shocks and monetary shocks are assumed to influence the real effective exchange rate in the long run. World output is considered as exogenous variable, which means that the outputs of potential economies do not influence the world output level. All the shocks are expected to influence the price levels in the long run. In addition, positive demand shocks and nominal shocks raise prices while positive supply shocks reduce them.

The structural VAR model can be considered as an infinite moving average (MA) representation using the lag operator L as follows:

$$\Delta x_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \cdots = \sum_{i=0}^{\infty} L^i A_i \varepsilon_t, \tag{1}$$

where the matrices A_i denotes the impulse response functions of the shocks to the elements of Δx_t. Assume that Δx_t represents the changes in world GDP, domestic GDP, real effective exchange rate, and CPI index, and ε_t represents external shocks, supply shocks, real demand shocks and nominal shocks. The structural VAR model then becomes

$$\begin{vmatrix} \Delta y_t^* \\ \Delta y_t \\ \Delta e_t \\ \Delta \pi_t \end{vmatrix} = \sum_{i=0}^{\infty} L^i \begin{vmatrix} a_{11i} & a_{12i} & a_{13i} & a_{14i} \\ a_{21i} & a_{22i} & a_{23i} & a_{24i} \\ a_{31i} & a_{32i} & a_{33i} & a_{34i} \\ a_{41i} & a_{42i} & a_{43i} & a_{44i} \end{vmatrix} \begin{vmatrix} \varepsilon_t^{s*} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \\ \varepsilon_t^{m} \end{vmatrix}, \tag{2}$$

where a_{11i} denotes element a_{11} in matrix Δx_t, and y_t^*, y_t, e_t, π_t denote the logarithms of world real GDP, domestic real GDP, real exchange rate and CPI index respectively. In addition, ε_t^{s*}, ε_t^{s}, ε_t^{d}, ε_t^{m} denote external supply shocks (such as oil price shock), domestic supply shocks (such as technology innovation), real demand shocks (such as the changes in consumption preference and investment preference) and nominal shocks (mainly are macroeconomic policies and international currency arrangement) respectively. It is assumed that y_t^*, y_t, e_t, π_t are stationary random processes, and the structural shocks are serially uncorrelated and orthogonality and have a variance-covariance matrix normalized to the identity matrix. That is:

$$E(\varepsilon_t\varepsilon_{t+i}) = 0, \quad V_i \neq 0 \quad \text{and } E(\varepsilon_t\varepsilon_{t+i}) = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}.$$

It is also assumed that ε_t^{s*}, ε_t^{s}, ε_t^{d}, ε_t^{m} are white noise sequences.

We simplify equation (1) as $\Delta x_t = A(L)\varepsilon_t$. Then equation (1) can be written as:

$$\Delta y_t^* = A_{11}(L)\varepsilon_t^{s*} + A_{12}(L)\varepsilon_t^{s} + A_{13}(L)\varepsilon_t^{d} + A_{14}(L)\varepsilon_t^{m}, \tag{3-1}$$

$$\Delta y_t = A_{21}(L)\varepsilon_t^{s*} + A_{22}(L)\varepsilon_t^{s} + A_{23}(L)\varepsilon_t^{d} + A_{24}(L)\varepsilon_t^{m}, \tag{3-2}$$

$$\Delta e_t = A_{31}(L)\varepsilon_t^{s*} + A_{32}(L)\varepsilon_t^{s} + A_{33}(L)\varepsilon_t^{d} + A_{34}(L)\varepsilon_t^{m}, \tag{3-3}$$

$$\Delta \pi_t = A_{41}(L)\varepsilon_t^{s*} + A_{42}(L)\varepsilon_t^{s} + A_{43}(L)\varepsilon_t^{d} + A_{44}(L)\varepsilon_t^{m}. \tag{3-4}$$

According to the hypothesis, the structural VAR model implies the necessary identification restrictions for equation (3-1)-(3-4) respectively as follows:

$$\sum_{i=0}^{\infty} A_{11i} \neq 0, \sum_{i=0}^{\infty} A_{12i} = 0, \sum_{i=0}^{\infty} A_{13i} = 0, \sum_{i=0}^{\infty} A_{14i} = 0, \tag{4-1}$$

$$\sum_{i=0}^{\infty} A_{21i} \neq 0, \sum_{i=0}^{\infty} A_{22i} \neq 0, \sum_{i=0}^{\infty} A_{23i} = 0, \sum_{i=0}^{\infty} A_{24i} = 0, \tag{4-2}$$

$$\sum_{i=0}^{\infty} A_{31i} \neq 0, \sum_{i=0}^{\infty} A_{32i} \neq 0, \sum_{i=0}^{\infty} A_{33i} \neq 0, \sum_{i=0}^{\infty} A_{34i} = 0, \tag{4-3}$$

$$\sum_{i=0}^{\infty} A_{41i} \neq 0, \sum_{i=0}^{\infty} A_{42i} \neq 0, \sum_{i=0}^{\infty} A_{43i} \neq 0, \sum_{i=0}^{\infty} A_{44i} \neq 0. \tag{4-4}$$

Then, equation (2) can be rewritten as

$$\begin{vmatrix} \Delta y_t^* \\ \Delta y_t \\ \Delta e_t \\ \Delta \pi_t \end{vmatrix} = \begin{vmatrix} A_{11}(L) & 0 & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & 0 \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) \end{vmatrix} \begin{vmatrix} \varepsilon_t^{s*} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \\ \varepsilon_t^{m} \end{vmatrix}. \tag{5}$$

The model defined by equations (5) can be estimated using a VAR. Each element of Δx_t can be regressed on lagged values of all the elements of Δx. Taking B as the estimated coefficients matrix, the estimated structural model becomes the reduced VAR model:

$$\Delta x_t = B_1 \Delta x_{t-1} + B_2 \Delta x_{t-2} + \cdots + B_n \Delta x_{t-n} + e_t = \sum_{i=1}^{n} B_i L^i \Delta x_i + e_t = B(L)\Delta x_t + e_t. \tag{6}$$

$$\begin{aligned} \Delta x_t &= [I - B(L)]^{-1} e_t \\ &= [I + B(L) + B(L)^2 + ...] e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + ... \\ &= \sum_{i=1}^{\infty} D_i e_{t-i} = D(L) e_t, \end{aligned} \tag{7}$$

where e_t represents the residuals from the equations in the reduced VAR. In the case considered, e_t is comprised of the disturbances of world output (e_t^{y*}), domestic output (e_t^{y}), real exchange rate (e_t^{e}) and prices (e_t^{π}), which are caused by the structural shocks of economy system, i.e., external supply shocks (ε_t^{s*}), domestic supply shocks (ε_t^{s}), real demand shocks (ε_t^{d}) and nominal shocks(ε_t^{m}).Then e_t can be written as the linear combination of the vector of four shocks. That is:

