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Abstract

This paper examines the viability of regional monetary integration in East Asia by focusing on the symmetry of shocks, which is one of the preconditions for forming an optimum currency area (OCA). We extend the conventional 2-variable structural VAR model by incorporating foreign (namely, US) variables, as well as real effective exchange rates to capture country-specific shocks in estimation. We also obtain similar estimates for European countries to check for robustness. Impulse response function analysis is conducted to measure the size of shocks and the speed of adjustment to shocks. The empirical results reveal that it is less feasible for East Asian economies to form an OCA than is suggested in previous studies, especially as only small sub-groups are potential candidates for a currency arrangement.

JEL Classification: F31, F33, F36, F41

Keywords: Optimum currency area, monetary integration, structural vector autoregression, East Asia

1. INTRODUCTION

There has been a long debate regarding a possible regional monetary arrangement in East Asia.[1] With the recent outbreak of the Asian financial crisis and the onset of the euro in Europe, renewed attention has been given to potential monetary integration in East Asia. However, there have been few of studies regarding the viability of an optimum currency area (OCA) in East Asia.[2] Among them, Bayoumi and Eichengreen (1994) first applied the structural vector autoregression (VAR) method developed by Blanchard and Quah (1989) to an analysis of OCA in East Asia. Recently Bayoumi, Eichengreen and Mauro (2000) and Yuen (2001) extended Bayoumi and Eichengreen's (1994) approach using a longer sample period. However, these studies have typically employed a 2-variable VAR model including output and prices, and their results have been mixed.

This paper reexamines the viability of regional monetary integration in East Asia by focusing on the symmetry of structural shocks as one of the preconditions for forming an OCA. In particular, we attempt to extend the conventional structural VAR approach first by employing a 3-variable VAR model of output, real effective exchange rates and money supply to identify supply and exchange rate shocks which are conditional on money supply growth in the East Asian region. We then, estimate a 5-variable VAR by including foreign (namely, US) variables to accommodate the effect of foreign shocks in identifying country-specific shocks. Impulse response function analysis is also

[1] East Asia is defined as the following 10 economies: China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand, although China and the Philippines are not considered in this paper owing to data problems.

[2] For a useful survey of the OCA literature, see Kawai (1987), Tavlas (1993) and De Grauwe (2000).

conducted to measure the size of the underlying shocks and the speed of adjustment to disturbances. We also apply this model to European countries to check for robustness of the empirical results.

The remainder of this paper is organized as follows. In section 2, we discuss the theoretical framework and methodology employed in the paper. Section 3 describes data issue. Section 4 presents the regression model designed to test the underlying structural shocks and adjustments to shocks. Section 5 gives some concluding comments.

2. ANALYTICAL FRAMEWORK

Most existing studies in the OCA literature have employed a 2-variable VAR model incorporating output and prices to identify the fundamental supply and demand shocks (e.g., Bayoumi and Eichengreen, 1993, 1994, and Bayoumi, Eichengreen and Mauro, 2000). However, as pointed out by Demertzis, Hallett and Rummel (2000), this type of model does not necessarily identify purely stochastic shocks because estimated demand shocks tend to include the effect of macroeconomic policies, whereas estimated supply shocks are less likely to include the impact of the implemented policies.[3] [4] Furthermore, the estimated structural shocks in the existing studies tend to include the

[3] Demertzis, Hallett and Rummel (2000) examined whether the symmetry of structural shocks for European countries is policy induced by performing a correlation analysis between the identified shocks and policy variables.

[4] Supply shocks are typically considered more informative for evaluating the symmetry of shocks, and hence the feasibility of OCAs than other shocks (Bayoumi and Eichengreen, 1993, 1994 and Bayoumi, Eichengreen and Mauro, 2000).

effect of foreign shocks in the open-economy framework, which may result in an inaccurate evaluation of the underlying shocks.[5]

Recently a few studies have attempted to identify monetary, supply and demand shocks (see, for instance, Demertzis, Hallett and Rummel, 2000; Shioji, 2000; Fielding and Shields, 2001; and Zhang, Sato and McAleer, 2002). After removing the effect of monetary shocks, Shioji (2000) compared the shock correlations between the US and EU regions as the USA may exhibit a higher degree of correlation in supply and demand shocks than the EU region. In this paper, we construct a 3-variable VAR model that includes the money supply variable to identify underlying shocks that are not the result of innovations in monetary policy. We include in the model the real effective exchange rate variable instead of domestic prices as the former is more appropriate in the open-economy framework to capture changes in the relative price of domestic and foreign countries.[6] We then extend the model to a 5-variable VAR by including foreign output and price variables. Although the conventional 2-variable VAR estimation detects a high degree of correlation in certain shocks, it is unclear whether the result simply reflects the correlation of local shocks or may be affected by foreign shocks. This is likely to happen for the East Asian economies given their close economic ties with the USA. Following

[5] Kawai and Okumura (1996) focus on this issue and remove the effect of global shocks in calculating the correlation of underlying shocks. Chow and Kim (2000) propose an alternative approach of structural VAR analysis to identify global, regional and country-specific shocks. Ogawa and Kawasaki (2002) employ a Generalized Purchasing Power Parity model to analyze the possibility of creating a common currency basket in East Asia.