$$e_t = C\varepsilon_t \tag{8}$$

We go to identify the structural shocks from the VAR reduced-form residuals and their variance. From equation (8), we know that the solution depends on the identification of the matrix C, which contains m^2 elements (where m is equal to the number of dependent variables in the model). It is clear that sixteen restrictions are necessary to define sixteen elements of the matrix C. Four of these restrictions are simple normalizations, which define the variance of ε_t^{s*}, ε_t^{s}, ε_t^{d} and ε_t^{m}, following the assumption that each shock has a variance-covariance matrix normalized to the identity matrix. Another six restrictions come from an assumption that pair-wise identified shocks are orthogonal. The assumption of normalization together with orthogonality implies that $CC' = \Sigma$, where Σ is the variance-covariance matrix of $e_t^{y*}, e_t^{y}, e_t^{e}$ and e_t^{π}. In order to uniquely identify the matrix C, the final six restrictions are embodied in the long-run identifying restrictions mentioned in equations (4-1)-(4-4). Combining equations of (1), (7) and (8), we summarize the identification restrictions as:

$$\Delta x_t = (I - B(L))^{-1} e_t = \sum_{i=1}^{\infty} D_i e_{t-i} = \sum_{i=1}^{\infty} D_i C \varepsilon_{t-i} = \sum_{i=0}^{\infty} L^i A_i \varepsilon_t$$

$$\sum_{i=1}^{\infty} D_i C = \sum_{i=0}^{\infty} A_i. \tag{9}$$

That is:

$$\sum_{i=1}^{\infty} \begin{vmatrix} d_{11i} & d_{12i} & d_{13i} & d_{14i} \\ d_{21i} & d_{22i} & d_{23i} & d_{24i} \\ d_{31i} & d_{32i} & d_{33i} & d_{34i} \\ d_{41i} & d_{42i} & d_{43i} & d_{44i} \end{vmatrix} \begin{vmatrix} c_{11} & c_{12} & c_{13} & c_{14} \\ c_{21} & c_{22} & c_{23} & c_{24} \\ c_{31} & c_{32} & c_{33} & c_{34} \\ c_{41} & c_{42} & c_{43} & c_{44} \end{vmatrix} = \begin{vmatrix} 0 & 0 & 0 & \cdot \\ 0 & 0 & \cdot & \cdot \\ 0 & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{vmatrix}. \tag{10}$$

When the equilibrium is achieved, we have $\Delta x_t = \Delta x_{t-i}$. We obtain:

$$\sum_{i=1}^{\infty} D_i = (I - B(L))^{-1} = (I - B_1 - B_2 - \cdots - B_n)^{-1}.$$

Then, matrix C is uniquely defined as:

$$C = D(L)^{-1} A(L) \tag{11}$$

Finally, the structural shocks matrix ε_t can be identified as:

$$\varepsilon_t = C^{-1} e_t \tag{12}$$

The system is now just-identified and can be estimated using structural VAR. We can calculate variance decomposition that represents the contribution of each shock to the variability in each endogenous variable, and impulse-response functions that represent the short-run dynamics of each endogenous variable in response to all identified structural shocks. The estimated supply disturbances are assumed to be less likely to include the influence of macroeconomic policies, which suggests that supply shocks are more informative for evaluating the symmetry of underlying shocks and the feasibility of OCAs than other shocks. Hence we calculate variance decomposition and impulse-response functions for domestic real output only.

3. Data Description and Stationary Test

3.1 Data Description

Using four-variable structural VAR approach, we investigate the nature of macroeconomic structural disturbances over the period of 1980Q1-2010Q4 among 10 East Asia economies, i.e., Japan, Korea, China, Singapore, Hong Kong, Taiwan, Malaysia, Indonesia, Philippines, and Thailand, to assess the dynamic trend of the possibility for these economies to form a potential currency union. In order to examine whether correlations of structural economic disturbances among these economies have undergone significant changes after Asian financial crisis and the global financial crisis, we divide the entire period into three sub-periods: 1980Q1-1997Q2, 1980Q1-2007Q2 and 1980Q1-2010Q4.

Time series for GDP are from IMF International Financial Statistics, among which that of Taiwan comes from Taiwan statistics authorities, part of those for Indonesia, Malaysia, Thailand and China are calculated according to the estimates of Abeysinghe, T. and Gulasekaran, R.'s homepage, and those of Singapore are available in the period of 1984Q3-2010Q4. The CPI index is used to measure price, and time series for CPI come from IMF International Financial Statistics, among which those of Taiwan are from Taiwan statistics authorities. Time series for real effective exchange rate are from IMF International Financial Statistics, among which those of Korea, Hong Kong, Taiwan, Indonesia and Thailand are calculated according to the monthly CPI-based real effective exchange rate of Bank of International Settlements, and those of Indonesia and Thailand during 1981Q1-1993Q4 are calculated as a trade weighted and CPI-based geometric average of exchange rates with 36 and 40 major trading partners respectively. Real GDP, CPI and real effective exchange rate of the United States are used to estimate the external shocks. All the related variables are seasonally adjusted and their logarithms are taken in the model.

3.2 Stationarity Test

We test the time series for stationarity and co-integration before estimating the structural VAR model. We use both ADF test and PP test to examine the related endogenous variables for the existence of the unit roots. The results indicate that the variables of most sample economies are non-stationary on the level. However, the first difference tests show that the time series are stationary, hence the variables are integrated of the order one (I (1)). We then estimate the model using the variables in the first differences. According to the Schwaz Information Criterion, two lags are used for variables estimation. By investigating the inverse roots of autoregressive characteristic polynomial of each VAR model, we find that all the modulus are less than one, which suggests the structural VAR models are stable.

3.3 Correlations and Variability of Macroeconomic Variables

3.3.1 The Correlations of Macroeconomic Variables

We first investigate the mean and standard deviation of GDP growth, inflation and variability of real effective exchange rate of East Asian economies during 1981Q1-2010Q4. The simple means highlight the high GDP growth achieved over all the sample periods in this region, especially, the overwhelmingly rapid growth of China. The standard deviations of GDP growth suggest much significant regional differences. The simple means and the standard deviations indicate that both inflation rates and regional differences are significantly low. Both simple means and regional differences of real effective exchange rates over all the sample periods are significantly high

though they have been shrinking. Thus, East Asia qualifies as an OCA according to the criterion of similarity in inflation rate (Fleming, 1971), but the conditions of real economic cycles and real effective exchange rate suggest that it is not fit for an OCA.

Tables 1, 2, 3 depict the pair-wise correlations of GDP growth, inflation and fluctuation of real effective exchange rate respectively. We can see that the correlation coefficients of GDP growth among East Asian economies increased rapidly after the two financial crises, and has displayed coherent pattern by the year of 2010. Asian financial crisis enhanced the correlation cross all East Asian economies, especially that of Korea, Thailand, Indonesia, Hong Kong and Singapore — which were severely hit by the crisis — with other economies, especially China and Japan. The current global financial crisis further increased the correlation of China, Taiwan and Philippines with other economies, with a generally increasing correlation between any two economies. The correlation degree of inflation among East Asian economies has reached a high level before Asian financial crisis. After Asian financial crisis, only the inflation correlation of China, Singapore and Taiwan with other economies have increased, while both the scope and the degree cross all economies have increased after global financial crisis. The coherent pattern in real effective exchange variability is different from those in the cases of GDP growth and inflation and it slightly increased after the two financial crises because these economies have employed different exchange rate system after Asian financial crisis. The correlations of macroeconomic variables of East Asia economies are increasing in general as time goes. However, the prospect of forming a common currency union is uncertain with the respect to correlation of macroeconomic variables.

3.3.2 The Variability of Real Exchange Rate

Table 4 presents the variability of bilateral real exchange rates of the currencies of East Asian economies. We can see that those of Korea Won, Indonesia Rupiah, Singapore dollar and Thailand Baht which had been severely hit by Asian financial crisis have increased, while those of the currencies of other economies continued to display very low variability even after Asian financial crisis. Global financial crisis has decreased exchange rate variability vis-à-vis one another in East Asia in general, but Chinese Yen and Korea Won display very high levels of variability against other economies. The reason is that Chinese Yen has been appreciating after global financial crisis, while Korea Won has been depreciating. Generally, the variability of bilateral real exchange rate is relative low and present symmetric responses to regional shocks and global shocks to a certain extent.

4. The Empirical Results

The fluctuations of macroeconomic variables may occur due to domestic or/and external supply shocks, real demand shocks, nominal shocks, or a combination of the two or three shocks. The underlying structural shocks transmit their influences to the observed macroeconomic variables through a complex chain of mechanisms including domestic, regional and international linkages. It should be noted that economies with high degree of macroeconomic correlations may employ different sets of policies. Observed macroeconomic variables may present strong international correlations even though the underlying disturbances are not correlated, if the international transmission mechanism is sufficiently strong. Therefore, it is crucial to decompose the fluctuations of these macroeconomic variables into underlying structural shocks and investigate their correlations. In this section, we would investigate the symmetry of underlying economic shocks, and present variance composition and impulse responses functions by employing the structural VAR model.

4.1 Correlation of Underlying Structural Shocks

Estimating the correlation coefficients of the identified economic shocks is a natural approach of investigating symmetry of structural shocks across potential economies. The structural shocks are symmetric if the correlation coefficients are positive, and they are asymmetric if the correlation coefficients are negative or not statistically different from zero. According to the structural VAR model, we first estimate the residual error e_t of the reduced VAR (6) and identify the matrix C, then calculate the ε_t,(that is, external shocks (ε_t^{y*}), supply shocks (ε_t^{y}), real demand shocks (ε_t^{e}) and monetary shocks (ε_t^{π}) according to equation (12). The results are reported in Table 5-7.

4.1.1 Correlations of Underlying External Shocks

The importance of global and regional shocks to explain the fluctuation of economic cycles has increased although the domestic shocks are still dominant for almost all the East Asian economies (Hsu, 2010). The higher the correlation of external shocks, the lower the costs for sample economies to form a currency union. The reason is that the potential disruptions caused by external shocks in macroeconomic variables are reduced to a large degree, or even are eliminated completely. Panels A in Table 5-7 show that the correlation of external shocks is highly significant between any two economies over both the entire sample period and the sub-periods,

and the correlation degree has been growing after Asian financial crisis. Most of East Asian economies have adopted export-oriented strategy from the early 1960s and late1970s, and have formed the triangle trade structure in which developed economies within this region act as the exporters of advanced techniques and capital, and United States and European Union act as the role of final markets. Through transmission mechanisms such as international trade and production factors flows, the international production/distribution network in East Asia further enhances the transmission of external shocks such as current global economic recession and oil price rising.

4.1.2 Correlations of Underlying Supply Shocks

Panels B in Table 5-7 highlight the correlation of supply disturbances with significant coefficients. The results indicate that both the degree and the scope of correlations for supply shocks in the period of 1980Q1-2010Q4 are low, which suggests that the general supply shocks are less symmetric and the costs from forming an common currency union for the entire East Asia are high. However, the symmetry of supply shocks presents an increasing trend. As is shown in panel B in Table 5, only the supply shocks between Korea and Hong Kong, Hong Kong and Taiwan, Malaysia and Indonesia, and Malaysia and Singapore share significant correlations before Asian financial crisis, while the supply shocks for all the other economies are independent. Panel B in Table 6 shows that the degree and the scope of pairwise correlations in supply shocks have increased dramatically after Asian financial crisis. There are two main reasons for this trend: First, East Asian economies, especially the economies that have been severely hit by Asian financial crisis, have realized the importance to cooperate with other economies and have strengthened the correlation with other economies in supply shocks. Second, the development of the international production/distribution network has enhanced the correlation among member economies through transmission mechanisms such as trade, capital mobility, labor mobility.

During the period of 1980Q1-2007Q2 and 1980Q1-2010Q4, supply shocks for Northeast Asian cluster, i.e., Japan and Korea, Korea and Hong Kong, Hong Kong and Taiwan, and Southeast Asian cluster, i.e., Indonesia, Malaysia, Singapore and Thailand are significantly correlated between any two economies within the sub-regions. This result is similar to most previous findings, such as those of Bayoumi and Eichengreen (1994), Bayoumi and Mauro (1999), Ling and Yuen (2001), Zhang et. al (2001 & 2003), Kwack (2004), Sato et al. (2003), Huang and Guo (2006), Tang (2006), Lee and Azali (2009), but the member economies of sub-regional cluster vary more or less. The picture of "sub-regional cluster" becomes much more evident after the global finance crisis, especially among Southeast Asian economies.

After the Asian financial crisis, the correlation between Northeast Asian economies and Southeast Asian economies has become more significant. For example, acting as the bridge between the two sub-regional clusters, Hong Kong shares significant correlation in supply shocks not only with Northeast Asian economies, but also with Indonesia and Singapore during the period of 1980Q1-2007Q2. The supply shocks for China and Philippines are insignificantly correlated with those of other eight economies although the correlation degree has increased, which reflects their intermediate positions. During 1980Q1-2010Q4, the correlation between some economis of two sub-group clusters has been further enhanced. For example, the supply shocks for both Japan and Hong Kong become significantly correlated with those for Malaysia. In addition, China enhanced the correlation with other East Asian economies although only the correlation coefficient of it with Hong Kong is significant.

It is shown that the global financial crisis has reinforced the degree and the scope of correlation in supply shocks among East Asian economies, which may not only strengthen the trend of sub-regional clusters but also promote the correlation in supply shocks in the entire region. The regional production network reduced the impact of the global economic depression caused by current global financial crisis to a large degree and most member economies have realized economic recovery rapidly. In addition, East Asian economies try to reduce the dependence on the external markets of America and Europe and strategically turn to the regional market in order to develop not only the regional production network but also the regional marketing network. Therefore, it is rational to anticipate an increasing correlation of supply shocks among East Asian economies. Compared to the correlations in GDP growth (Table 1), the correlations in supply disturbances (Table 7) is lower, which manifests that it is necessary for us to distinguish underlying structural disturbances from observed macroeconomic variables.