[6] Demertzis, Hallett and Rummel (2000) and Zhang, Sato and McAleer (2002) incorporate the real exchange rate variable into the model for their structural VAR analysis of EU countries and East Asian economies, respectively.

Fielding and Shields (2001), we include US output and price variables in the model to identify the country-specific supply and demand shocks.[7]

2.1 Baseline Case: 3-Variable Model

Consider the following 3-variable model (Model 1):

$$\Delta x_t = A_0 \varepsilon_t + A_1 \varepsilon_{t-1} + A_2 \varepsilon_{t-2} + \cdots = A(L)\varepsilon_t , \qquad (1)$$

where $\Delta x_t = \begin{bmatrix} \Delta y_t \\ \Delta q_t \\ \Delta m_t \end{bmatrix}$, $A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix}$, $\varepsilon_t = \begin{bmatrix} \varepsilon_{st} \\ \varepsilon_{qt} \\ \varepsilon_{mt} \end{bmatrix}$.

$A_{ij}(L) = a_{ij}^0 + a_{ij}^1 L + a_{ij}^2 L + \cdots$, is a polynomial function of the lag operator, L. The variables are the first-difference of the log of output (Δy), real effective exchange rate (Δq) and money supply (Δm) that are subject to the fundamental structural shocks, namely supply, exchange rate and monetary shocks ($\varepsilon_s, \varepsilon_q$ and ε_m). We assume that the structural shocks are serially uncorrelated and have a covariance matrix normalized to the identity matrix.

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[7] Fielding and Shields (2001) examine whether the African CFA Franc Zone meets the OCA criteria by identifying and comparing structural shocks among the member countries. They incorporate French price variable in the VAR model for each member country to accommodate foreign price shocks, even though France is not itself part of the CFA Franc Zone.

In order to identify the structural A_i matrices, we follow the method developed by Blanchard and Quah (1989). We impose the following long-run restrictions based on standard macroeconomic theory: (i) only supply shocks affect output in the long-run; (ii) both supply and exchange rate shocks influence real effective exchange rates in the long-run; and (iii) monetary shocks have no long-run effect on either output or real effective exchange rates. Thus, the restrictions require $A_{12}(1) = A_{13}(1) = A_{23}(1) = 0$ which are sufficient to identify the structural A_i matrices and the time series of structural shocks.

We estimate a reduced-form VAR as:

$$\Delta x_t = B(L)\Delta x_{t-1} + u_t , \qquad (2)$$

where u_t is a vector reduced form disturbance and $B(L)$ is a 3×3 matrix of lag polynomials. An MA representation of equation (2) is given as:

$$\Delta x_t = C(L)u_t , \qquad (3)$$

where $C(L) = (1 - B(L)L)^{-1}$ and the lead matrix of $C(L)$ is, by construction, $C_0 = I$. By comparing equations (1) and (3), we obtain the relationship between the structural and reduced form disturbances: $u_t = A_0\varepsilon_t$. As the shocks are mutually orthogonal and each shock has unit variance, $C(1)\Sigma C(1)' = A(1)A(1)'$ where $\Sigma = Eu_t u_t' = EA_0\varepsilon_t\varepsilon_t' A_0' = A_0 A_0'$. Letting H denote the lower triangular Choleski decomposition of $C(1)\Sigma C(1)'$, we obtain $A(1) = H$ since our long-run restrictions imply that $A(1)$ is also lower triangular.

Consequently, we obtain $A_0 = C(1)^{-1} A(1) = C(1)^{-1} H$. Given an estimate of A_0, we can recover the time series of structural shocks.

It should be noted that in estimating a reduced-form VAR for each country, the estimated reduced form disturbances (u_t) may be correlated across countries. In order to accommodate possible cross-country residual correlations, we employ the seemingly unrelated regression (SUR) method in estimation as SUR is asymptotically more efficient than OLS.[8] We first stack the Δy (Δq and Δm) equations for each country and estimate them using SUR. Then we construct a matrix of the reduced form residuals for each country using the estimates and impose the above long-run restrictions to recover the associated structural disturbances.