4.1.3 Correlations of Underlying Real Demand Shocks

As a reflection of the structure of vertical international division of labor due to the "Flying Geese Pattern" (Akamatsu, 1962) from the late-1950's and the early-1960's, the real demand shocks for pairwise economies within NIEs and ASEAN are significantly correlated before Asian financial crisis (Panel C of Table 5). As is

shown in Panel C of Table 6, Korea, Indonesia, Thailand, Philippines and Malaysia have enhanced correlation in demand shocks with other economies during 1980Q1-2007Q2. The correlation of real demand shocks among both "Northern East Asian" economies and "Southern East Asian " economies have been enhanced, although the correlation degree among Northern East Asian economies is lower than that of supply shocks while the correlation degree among Southeast Asian economies is higher than that of supply shocks. As for the symmetry in demand shocks, the potential "Great China Circle", i.e., mainland of China, Hong Kong and Taiwan becomes significant after Asian financial crisis, though it is not significant in case of supply shocks. Global financial crisis did not change the picture of the correlations of demand shocks (panel C of Table 7). The international production network and the intra-industry (or intra-product) trade have been prompting the development of mutual demand mechanism in East Asia. As member economies turn from relying on external market to developing regional market, the correlation degree of demand shocks will increase and much deeper economic integration will be achieved.

It is interesting that the demand disturbances for Japan are not significantly correlated with those for other East Asian economies. This can be explained as follows: First, Japan is the most important exports country for other East Asian economies. The increase in demand for capital and technology intensive products will increase the prices and vice verse. Second, Japan is the only developed country in East Asia, and its consumption preferences are different from those of other economies. Thirdly, Japan employs flexible exchange rate system, while other East Asian economies factually employ US Dollar-pegged exchange rates although they declared to adopt free flexible exchange rate after Asian financial crisis.

4.1.4 Correlations of Underlying Monetary Shocks

The correlations of monetary shocks in East Asian economies display different picture from those of supply and demand shocks as shown in panels D in Table 5-7. The development of international industry transferring channels and the trade-oriented foreign direct investment have deepened the financial inter-dependence between Japan and NIEs, and between NIEs and ASEANS from the mid 1970s, which enhances the correlations in monetary disturbances. After global financial crisis, monetary shocks for Japan and Korea have become further significantly correlated with those for ASEAN, and the correlations of monetary shocks between pairwise ASEAN economies also increased. The correlations in monetary shocks suggest the increased correlation in monetary policies and inflation rate movement among East Asian economies, which indicates the decreasing costs from forming a currency union.

4.2 Variance Decomposition

In order to gauge the relative contributions of underlying economic shocks to GDP fluctuations in each sample economy, we calculate the variance decomposition of domestic GDP for sample economies at fist-, second-, third-, fourth-, eighth-, twelfth- and 20-quarter forecast horizons. We found that supply shocks are dominant at all horizons and explain over 70% of domestic output variation for East Asian economies. After Asian financial crisis, the relative contributions of supply shocks in China, Japan, Korea, Philippines, Singapore and Taiwan have risen up to over 70%. In contrast, those in economies hit severely by this crisis, such as Hong Kong, Indonesia, Malaysia and Thailand have decreased, while the relative contributions of demand shocks have increased in these economies. After global financial crisis, the relative contributions of supply shocks have increased in Hong Kong, Indonesia, Philippines and Singapore, while those in China, Japan, Korea, Malaysia, Taiwan and Thailand have decreased. The relative contributions of external shocks and monetary shocks in some economies, such as Malaysia and Thailand, have increased.

The changes of relative contributions of structural shocks to domestic GDP variances have important implications for the exchange rate policies in East Asian economies. Supply shocks are independent from changes in demand management policies and are less possible to be sensitive to the changes of international monetary arrangements (Bayoumi & Eichengreen, 1994), while real demand shocks and monetary shocks tend to include the influence of macroeconomic policies as well as purely stochastic disturbances. Therefore, we take the supply shocks as the leading variable in estimating the symmetry of structural shocks. The correlations of supply shocks suggest that East Asia has not reached the stage of forming a common currency union. However, a viable approach for regional monetary integration would be to start with Northeast Asian sub-region cluster including Japan, Korea, Taiwan and Hong Kong, and Southeast sub-regional cluster including Indonesia, Malaysia, Singapore and Thailand (maybe including Philippines). In fact, China has experienced mainly idiosyncratic shocks or insignificant correlations in supply shocks with the rest of the East Asian economies, and the combination of the Greater China region including mainland of China, Taiwan and Hong Kong advocated by some previous literature may not be a plausible option.

4.3 Sizes of Disturbances and Speed of Adjustment

Given certain cross-country asymmetry, the larger the size of disturbances and the slower the speed of dynamic adjustment, the larger the costs from forming a common currency union for certain region due to foregoing the autonomy of independent macroeconomic policies (Bayoumi & Eichengreen, 1994; Boone, 1997). Hence, besides the estimation analysis of symmetry structure of structural disturbances, it is necessary to assess the size of disturbances and the speed of dynamic adjustment.

Structural VAR methodology assumes that the estimated potential structural disturbances have unit variances, which allows us to estimate the relative size of structural disturbances and the adjustment speed to disturbances in sample economies based on the impulse response function analysis. For both external and domestic supply shocks, we use the average absolute value of the log-run (20-quarter horizon) effect of one unit shock on changes in real GDP as a measure of size since the supply disturbances have permanent effects on output. On the other hand, it is assumed that the demand and monetary disturbances have transitory effects on output, so the sizes of them are measured by the average absolute values of the short-run (4-quarter horizon) effect of one unit shock on changes in real effective exchange rates and CPIs respectively (Huang & Guo, 2006; Zhang et. al, 2001 & 2003). The adjustment speed to disturbances is the ratio of the response after 4-qurters to its long-run level (the response after a 20-qurter horizon).

As is shown in Table 8, the sizes of supply shocks are large in most of the developing and open economies, such as Indonesia, Singapore, Malaysia and Thailand, which suggests the rapid growth of GDP in these economies. Asian financial crisis increased dramatically the sizes of structural shocks for Korea, Indonesia, Malaysia, Thailand, Philippines and Singapore, most of which have been severely hit by the crisis. Global financial crisis did not change the sizes of structural shocks significantly. However, the adjustment speed to structural disturbances is fast, and most East Asian economies take less than one year to complete the adjustment to one unit structural shock. For supply shocks, the adjustment speed of China, Hong Kong, Indonesia, Singapore and Taiwan increased after Asian financial crisis, which results in the increase of average adjustment speed during 1980Q1-2007Q2. The adjustment speed of China, Korea, Singapore, Taiwan and Indonesia continued to increase after the global financial crisis, which is consistent with their economic growth after the crisis. For the demand shocks, the average adjustment speed did not change after Asian financial crisis, while decreased after the global financial crisis. The average adjustment speed of monetary shocks increased after both Asian financial crisis and currenct globle financial crisis, may be due to the enhancement of intra-regional capital mobility.

A possible explanation of the high adjustment speed to structural disturbances is that East Asia possesses much flexibility in cost-price structures, especially the labor market is relatively more flexible and subject to comparatively little minimum wage legislation in most member economies, which leads to the faster internal adjustment to disturbances for them (Bayoumi & Eichengreen, 1994; Goto & Hamada, 1994; Zhang et. al, 2001 & 2003; Sato et al., 2003; Zhang & Lan, 2005; Tang, 2006; Huang & Guo, 2006; Lee & Azali, 2009). This also confirms the OCA criteria of factor mobility originated by Mundell (1961).

5. Conclusions

There has been a resurgence of interest in a concerted monetary arrangement and currency union in both academia and policy circle in East Asia in the aftermath of the global financial crisis. Focusing on the symmetry in structural shocks and employing four-variable structural VAR technique, this paper investigated the dynamic trend of the feasibility for East Asia to create a common currency union.

The correlations of supply shocks show that East Asia did not reach the stage where they can form a common currency area. However, the results also suggest that two "sub-regional clusters" have better poised for deeper monetary integration as a transition process: one is Northeast Asian cluster including Japan, Korea, Hong Kong, and Taiwan, the other is Southeast Asian cluster including Indonesia, Malaysia, Singapore and Thailand. Underlying supply shocks are significantly correlated and symmetric between each other economies in these two clusters. Monetary integration in East Asia could begin with these smaller groupings, which will facilitate regional monetary cooperation and integration through the establishment of swap arrangements, free trade agreements, and regional coordinating institutions. Then other economies could be included in the future. When a sufficient degree of convergence is achieved, the integration of these sub-regional currency areas may lead to a single currency in East Asia, given full economic integration and harmonization. It should be noted that the symmetry of underlying shocks is part of the (albeit more important) "screening device" to assess the suitability of different groups of economies for potential monetary union. Hence, the results of this study are suggestive rather than definitive since the formation of monetary integration will depend on other economic and noneconomic factors as well. The importance of the intensity of intra-regional trade, flexibility of factor markets,

and macroeconomic policy coordination in determining the process of monetary integration should also be noted. The weak financial systems, not well developed foreign exchange markets of some of the prospective members, and the complex of preferences concerning exchange rate policy, budget deficits, and inflation rates still hamper the formation of currency unification in East Asia. It also should be recognized that East Asian economies are lack of the political solidarity, commitment and experience with political cooperation for a monetary union like that of euro area at present. Hence, a currency union would be much harder to accomplish in East Asia than in Europe.

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Appendix

Table 1. Correlation Matrix of Real GDP Growth across 10 Economies in East Asia

	CHN	JPN	KOR	HKG	TWN	SGP	PHI	MLY	THA	IND
Panel A: 1981Q1-2010Q4										
CHN	1									
JPN	0.073	1								
KOR	0.105	0.568***	1							
HKG	0.248***	0.476***	0.626***	1						
TWN	0.162	0.564***	0.579***	0.625***	1					
SGP	0.186*	0.467***	0.454***	0.615***	0.619***	1				
PHI	-0.340***	-0.110	-0.004	0.089	-0.073	0.280***	1			
MLY	0.021	0.428***	0.631***	0.515***	0.475***	0.727***	0.226**	1		
THA	0.121	0.620***	0.714***	0.533***	0.526***	0.598***	0.145	0.735***	1	
IND	0.097	0.313***	0.539***	0.539***	0.249***	0.408***	0.215**	0.688***	0.660***	1
Panel B: 2007Q3-2010Q4										
CHN	1									
JPN	0.666***	1								
KOR	0.780***	0.883***	1							
HKG	0.773***	0.971***	0.918***	1						
TWN	0.702***	0.911***	0.962***	0.923***	1					
SGP	0.633**	0.893***	0.857***	0.875***	0.905***	1				
PHI	0.486***	0.858***	0.597**	0.772***	0.648**	0.794***	1			
MLY	0.759***	0.934***	0.932***	0.946***	0.894***	0.841***	0.757***	1		
THA	0.727***	0.938***	0.972***	0.935***	0.961***	0.885***	0.722***	0.967***	1	
IND	0.538**	0.768***	0.644**	0.777***	0.625**	0.544*	0.662***	0.777***	0.690***	1
Panel C: 1997Q3-2007Q2										
CHN	1									
JPN	0.532***	1								
KOR	-0.022	0.526***	1							
HKG	0.405***	0.843***	0.675***	1						
TWN	0.250	0.408***	0.329**	0.468***	1					
SGP	0.439***	0.729***	0.425***	0.822***	0.726***	1				
PHI	0.388**	0.503***	0.250	0.457***	0.050	0.255	1			
MLY	0.166	0.699***	0.832***	0.858***	0.458***	0.690***	0.533***	1		
THA	0.281*	0.667***	0.761***	0.743***	0.191	0.436***	0.649***	0.810***	1	
IND	0.296*	0.671***	0.682***	0.789***	0.112	0.531***	0.608***	0.849***	0.868***	1
Panel D: 1981Q1-1997Q2										
CHN	1									
JPN	-0.228	1								
KOR	-0.036	0.132	1							
HKG	0.124	-0.057	0.389***	1						
TWN	-0.078	-0.075	0.384***	0.562***	1					
SGP	-0.070	-0.192	0.015	0.211	-0.023	1				
PHI	-0.525***	-0.122	0.263**	0.068	0.031	0.487***	1			
MLY	-0.240	-0.241	-0.058	-0.055	-0.008	0.682***	0.352***	1		
THA	-0.159	0.199	0.183	0.024	0.187	0.524***	0.250**	0.407***	1	
IND	-0.212	-0.152	-0.073	0.226*	0.315***	0.359**	0.274**	0.488***	0.187	1

Note: ***, ** and * means that we reject the null hypothesis at the significance level of 1%, 5% and 10%, and the same as below. JPN, TWN, SGP, THA, HKG, PHI, CHN, MLY, KOR and IND denote Japan, Taiwan, Singapore, Thailand, Hong Kong, Philippines, China, Malaysia, Korea and Indonesia respectively, and the same as below. Real seasonally adjusted GDP growth rates are the percentage changes over corresponding period of previous year.

Source: The author's estimation by SPSS 16.0.