2.2 Extension: 5-Variable Model

We next consider the 5-variable model with two foreign variables (Model 2):

$$\Delta x_t = A(L)\varepsilon_t ,$$

where $$\Delta x_t = \begin{bmatrix} \Delta y_t^* \\ \Delta p_t^* \\ \Delta y_t \\ \Delta p_t \\ \Delta m_t \end{bmatrix}, \; A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) & A_{15}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & A_{25}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & A_{35}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & A_{45}(L) \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) \end{bmatrix}, \; \varepsilon_t = \begin{bmatrix} \varepsilon_{st}^* \\ \varepsilon_{dt}^* \\ \varepsilon_{st} \\ \varepsilon_{dt} \\ \varepsilon_{mt} \end{bmatrix}.$$

8 Fielding and Shields (2001) apply a similar approach.

Δy^* and Δp^* denote the changes in the log of foreign output and prices, respectively. For domestic variables, we use the first-difference of the log of price (Δp) instead of real effective exchange rates (Δq) in the 5-variable model. By including foreign variables in the model, we are able to identify supply and demand shocks conditional on foreign output and price shocks as well as domestic monetary policy.[9] We assume that domestic shocks have no impact on foreign variables in the long run, while foreign shocks have a long run effect on domestic variables. Hence, we impose the following long run restrictions: $A_{13}(1) = A_{14}(1) = A_{15}(1) = A_{23}(1) = A_{24}(1) = A_{25}(1) = 0$.

Furthermore, we assume that shocks to foreign price will have no long run impact on foreign output ($A_{12}(1) = 0$), such that, $A_{34}(1) = A_{35}(1) = A_{45}(1) = 0$. Thus, the $A(1)$ matrix is lower triangular and these long run restrictions are sufficient to identify the time series of structural shocks.[10]

Again, we apply the SUR method to estimate the Δy, Δp and Δm equations, respectively. For the foreign output (Δy^*) and price (Δp^*) equations, we estimate a 2-variable VAR with a lag order of one, following Fielding and Shields (2001). We finally construct the matrix of reduced form residuals for each country using the estimates obtained above, and impose the long run restrictions to identify the structural shocks.

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[9] Fielding and Shields (2001) conduct a similar analysis by incorporating the foreign price variable in the model with $\Delta x = \left[\Delta p^*, \Delta p, \Delta y, \Delta m\right]'$, although the order of variables differs from the model considered here. They make a different assumption from previous studies in that shocks to inflation have a long run impact on output but shocks to output have no impact on inflation.

[10] Within a different setting, Fielding and Shields (2001) model the foreign price inflation equation as an autoregressive process. A lag order of one is chosen based on SBIC in the empirical analysis presented here.

3. DATA

We use real GDP, consumer price index (CPI) and narrow money (M1)[11] as proxies for real output, price and money supply, respectively. Real effective exchange rates are based on relative CPI. All data are quarterly, expressed in natural logarithms and seasonally adjusted, except for exchange rates.[12] The sample period covers 1981Q1-1996Q4 for the East Asian economies and the USA, and 1980Q1-1997Q4 for the European countries.[13]

The major data sources are IMF, *International Financial Statistics*, CD-ROM, the websites of the statistics authorities in the USA, Japan, Korea, Taiwan and Hong Kong, the NUS ESU databank[14], and the ICSEAD database (see the Data Appendix for details).

4. EMPIRICAL RESULTS

We investigated the stationarity of variables using the augmented Dickey-Fuller (ADF) test and the Kwiatkowski et al. (1992) (KPSS) test. Based on the results of both

[11] For some European countries, consistent series of M1 are not available and other money supply data are used instead: the sum of Currency in Circulation and Demand Deposits is used for Finland, Italy and the Netherlands, M2 is used for Norway and Sweden, and M0 (the wider monetary base) is used for the UK.

[12] We use *EViews 4.1* for the empirical analysis. Seasonality is adjusted using Census X-11 (multiplicative).

[13] The post-crisis period is not included in the sample for East Asia to avoid structural breaks in the series, whereas a longer sample period is preferable for the time series analysis. In a later section, we report the estimated results for a longer sample period. For the European countries, we chose the sample that ends in 1998Q4, namely before the start of the euro. Due to a lack of 1998 data for some countries, the sample period is from 1980Q1-1997Q4.

[14] We are grateful to Tilak Abeysinghe for providing us with the real GDP series for some East Asian economies.

unit root tests, we obtained the first-differences of all variables to ensure stationarity (the results of the unit root tests are available upon request). In the empirical estimation, the equations have been estimated with one lag on the basis of SBIC. We present the results of cross-country correlations in supply, exchange rate and demand shocks in the following sub-sections. If the correlations of the structural shocks are positive, the shocks are considered to be symmetric, and if negative and/or insignificant, they are considered asymmetric.