Table 2. Correlation Matrix of Inflation Rate across 10 Economies in East Asia

	CHN	JPN	KOR	HKG	TWN	SGP	PHI	MLY	THA	IND
Panel A: 1981Q1-2010Q4										
CHN	1									
JPN	0.257*	1								
KOR	0.335***	0.697***	1							
HKG	0.598***	0.675***	0.460***	1						
TWN	0.585***	0.404***	0.575***	0.519***	1					
SGP	0.315***	0.599***	0.651***	0.441***	0.439***	1				
PHI	0.203**	0.476***	0.115	0.375***	0.016	0.209**	1			
MLY	0.198*	0.617***	0.697***	0.464***	0.412***	0.665***	0.224*	1		
THA	0.284***	0.605***	0.776***	0.525***	0.532***	0.594***	0.049	0.725***	1	
IND	-0.211**	-0.019	0.107	-0.042	-0.079	-0.180**	0.06	0.319***	0.243***	1
Panel B: 2007Q3-2010Q4										
CHN	1									
JPN	0.707***	1								
KOR	0.437	0.904***	1							
HKG	0.847***	0.805***	0.721***	1						
TWN	0.797***	0.458	0.196	0.645**	1					
SGP	0.805***	0.928***	0.823***	0.876***	0.520*	1				
PHI	0.343	0.816***	0.933***	0.679***	0.249	0.741***	1			
MLY	0.434	0.901***	0.934***	0.674***	0.257	0.777***	0.950***	1		
THA	0.810***	0.689***	0.633**	0.928***	0.625**	0.785***	0.646**	0.629**	1	
IND	0.365	0.890***	0.910***	0.530*	0.176	0.765***	0.880***	0.947***	0.446	1
Panel C: 1997Q3-2007Q2										
CHN	1									
JPN	0.183	1								
KOR	0.009	0.442***	1							
HKG	0.284*	0.602***	0.467***	1						
TWN	0.384**	0.159	0.193	0.114	1					
SGP	0.608***	0.324**	0.035	0.020	0.189	1				
PHI	-0.050	0.391**	0.450***	0.712***	0.186	-0.194	1			
MLY	-0.336**	0.407***	0.402**	0.481***	0.23	-0.336**	0.689***	1		
THA	0.089	0. 634***	0.690***	0.642***	0.392**	0.158	0.574***	0.738***	1	
IND	-0.483***	0.157	0.454***	0.280*	0.065	-0.569***	0.646***	0.783***	0.468***	1
Panel D: 1981Q1-1997Q2										
CHN	1									
JPN	-0.380**	1								
KOR	-0.193	0.686***	1							
HKG	0.064	0.303**	0.178	1						
TWN	0.233	0.145	0.622***	0.540***	1					
SGP	-0.064	0.648***	0.783***	0.513***	0.417***	1				
PHI	-0.309**	0.331***	-0.066	0.063	-0.241	0.151	1			
MLY	0.070	0.585***	0.756***	0.450***	0.451***	0.824***	0.059	1		
THA	-0.127	0.526***	0.872***	0.278**	0.530***	0.755***	-0.220	0.739***	1	
IND	0.053	0.301**	0.431***	0.326***	-0.019	0.405***	0.119	0.546***	0.399***	1

Note: Inflation rates is the percentage changes over corresponding period of previous year.

Source: The author's estimation by SPSS 16.0.

Table 3. Correlation Matrix of Real Effective Exchange variability across 10 Economies in East Asia

	CHN	JPN	KOR	HKG	TWN	SGP	PHI	MLY	THA	IND
Panel A: 1981Q1-2010Q4										
CHN	1									
JPN	-0.269***	1								
KOR	0.130	-0.393***	1							
HKG	0.360***	-0.367***	-0.094	1						
TWN	0.202**	-0.232**	0.471***	0.202**	1					
SGP	0.249***	-0.438***	0.146	0.511***	0.360***	1				
PHI	0.171*	-0.471***	0.476***	0.310***	0.453***	0.434***	1			
MLY	0.217**	-0.375***	0.453***	0.076	0.419***	0.493***	0.568***	1		
THA	-0.024	-0.160	0.414***	-0.055	0.323***	0.085	0.420***	0.343***	1	
IND	-0.045	-0.206**	0.505***	-0.175	0.003	0.011	0.465***	0.354***	0.374***	1
Panel B: 2007Q3-2010Q4										
CHN	1									
JPN	0.510*	1								
KOR	-0.751***	-0.772***	1							
HKG	0.209	0.762***	-0.516**	1						
TWN	0.007	-0.094	0.001	-0.062	1					
SGP	0.404	0.111	-0.334	-0.196	0.758***	1				
PHI	0.013	-0.700***	0.376	-0.740***	0.168	0.339	1			
MLY	-0.179	-0.261	0.357	-0.089	0.727***	0.535**	0.363	1		
THA	-0.550**	-0.563**	0.636**	-0.313	0.486*	0.187	0.484***	0.697***	1	
IND	-0.436	-0.412	0.791***	-0.321	0.076	-0.205	0.066	0.392	0.287	1
Panel C: 1997Q3-2007Q2										
CHN	1									
JPN	-0.482***	1								
KOR	-0.546***	0.010	1							
HKG	0.941***	-.0358**	-0.615***	1						
TWN	-0.098	0.151	0.658***	-0.196	1					
SGP	0.575***	-0.439***	-0.199	0.411***	0.150	1				
PHI	-0.258	-0.300	0.706***	-0.341**	0.352**	-0.103	1			
MLY	-0.236	-0.269	0.758***	-0.448***	0.580***	0.109	0.654***	1		
THA	-0.488***	-0.206	0.711***	-0.576***	0.244	-0.337**	0.727***	0.670***	1	
IND	-0.626***	0.163	0.763***	-0.663***	0.318**	-0.410***	0.687***	0.669***	0.656***	1
Panel D: 1981Q1-1997Q2										
CHN	1									
JPN	-0.325***	1								
KOR	0.622***	-0.537***	1							
HKG	0.399***	-0.631***	0.537***	1						
TWN	0.336***	-0.431***	0.633***	0.331***	1					
SGP	0.248**	-0.648***	0.564***	0.636***	0.351***	1				
PHI	0.282**	-0.610***	0.484***	0.766***	0.502***	0.568***	1			
MLY	0.395***	-0.559***	0.290**	0.509***	0.359***	0.668***	0.513***	1		
THA	0.111	-0.177	0.254**	0.245*	0.331***	0.169	0.242*	0.079	1	
IND	0.028	-0.426***	0.186	0.492***	-0.108	0.326***	0.414***	0.020	0.245*	1

Note: Real effective exchange rate variability is the percentage changes over corresponding period of previous year.
Source: The author's estimation by SPSS 16.0.

Table 4. Variability of Bilateral Real Exchange Rate between 10 East Asian economies

	CHN	JPN	KOR	HKG	TWN	SGP	PHI	MLY	THA	IND
Panel A: 2007Q3-2010Q4										
CHN	1									
JPN	0.0379	1								
KOR	0.1162	0.1152	1							
HKG	0.0615	0.0452	0.1581	1						
TWN	0.2034	0.2025	0.0749	0.2618	1					
SGP	0.0559	0.0198	0.0723	0.1103	0.1279	1				
PHI	0.0656	0.0885	0.1000	0.1156	0.1562	0.0422	1			
MLY	0.0419	0.0617	0.0903	0.0561	0.1738	0.0288	0.0400	1		
THA	0.0601	0.0759	0.0764	0.1130	0.1451	0.0271	0.0405	0.0333	1	
IND	0.0400	0.0549	0.0847	0.0884	0.1702	0.0342	0.0564	0.0178	0.0402	1
Panel B: 1997Q3-2007Q2										
CHN	1									
JPN	0.0374	1								
KOR	0.5171	0.5713	1							
HKG	0.0927	0.1109	0.4653	1						
TWN	0.1696	0.2032	0.2731	0.1467	1					
SGP	0.1311	0.0649	0.2987	0.1336	0.0749	1				
PHI	0.1293	0.1537	0.3248	0.1292	0.0821	0.0746	1			
MLY	0.0484	0.0769	0.4303	0.0585	0.1222	0.0874	0.0927	1		
THA	0.1609	0.1964	0.3116	0.1550	0.0814	0.0788	0.0785	0.1215	1	
IND	0.0678	0.0930	0.4170	0.0647	0.1091	0.0808	0.0952	0.0458	0.1125	1
Panel C: 1981Q1-1997Q2										
CHN	1									
JPN	0.0229	1								
KOR	0.0282	0.0971	1							
HKG	0.1104	0.1372	0.2088	1						
TWN	0.0629	0.0663	0.1271	0.1450	1					
SGP	0.0151	0.0738	0.1215	0.1562	0.0891	1				
PHI	0.0221	0.0725	0.1029	0.1626	0.0988	0.0911	1			
MLY	0.0267	0.0497	0.1083	0.0415	0.0607	0.0444	0.0922	1		
THA	0.0282	0.0669	0.1259	0.1273	0.0656	0.0526	0.1071	0.0460	1	
IND	0.0156	0.0709	0.1561	0.1392	0.0606	0.0761	0.0923	0.0707	0.0725	1

Note: Real exchange rate variability is the standard deviation of percentage changes over corresponding period of previous year. Real exchange rate of China begins from the year of 1995 considering the unification of its dual exchange rates in early 1994.
Source: Calculated by the author according to the data from IMF International Financial Statistics.