4.1 Cross-Country Correlation in Shocks

The results of cross-country correlations in supply and exchange rate shocks among the East Asian economies are reported in Table 1.[15] It is found that supply shocks are correlated significantly only among a few ASEAN economies (Singapore, Malaysia and Indonesia) and Asian NIEs (Korea, Taiwan and Hong Kong). For the rest of the East Asian economies, asymmetric shocks seem to prevail (Panel A of Table 1). The East Asian economies have no significant correlations in supply shocks with Japan or the USA. This finding contrasts with previous studies which have found significant positive correlations in supply shocks between Japan and Asian NIEs. Moreover, the supply shocks are far less symmetric in East Asia than in Europe, where the supply shocks are

[15] We assess the significance levels of correlation coefficients using Fisher's variance-stabilizing transformation of *r*, $z = (1/2)\ln[(1+r)/(1-r)]$, which has a distribution that approaches normality much faster than that of *r*, where *r* denotes the estimated correlation coefficient. Asymptotically, the mean of *z* is zero and the standard deviation is approximately $(n-3)^{-1/2}$, under the null hypothesis that the correlation coefficient is zero, where *n* denotes the sample size (see Rodriguez (1982)).

significantly correlated among France, Italy, UK, Sweden and Finland (Panel A of Table 2).[16]

[Insert Table 1 about here]

Panel B of Table 1 shows a very different pattern of correlations in exchange rate shocks across the East Asian region as compared with supply shocks. There are significant positive correlations of exchange rate shocks between the USA and all the East Asian economies, with the exception of Japan, but the shocks are negatively correlated between Japan and the other East Asian economies. The result reflects the *de facto* pegging of the exchange rates of most East Asian economies, at least well before the financial crisis, to the US dollar, implying the effect of economic policies on the estimated shocks.

[Insert Table 2 about here]

Table 2 presents the correlations of structural shocks in the European countries. As seen in Panel B of Table 2, the exchange rate shocks are correlated significantly within the sub-group of countries: the first includes Germany, the Netherlands,

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[16] It is noteworthy that Germany, which is typically considered as the leading regional country, has significant correlations in supply shocks only with France and Italy (Panel A of Table 2). With a different setting and data source, Bayoumi and Eichengreen (1994, Table 5) have found that Germany's supply shocks are significantly correlated with those of France, the Netherlands, Belgium, Denmark, Austria and Switzerland. Demertzis, Hallett and Rummel (2000, Table 2) have also shown that significant correlations of supply shocks with Germany are observed in France, Belgium, Denmark, Luxembourg, the Netherlands, UK, Sweden and Italy.

Switzerland and France, and the other consists of Italy, UK, Sweden, Finland and Norway. These significant correlations appear to reflect the close coordination of their macroeconomic policy, as well as their exchange rate policy. In contrast to the finding that Japan has no significant correlations in both supply and exchange rate shocks with other East Asian countries, Germany is found to be significantly correlated with several European countries.

4.2 Correlation after Removing the Effect of Foreign Shocks

In order to reflect the impacts of foreign output and price shocks and to identify country-specific demand shocks, we incorporate two foreign variables, namely US output and prices, in estimating the 5-variable model. The estimates for East Asia are reported in Table 3.[17]

[Insert Table 3 about here]

According to Panel A of Table 3, the number of significant correlation in supply shocks improves slightly among the East Asian economies, whereas Japan still exhibits no significant correlations with the rest of East Asia.[18] In contrast, Panel B of Table 3

[17] The 5-variable model does not necessarily capture the effect of the exchange rate policy. In order to accommodate the effect of exchange rates, we estimated another 5-variable model including the US price multiplied by the exchange rates vis-à-vis the US dollar. The results are available upon request.

[18] In estimating Model 2, we assume that the East Asian economies are small open economies and are affected substantially by the US economy. However, this assumption is not necessarily applicable to Japan.

shows a different pattern of cross-country correlations in demand shocks from the exchange rate shocks. By accommodating the effects of US output and price shocks, the degree of symmetry in demand shocks declines considerably among the East Asian economies in comparison with the correlation pattern of exchange rate shocks (see Panel B of Table 1).[19] In particular, the number of significant correlations in demand shocks with other economies has decreased for Korea and Taiwan, but improved for Singapore. Again, Japan still shows no significant correlations in demand shocks with other East Asian economies, even after including the US variables in the model.

[Insert Table 4 about here]

Table 4 reports the results of estimating the 5-variable model for the European countries with the USA being the source of foreign shocks. As shown in Panel A of Table 4, the correlation pattern of supply shocks is very similar to that of Table 2, implying that symmetric supply shocks prevail in Europe. Panel B indicates that the correlation of demand shocks deteriorates somewhat in the 5-variable model compared with the correlation pattern of exchange rate shocks in the 3-variable model, but the number of significant correlations is still greater than in East Asia.

We also estimated Model 2 by including the post-financial crisis period (the results for 1981Q1-2001Q3 are reported in Table A1). The results show that, by

[19] In estimating a 3-variable model that includes domestic output, price and money supply, the correlation pattern of estimated demand shocks differs markedly from the 5-variable model which includes US output and price variables. Thus, demand shocks are correlated significantly among the USA, Japan and other East Asian economies, except for Taiwan and Indonesia in the above 3-variable model.

including the post-crisis period, the degree of correlation in supply shocks improves substantially across the East Asian economies, and the demand shocks became significantly correlated among the most heavily affected economies. In addition, Japan has substantially improved the degree of correlation in supply shocks, indicating a significant correlation with Korea and Malaysia. However, the inclusion of post-crisis period observations in estimation may cause structural breaks in the series, and hence may significantly affect the estimates.

4.3 The Size of Shocks and the Speed of Adjustment

Now we examine the other conditions associated with the OCA, namely (1) the size of shocks and (2) the speed of adjustment to shocks. Asymmetric shocks would not have significant impacts on an economy if the size of shocks were much smaller and if an economy responded more quickly to shocks. As the estimated shocks are assumed to have unit variances in the structural VAR method, their size and adjustment speed can be inferred by examining the associated impulse response functions (see Bayoumi and Eichengreen, 1994; Bayoumi, Eichengreen and Mauro, 2000). We conduct an impulse response function analysis to determine the size of the underlying shocks and the speed of adjustment to shocks, both for the East Asian and European regions. We use the long run impacts of a unit shock on changes in real GDP, real effective exchange rate and CPI, respectively, as measures of the size of supply, exchange rate and demand shocks. The speed of adjustment in each case is measured by the response after 4 quarters as a share of the long run effect.[20]

[Insert Table 5 about here]

Table 5 reports the estimated results of the impulse response function analysis. It is interesting to note that the size of shocks and the adjustment speed to shocks are very different between East Asia and Europe. On average, the sizes of supply shocks and exchange rate shocks in Europe are smaller than in East Asia, but the size of demand shocks in Europe is larger than in East Asia. Nevertheless, the speed of adjustment to shocks is much faster in East Asia than in Europe, with the exception of adjustment to exchange rate shocks.[21] A possible explanation for this result is that the labour market and wage rates in most East Asian economies are relatively more flexible, so that it is easier for these economies to make internal adjustments to shocks.

5. CONCLUDING REMARKS

In this paper we have applied two structural VAR models with three and five variables, respectively, to examine the symmetric nature of fundamental shocks in East Asian economies according to the criteria of the optimum currency area literature. The

[20] Whereas our choice of time horizon for calculating the size and the adjustment speed is somewhat arbitrary, choosing other horizons will not change the conclusion appreciably.

[21] In Table 5, the speed of adjustment to supply shocks in Spain is exceptionally low in Europe. Even if Spain were excluded, the average adjustment speed to supply shocks is still slower in Europe than in East Asia.

results show that it is less suitable for the whole East Asian region to form an OCA than has been suggested in previous studies, as the identified underlying shocks (supply and demand shocks) are significantly correlated only among a few ASEAN economies and Asian NIEs. This conclusion is assured when we compare the correlation patterns of the underlying shocks with those of the European countries. The results also show that Japan has no significant correlations in supply, exchange rate and demand shocks with other East Asian economies, which is in contrast with the case of Germany in the European region.

The impulse response function analysis concludes that, although the underlying structural shocks are less symmetric and the average size of the shocks is larger, the speed of adjustment to shocks in East Asia is much faster than in the EU region. On average, it takes less than one year to complete the adjustment to shocks. This is largely due to the fact that the labour market and wage rates in most East Asian economies are relatively more flexible, so that it is easier for the economies to make an internal adjustment in response to shocks.

Although the results do not suggest an OCA in the entire East Asian region, they do imply that some sub-groups of the economies, such as some Asian NIEs and ASEAN economies, are more appropriate candidates as their underlying shocks are correlated and symmetric, and the speed of their adjustment to shocks is faster. Moreover, besides the symmetry of underlying shocks, theory also suggests the importance of other factors such as the intensity of intra-regional trade, flexibility of factor markets, and macroeconomic policy coordination, in determining the process of monetary integration. Further research on these issues will provide evidence regarding the viability of regional monetary integration in East Asia.

DATA APPENDIX

Real GDP series for the East Asian economies are obtained primarily from the NUS ESU databank, the ICSEAD database and the private data sources. Japan's real GDP data are collected from the Economic and Social Research Institute, Cabinet Office, Government of Japan (http://www.esri.cao.go.jp/index.html), data for Korea from the web site of the Bank of Korea (http://www.bok.or.kr/index_e.html), and data for Taiwan from the Taiwan Economic Data Center. Real US GDP series are obtained from the web site of the Bureau of Economic Analysis, U.S. Department of Commerce (http://www.bea.doc.gov/bea/dn1.htm). Real GDP data for other countries are obtained from IMF, *International Financial Statistics, Monthly*, CD-ROM (IFS, henceforth).