Table 5. Correlation Matrix of Structural Shocks across East Asian Economies during 1980Q1-1997Q2

	CHN	JPN	KOR	HKG	TWN	IND	MLY	PHI	SGP	THA
Panel A: External Shocks										
CHN	1									
JPN	0.716***	1								
KOR	0.687***	0.810***	1							
HKG	0.668***	0.744***	0.716***	1						
TWN	0.576***	0.695***	0.762***	0.714***	1					
IND	0.822***	0.778***	0.723***	0.753***	0.707***	1				
MLY	0.879***	0.839***	0.780***	0.683***	0.750***	0.806***	1			
PHI	0.815***	0.922***	0.837***	0.741***	0.771***	0.786***	0.866***	1		
SGP	0.902***	0.817***	0.727***	0.744***	0.691***	0.782***	0.820***	0.886***	1	
THA	0.610***	0.768***	0.707***	0.722***	0.691***	0.750***	0.730***	0.746***	0.675***	1
Panel B: Supply Shocks										
CHN	1									
JPN	-0.515	1								
KOR	-0.133	-0.083	1							
HKG	0.225	-0.088	0.272**	1						
TWN	-0.191	-0.126	0.084	0.244*	1					
IND	-0.018	-0.041	0.017	0.102	0.039	1				
MLY	0.111	-0.114	-0.114	0.005	0.011	0.259**	1			
PHI	-0.400	0.128	-0.018	0.015	-0.079	0.182	-0.126	1		
SGP	0.055	0.102	-0.139	0.169	-0.201	0.17	0.242*	0.081	1	
THA	-0.035	-0.035	0.000	-0.133	0.123	0.126	0.151	0.030	-0.080	1
Panel C: Demand Shocks										
CHN	1									
JPN	-0.016	1								
KOR	0.161	-0.423	1							
HKG	0.307*	-0.279	0.523***	1						
TWN	0.240	-0.304	0.566***	0.493***	1					
IND	-0.286	-0.173	0.187	0.134	-0.058	1				
MLY	0.251	-0.294	0.288**	0.219*	0.240*	-0.007	1			
PHI	-0.137	-0.359	0.568***	0.390***	0.298**	0.117	0.366***	1		
SGP	0.083	-0.488	0.267*	0.350**	0.515***	0.151	0.401***	0.322**	1	
THA	-0.111	-0.133	0.339***	0.090	0.210*	0.276**	0.046	0.181	0.008	1
Panel D: Monetary Shocks										
CHN	1									
JPN	-0.125	1								
KOR	0.161	-0.037	1							
HKG	0.258	0.287**	0.352***	1						
TWN	-0.159	0.164	0.044	0.358***	1					
IND	0.156	-0.118	0.202	-0.092	-0.081	1				
MLY	0.367**	-0.031	0.359***	0.13	-0.057	0.176	1			
PHI	0.043	0.009	0.103	-0.034	0.023	0.042	0.081	1		
SGP	0.210	0.308**	0.067	0.156	-0.026	-0.024	0.143	-0.055	1	
THA	-0.138	0.239*	-0.103	0.310**	0.200	-0.356	-0.060	-0.055	0.181	1

Source: The author's estimation by SPSS 16.0.

Table 6. Correlation Matrix of Structural Shocks across East Asian Economies during 1980Q1-2007Q2

	CHN	JPN	KOR	HKG	TWN	IND	MLY	PHI	SGP	THA
Panel A: External Shocks										
CHN	1									
JPN	0.894***	1								
KOR	0.874***	0.909***	1							
HKG	0.881***	0.891***	0.835***	1						
TWN	0.818***	0.858***	0.889***	0.875***	1					
IND	0.894***	0.887***	0.863***	0.871***	0.837***	1				
MLY	0.932***	0.936***	0.924***	0.884***	0.866***	0.923***	1			
PHI	0.894***	0.949***	0.909***	0.892***	0.866***	0.875***	0.929***	1		
SGP	0.937***	0.907***	0.862***	0.865***	0.825***	0.889***	0.931***	0.893***	1	
THA	0.818***	0.859***	0.843***	0.842***	0.850***	0.878***	0.870***	0.839***	0.796***	1
Panel B: Supply Shocks										
CHN	1									
JPN	-0.210	1								
KOR	-0.055	0.229**	1							
HKG	0.294***	0.122	0.308***	1						
TWN	-0.064	0.119	0.107	0.289***	1					
IND	0.035	0.150	0.461***	0.273***	0.087	1				
MLY	0.057	0.035	0.346***	0.036	0.128	0.256***	1			
PHI	-0.180	0.099	0.118	0.013	0.012	0.035	0.032	1		
SGP	0.158	0.178*	0.195*	0.310***	0.305***	0.281***	0.349***	-0.002	1	
THA	0.055	0.044	0.274***	0.037	0.057	0.367***	0.263***	-0.019	0.125	1
Panel C: Demand Shocks										
CHN	1									
JPN	-0.125	1								
KOR	0.097	-0.314	1							
HKG	0.254**	-0.263	0.293***	1						
TWN	0.198*	-0.288	0.513***	0.257***	1					
IND	-0.231	-0.144	0.287***	0.036	0.066	1				
MLY	0.209*	-0.242	0.249***	0.171*	0.300***	0.182*	1			
PHI	-0.101	-0.321	0.483***	0.318***	0.276***	0.246**	0.342***	1		
SGP	0.036	-0.353	0.244**	0.245**	0.416***	0.191*	0.282***	0.240**	1	
THA	-0.08	-0.212	0.212**	0.029	0.243**	0.187*	0.162*	0.303***	0.041	1
Panel D: Monetary Shocks										
CHN	1									
JPN	-0.154	1								
KOR	0.070	0.016	1							
HKG	-0.05	0.028	0.077	1						
TWN	-0.125	0.137	0.056	0.074	1					
IND	-0.051	-0.077	0.137	-0.106	0.061	1				
MLY	0.230**	-0.004	0.323***	-0.040	-0.108	0.233**	1			
PHI	0.047	-0.075	0.013	0.114	-0.026	-0.044	0.070	1		
SGP	0.151	0.224**	0.045	0.041	0.030	-0.135	0.192*	0.166	1	
THA	-0.007	0.272***	0.053	0.061	0.289***	-0.112	-0.003	0.002	0.317***	1

Source: The author's estimation by SPSS 16.