Money supply data are obtained from IFS, the web site of the Hong Kong Monetary Authority (http://www.info.gov.hk/hkma/eng/statistics/index.htm), and the Taiwan Economic Data Center. Nominal exchange rate series are obtained from IFS and the Taiwan Economic Data Center. The consumer price index (CPI) series are obtained from IFS, *Hong Kong Monthly Digest of Statistics*, the web site of Hong Kong Monetary Authority (http://www.info.gov.hk/censtatd/eng/hkstat/fas/cpi/cpi_long_index.html), and National Statistics of Taiwan (http://www.stat.gov.tw/bs3/index/cpiidx.htm).

Real effective exchange rates (based on relative CPI) for the USA and the European countries are obtained from IFS. The data for the East Asian economies are calculated as a trade weighted geometric average of real exchange rates, with 29 major trading partners for each individual economy. Trade data are collected from Statistics Canada, *World Trade Analyzer*, CD-ROM and ICSEAD (2002).

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Table 1. Correlation of Structural Shocks between the USA and the East Asian Economies (Model 1)

	US	Jp	Kr	Tw	HK	Si	Ml	Id	Th
	Panel A: Supply Shocks (1981Q1-1996Q4)								
United States	1.00								
Japan	-0.05	1.00							
Korea	-0.05	0.04	1.00						
Taiwan	0.16	-0.07	0.32 *	1.00					
Hong Kong	0.00	0.00	0.12	0.50 *	1.00				
Singapore	0.03	-0.08	-0.02	0.10	0.17	1.00			
Malaysia	-0.03	0.04	-0.01	0.04	-0.03	0.33 *	1.00		
Indonesia	0.15	-0.08	-0.03	-0.01	-0.07	0.06	0.36 *	1.00	
Thailand	0.18	-0.25	0.12	-0.02	-0.05	0.15	0.19	0.15	1.00
	Panel B: Exchange Rate Shocks (1981Q1-1996Q4)								
United States	1.00								
Japan	-0.73	1.00							
Korea	0.68 **	-0.55	1.00						
Taiwan	0.61 *	-0.45	0.66 *	1.00					
Hong Kong	0.42 *	-0.30	0.30 *	0.34 *	1.00				
Singapore	0.33 *	-0.27	0.32 *	0.14	0.46 *	1.00			
Malaysia	0.55 *	-0.60	0.27	0.28	0.21	0.17	1.00		
Indonesia	0.30 *	-0.30	0.29 *	0.10	0.19	-0.14	0.16	1.00	
Thailand	0.42 *	-0.46	0.29 *	0.33 *	0.35 *	0.08	0.31 *	0.08	1.00

Notes:

1. Model 1: 3-variable model with $\Delta x = [\Delta y, \Delta q, \Delta m]'$.
2. Sample period is from 1981Q1 to 1996Q4.
3. Significance levels are assessed using the Fisher's variance-stabilizing transformation (see Rodriguez, 1982).
4. Painted figures denote correlation coefficients that are significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.209); * not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.288); ** significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.665).

Table 2. Correlation of Structural Shocks between the European Countries (Model 1)

	Ger	Net	Swi	Fra	Ita	UK	Swe	Fin	Nor	Spa	Por
					Panel A: Supply Shocks (1980Q1-1997Q4)						
Germany	1.00										
Netherlands	0.05	1.00									
Switzerland	-0.12	0.38 *	1.00								
France	0.22	0.14	0.27	1.00							
Italy	0.37 *	0.25	0.19	0.53 *	1.00						
United Kingdom	0.00	0.02	0.21	0.35 *	0.29	1.00					
Sweden	0.05	0.00	0.05	0.51 *	0.39 *	0.45 *	1.00				
Finland	-0.17	0.05	0.08	0.44 *	0.31 *	0.34 *	0.45 *	1.00			
Norway	0.07	0.25	0.19	0.24	0.21	0.01	0.20	0.14	1.00		
Spain	0.04	0.06	0.18	0.30	0.40 *	0.26	0.21	0.19	0.01	1.00	
Portugal	-0.01	0.04	0.23	0.36 *	0.22	0.19	0.07	0.03	-0.05	0.20	1.00
					Panel B: Exchange Rate Shocks (1980Q1-1997Q4)						
Germany	1.00										
Netherlands	0.87 **	1.00									
Switzerland	0.47 *	0.50 *	1.00								
France	0.54 *	0.48 *	0.30	1.00							
Italy	-0.14	-0.07	-0.10	-0.02	1.00						
United Kingdom	-0.29	-0.25	-0.18	-0.26	0.24	1.00					
Sweden	-0.33	-0.31	-0.13	-0.06	0.39 *	0.20	1.00				
Finland	-0.06	-0.02	0.10	-0.05	0.27	0.20	0.63 *	1.00			
Norway	0.19	0.14	0.11	0.34 *	0.12	0.26	0.20	0.34 *	1.00		
Spain	0.09	0.12	-0.06	-0.03	0.16	0.06	0.09	0.13	-0.01	1.00	
Portugal	0.10	-0.04	0.00	0.37 *	-0.06	-0.19	0.00	0.07	0.22	0.16	1.00

Notes:

1. Model 1: 3-variable model with $\Delta x = [\Delta y, \Delta q, \Delta m]'$.
2. Sample period is from 1980Q1 to 1997Q4.
3. Significance levels are assessed using the Fisher's variance-stabilizing transformation (see Rodriguez, 1982).
4. Painted figures denote correlation coefficients that are significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.197); * not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.302); ** significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.657).

Table 3. Correlation of Structural Shocks between the East Asian Economies (Model 2)

	Jp	Kr	Tw	HK	Si	Ml	Id	Th
	Panel A: Supply Shocks (1981Q1-1996Q4)							
Japan	1.00							
Korea	0.09	1.00						
Taiwan	-0.07	0.32 *	1.00					
Hong Kong	-0.01	0.13	0.50 *	1.00				
Singapore	-0.08	-0.01	0.08	0.22	1.00			
Malaysia	0.11	0.07	0.03	-0.07	0.30 *	1.00		
Indonesia	-0.17	-0.01	-0.05	-0.16	0.04	0.29 *	1.00	
Thailand	-0.18	0.10	-0.06	-0.06	0.14	0.22	0.18	1.00
	Panel B: Demand Shocks (1981Q1-1996Q4)							
Japan	1.00							
Korea	0.11	1.00						
Taiwan	-0.06	0.37 *	1.00					
Hong Kong	0.06	0.14	0.19	1.00				
Singapore	0.04	0.28	-0.14	0.32 *	1.00			
Malaysia	0.08	0.09	-0.08	0.23	0.45 *	1.00		
Indonesia	-0.06	-0.11	0.06	0.04	0.21	0.06	1.00	
Thailand	-0.10	0.08	-0.10	0.27	0.29 *	0.10	0.02	1.00

Notes:

1. Model 2: 5-variable model with $\Delta x = \left[\Delta y^*, \Delta p^*, \Delta y, \Delta p, \Delta m\right]'$.
2. Sample period is from 1981Q1 to 1996Q4.
3. Significance levels are assessed using the Fisher's variance-stabilizing transformation (see Rodriguez, 1982).
4. Painted figures denote correlation coefficients that are significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.209); * not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.288); ** significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.665).

Table 4. Correlation of Structural Shocks between the European Countries (Model 2)

	Ger	Net	Swi	Fra	Ita	UK	Swe	Fin	Nor	Spa	Por
	Panel A: Supply Shocks (1980Q1-1997Q4)										
Germany	1.00										
Netherlands	0.09	1.00									
Switzerland	-0.07	0.40 *	1.00								
France	0.21	0.17	0.21	1.00							
Italy	0.37 *	0.17	0.18	0.57 *	1.00						
United Kingdom	0.00	-0.08	0.20	0.35 *	0.23	1.00					
Sweden	0.02	-0.07	0.08	0.52 *	0.36 *	0.57 *	1.00				
Finland	-0.24	-0.02	0.08	0.45 *	0.28	0.40 *	0.46 *	1.00			
Norway	0.14	0.11	0.05	0.26	0.19	-0.02	0.19	0.07	1.00		
Spain	0.03	0.04	0.21	0.27	0.39 *	0.20	0.22	0.16	-0.05	1.00	
Portugal	0.01	0.03	0.22	0.39 *	0.26	0.07	0.12	0.12	-0.08	0.19	1.00
	Panel B: Demand Shocks (1980Q1-1997Q4)										
Germany	1.00										
Netherlands	0.45 *	1.00									
Switzerland	0.31 *	0.16	1.00								
France	0.14	0.00	-0.03	1.00							
Italy	0.08	0.17	0.23	-0.01	1.00						
United Kingdom	0.13	0.05	0.15	0.27	-0.06	1.00					
Sweden	0.04	-0.02	0.25	0.21	0.15	0.23	1.00				
Finland	-0.10	-0.07	-0.12	0.34 *	0.03	0.24	0.46 *	1.00			
Norway	-0.20	-0.17	0.04	0.09	0.15	-0.13	0.06	0.11	1.00		
Spain	0.01	-0.03	0.02	0.27	0.29	0.28	0.13	0.21	0.12	1.00	
Portugal	0.02	-0.03	0.18	0.45 *	0.09	0.38 *	0.34 *	0.27	0.18	0.57 *	1.00

Notes:

1. Model 2: 5-variable model with $\Delta x = \left[\Delta y^*, \Delta p^*, \Delta y, \Delta p, \Delta m\right]'$.
2. Sample period is from 1980Q1 to 1997Q4.
3. Significance levels are assessed using the Fisher's variance-stabilizing transformation (see Rodriguez, 1982).
4. Painted figures denote correlation coefficients that are significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.197); * not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.302); ** significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.657).