Table 7. Correlation Matrix of Structural Shocks across East Asian Economies during 1980Q1-2010Q4

	CHN	JPN	KOR	HKG	TWN	IND	MLY	PHI	SGP	THA
Panel A: External Shocks										
CHN	1									
JPN	0.880***	1								
KOR	0.918***	0.925***	1							
HKG	0.914***	0.889***	0.879***	1						
TWN	0.825***	0.843***	0.904***	0.847***	1					
IND	0.919***	0.879***	0.885***	0.884***	0.828***	1				
MLY	0.895***	0.894***	0.907***	0.854***	0.834***	0.890***	1			
PHI	0.930***	0.928***	0.923***	0.905***	0.859***	0.900***	0.918***	1		
SGP	0.771***	0.723***	0.711***	0.658***	0.647***	0.727***	0.745***	0.722***	1	
THA	0.875***	0.874***	0.874***	0.865***	0.844***	0.885***	0.877***	0.883***	0.687***	1
Panel B: Supply Shocks										
CHN	1									
JPN	-0.121	1								
KOR	0.008	0.299***	1							
HKG	0.322***	0.278***	0.332***	1						
TWN	-0.046	0.252***	0.202**	0.344***	1					
IND	0.06	0.105	0.428***	0.237***	0.021	1				
MLY	0.109	0.180**	0.420***	0.159*	0.184**	0.254***	1			
PHI	-0.136	0.046	0.102	0.015	-0.028	0.025	0.041	1		
SGP	0.129	0.284***	0.121	0.313***	0.111	0.193*	0.373***	-0.025	1	
THA	0.082	0.053	0.267**	0.036	0.081	0.307***	0.256***	-0.015	0.107	1
Panel C: Demand Shocks										
CHN	1									
JPN	-0.073	1								
KOR	0.091	-0.342	1							
HKG	0.272***	-0.239	0.269***	1						
TWN	0.199*	-0.262	0.454***	0.297***	1					
IND	-0.239	-0.125	0.295***	-0.005	0.038	1				
MLY	0.173*	-0.220	0.306***	0.116	0.293***	0.185**	1			
PHI	-0.095	-0.346	0.466***	0.291***	0.300***	0.253***	0.397***	1		
SGP	0.053	-0.325	0.178*	0.245**	0.401***	0.193*	0.300***	0.315***	1	
THA	-0.090	-0.163	0.162*	-0.006	0.237**	0.193**	0.202**	0.314***	0.055	1
Panel D: Monetary Shocks										
CHN	1									
JPN	-0.182	1								
KOR	0.062	0.102	1							
HKG	-0.051	0.077	0.081	1						
TWN	-0.131	0.217**	0.044	0.097	1					
IND	-0.044	-0.038	0.149*	-0.083	0.111	1				
MLY	0.158	0.204**	0.328***	0.041	0.110	0.324***	1			
PHI	0.042	-0.006	0.061	0.083	0.031	0.023	0.183**	1		
SGP	0.053	0.273***	0.062	0.080	0.151	-0.013	0.318***	0.164*	1	
THA	0.041	0.312***	0.158*	0.131	0.245***	0	0.221**	0.036	0.146	1

Source: the author's estimation by SPSS 16.0.

Table 8. Size of Disturbances and Adjustment Speed to Disturbances in East Asian Economies

	External Shocks		Supply Shocks		Demand Shocks		Nominal Shocks	
	Size	Speed	Size	Speed	Size	Speed	Size	Speed
Panel A: 1980Q1-2010Q4								
China	0.0007	0.8095	0.0007	1.0312	0.0149	1.2082	0.0082	1.1670
Hong Kong	0.0008	0.7392	0.0010	0.9866	0.0091	1.0044	0.0071	0.6557
Indonesia	0.0008	0.7613	0.0012	1.1295	0.0431	1.0930	0.0069	1.1345
Japan	0.0007	0.8869	0.0008	0.9079	0.0163	0.9761	0.0022	0.8040
Korea	0.0006	0.9021	0.0011	1.0053	0.0160	0.9959	0.0043	0.8068
Malaysia	0.0006	0.8922	0.0012	0.9171	0.0099	0.9045	0.0027	0.9919
Philippines	0.0007	0.8947	0.0012	0.8944	0.0141	1.0460	0.0094	0.6846
Singapore	0.0005	0.9154	0.0015	1.2988	0.0043	0.9654	0.0016	1.0905
Taiwan	0.0008	0.7497	0.0010	1.0099	0.0082	1.0381	0.0016	0.9118
Thailand	0.0008	0.7182	0.0014	0.9644	0.0270	1.0080	0.0030	1.0405
Average	0.0007	0.8269	0.0011	1.0145	0.0163	1.0240	0.0047	0.9287
Panel B: 1980Q1-2007Q2								
China	0.0004	0.9117	0.0008	0.9896	0.0159	1.1988	0.0087	1.2391
Hong Kong	0.0007	0.7848	0.0010	1.0079	0.0095	0.9868	0.0074	0.6233
Indonesia	0.0006	0.8006	0.0013	1.1518	0.0459	1.1135	0.0070	1.1435
Japan	0.0005	0.9301	0.0007	0.8321	0.0151	1.0290	0.0022	0.6684
Korea	0.0005	0.9131	0.0011	0.9824	0.0164	0.9778	0.0043	0.7719
Malaysia	0.0005	0.9249	0.0012	0.8572	0.0104	0.9630	0.0026	0.6618
Philippines	0.0006	0.8992	0.0011	0.9660	0.0145	1.1300	0.0098	0.6551
Singapore	0.0004	0.8610	0.0013	1.1171	0.0043	1.0568	0.0011	0.9595
Taiwan	0.0007	0.7674	0.0007	1.0042	0.0085	1.0277	0.0027	0.9200
Thailand	0.0007	0.7631	0.0014	0.9101	0.0285	1.0015	0.0028	0.9490
Average	0.0006	0.8556	0.0011	0.9818	0.0169	1.0485	0.0049	0.8592
Panel C: 1980Q1-1997Q2								
China	0.0005	0.9044	0.0011	0.9694	0.0225	1.3266	0.0114	1.5387
Hong Kong	0.0007	0.7447	0.0011	0.9407	0.0097	1.0462	0.0029	0.6183
Indonesia	0.0008	0.7850	0.0007	1.0973	0.0464	0.9772	0.0039	0.9539
Japan	0.0006	0.9434	0.0006	0.9051	0.0157	1.0395	0.0026	0.7152
Korea	0.0005	0.9184	0.0008	0.9842	0.0114	0.9944	0.0045	0.7299
Malaysia	0.0006	0.9169	0.0010	0.9058	0.0072	1.0040	0.0029	0.7800
Philippines	0.0007	0.9468	0.0013	1.0043	0.0147	1.2111	0.0110	0.7483
Singapore	0.0005	0.7623	0.0013	0.8952	0.0059	0.8719	0.0010	0.7318
Taiwan	0.0008	0.7017	0.0007	0.9229	0.0099	1.0337	0.0028	0.7990
Thailand	0.0008	0.7508	0.0009	0.9938	0.0381	1.0684	0.0022	0.8458
Average	0.0007	0.8375	0.0009	0.9619	0.0181	1.0573	0.0045	0.8461

Source: The author's estimation by Eviews 6.0