Table 5. The Size of Shocks and the Speed of Adjustment to Shocks across Different Economies

	Model 1				Model 2			
	Supply Shocks		*Exchange Rate Shocks*		*Supply Shocks*		*Demand Shocks*	
	Size	Speed	Size	Speed	Size	Speed	Size	Speed
Panel A: United States and the East Asian Economies (1981Q1-1996Q4)								
United States	0.010	0.987	0.043	0.995	n.a.	n.a.	n.a.	n.a.
Japan	0.008	0.995	0.066	0.989	0.008	1.001	0.003	1.012
Korea	0.011	0.995	0.037	0.994	0.011	0.990	0.008	0.999
Taiwan	0.010	1.003	0.036	1.005	0.010	0.993	0.012	0.986
Hong Kong	0.018	1.000	0.039	1.000	0.018	1.000	0.009	0.998
Singapore	0.017	0.998	0.027	0.987	0.016	0.999	0.006	1.000
Malaysia	0.015	0.990	0.032	0.976	0.015	1.002	0.006	1.002
Indonesia	0.009	1.001	0.073	0.995	0.009	1.000	0.012	0.998
Thailand	0.013	1.002	0.035	0.993	0.013	1.001	0.007	1.001
Average	0.013	0.998	0.043	0.992	0.012	0.998	0.008	0.999
Panel B: European Countries (1980Q1-1997Q4)								
Germany	0.014	0.995	0.021	0.988	0.015	0.999	0.005	0.992
Netherlands	0.007	1.000	0.018	1.000	0.006	1.001	0.006	0.958
Switzerland	0.008	1.006	0.027	1.008	0.007	0.994	0.005	1.000
France	0.006	0.999	0.018	0.994	0.007	0.976	0.013	0.647
Italy	0.006	1.000	0.034	0.988	0.005	1.005	0.013	0.724
United Kingdom	0.009	1.007	0.042	1.007	0.007	1.004	0.006	1.018
Sweden	0.011	0.984	0.046	0.986	0.010	0.967	0.010	0.988
Finland	0.015	0.984	0.031	0.978	0.013	1.003	0.013	0.733
Norway	0.010	0.999	0.020	0.986	0.009	0.970	0.015	0.746
Spain	0.010	0.655	0.024	1.001	0.009	0.693	0.011	0.940
Portugal	0.017	0.997	0.026	0.999	0.017	0.980	0.025	0.896
Average	0.010	0.966	0.028	0.994	0.010	0.963	0.011	0.877

Notes:

1. Model 1: 3-variable model with $\Delta x = [\Delta y, \Delta q, \Delta m]'$.
2. Model 2: 5-variable model with $\Delta x = [\Delta y^*, \Delta p^*, \Delta y, \Delta p, \Delta m]'$.
3. The size of supply, exchange rate and demand shocks is inferred from the associated impulse response functions that trace out the effects of a unit shock on changes in real GDP, real effective exchange rates and CPI, respectively, over a long time horizon.
4. The speed of adjustment is summarized by the response after 4 quarters as a share of the long run effect.
5. In Panel A, the average of 8 East Asian economies (including Japan) is reported.

Appendix Table A1. Correlation of Structural Shocks between the East Asian Economies for a Longer Sample Period (Model 2)

	Jp	Kr	Tw	HK	Si	Ml	Id	Th
	Panel A: Supply Shocks (1981Q1-2001Q3)							
Japan	1.00							
Korea	0.19	1.00						
Taiwan	0.16	0.36 *	1.00					
Hong Kong	0.11	0.31	0.48 *	1.00				
Singapore	0.05	0.19	0.34 *	0.30	1.00			
Malaysia	0.22	0.45 *	0.27	0.20	0.40 *	1.00		
Indonesia	0.11	0.59 *	0.18	0.14	0.21	0.50 *	1.00	
Thailand	0.00	0.40 *	0.01	0.15	0.21	0.31	0.46 *	1.00
	Panel B: Demand Shocks (1981Q1-2001Q3)							
Japan	1.00							
Korea	0.08	1.00						
Taiwan	0.08	0.36 *	1.00					
Hong Kong	-0.04	0.16	0.17	1.00				
Singapore	0.06	0.17	-0.17	0.11	1.00			
Malaysia	0.18	0.24	0.03	0.08	0.32 *	1.00		
Indonesia	-0.05	0.20	0.17	0.10	0.13	0.14	1.00	
Thailand	0.02	0.26	0.02	0.35 *	0.21	0.20	0.12	1.00

Notes:

1. Model 2: 5-variable model with $\Delta x = \left[\Delta y^*, \Delta p^*, \Delta y, \Delta p, \Delta m\right]'$.
2. Sample period is from 1981Q1 to 2001Q3.
3. Significance levels are assessed using the Fisher's variance-stabilizing transformation (see Rodriguez, 1982).
4. Painted figures denote correlation coefficients that are significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.183); * not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.317); ** significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.647).