Shocking Aspects of East Asian Monetary Integration: An Optimum Currency Area Approach

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Abstract: This paper examines the viability of regional monetary integration in East Asia by focusing on the symmetry of shocks, one of the preconditions for forming an optimum currency area (OCA). We extend the conventional 2-variable structural VAR model by incorporating foreign (specifically, US) variables, as well as real effective exchange rates to capture country-specific shocks in our estimation. We also provide similar estimates for European countries to test 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 the East Asian economies to form an OCA than suggested in previous studies, whereas only small sub-groups are potential candidates for a currency arrangement.

Keywords: Optimum currency area; structural VAR; correlated shocks; monetary integration; East Asia.

1. INTRODUCTION

There has been a long debate regarding a possible regional monetary arrangement in East Asia. With the recent outbreak of the Asian financial crisis and the introduction of the euro in Europe, renewed attention has been given to potential monetary integration in East Asia. There have been few studies regarding the viability of an optimum currency area (OCA) in East Asia. 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. More recently, Bayoumi, Eichengreen and Mauro (2000) and Yuen (2002) extended Bayoumi and Eichengreen's (1994) approach using a longer sample period. However, these studies have typically used a 2-variable VAR model of output and prices, and their empirical results have been mixed.

In this paper, we extend the conventional structural VAR approach by employing a 3-variable VAR model of output, real effective exchange rates and money supply. This identifies supply and exchange rate shocks which are conditional on money supply growth in the East Asian region. In particular, we include foreign (specifically, US) variables in the VAR model to allow for the effects of foreign shocks. We also provide estimates for European countries to test robustness and to compare the degree of similarity in the long-run effects of shocks among the East Asian economies.

The remainder of the paper is organized as follows. In section 2, we discuss the theoretical framework and methodology employed in this paper. Section 3 describes the data. Section 4 interprets the empirical results. The final section provides some concluding remarks.

2. ANALYTICAL FRAMEWORK

Existing studies in the OCA literature typically use a 2-variable VAR model incorporating output and prices to identify the fundamental supply and demand shocks. However, as noted by Demertzis, Hallett and Rummel (2000), the model does not necessarily identify purely stochastic shocks. The estimated demand shocks tend to include the effects of macroeconomic policies, whereas estimated supply shocks are generally assumed to be less likely to include the impacts of the implemented policies (see Bayoumi and Eichengreen, 1994). Furthermore, the estimated structural shocks in existing studies tend to include the effects of foreign shocks in the open-economy framework, which may result in an inaccurate evaluation of underlying shocks (see Kawai and Okumura, 1996).

In this paper, we present a VAR model that includes the money supply variable to identify shocks that are not the result of innovations in monetary policy (see Shioji, 2000, and Fielding and Shields, 2001). We also include real effective exchange rates that are more appropriate in the open-economy framework to capture changes in the relative price of domestic and foreign countries (see Demertzis, Hallett and Rummel, 2000, and Zhang, Sato and McAleer, 2002).

Foreign variables are also included in the VAR. Even though the conventional 2-variable VAR detects a high degree of correlation in certain shocks, it is unclear whether the result simply reflects the correlation of local or foreign shocks. This may well happen for the East Asian economies, given the close economic ties with the USA. Hence, following Fielding and Shields (2001), we include US output and price variables in the model for each East Asian economy in order to identify country-specific supply and demand shocks.

2.1 Baseline Case: 3-Variable Model

Consider the following 3-variable Model 1:

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

where

$$\Delta x_t = \left[\Delta y_t, \Delta q_t, \Delta m_t\right]', \ \varepsilon_t = \left[\varepsilon_{st}, \varepsilon_{qt}, \varepsilon_{mt}\right]',$$

$$A(L) = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{pmatrix}.$$

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

In order to identify the structural A_i matrices, we use the econometric technique of 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 effects on either output or real effective exchange rates. Thus, the restrictions are $A_{12}(1) = A_{13}(1) = A_{23}(1) = 0$ which are sufficient to identify the structural A_i matrices and the time series of structural shocks.

We typically estimate a reduced form VAR, as follows:

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

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:

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

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, $u_t = A_0\varepsilon_t$. Since the shocks are mutually orthogonal and each shock has a 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 the 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 when estimating a reduced form VAR for each country, the estimated reduced form disturbances (u_t) may be correlated across countries. In order to allow for possible cross-country residual correlations, we follow the approach of Fielding and Shields (2001) and use the seemingly unrelated regression (SUR) method, which is asymptotically more efficient than OLS. We stack the Δy equations for each country and estimate them using SUR. The same procedure is conducted for the Δq and Δm equations. Then we construct the matrix of reduced form residuals for each country using the estimates obtained by SUR, and then impose the above long run restrictions to recover the associated structural disturbances.

2.2 Extended Case: 5-Variable Model

We also consider the 5-variable Model 2 with two foreign variables:

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

$$\Delta x_t = \left[\Delta y_t^*, \Delta p_t^*, \Delta y_t, \Delta p_t, \Delta m_t\right]',$$

$$\varepsilon_t = \left[\varepsilon_{st}^*, \varepsilon_{dt}^*, \varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}\right]',$$

$$A(L)=\begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) & A_{15}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & A_{25}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & A_{35}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & A_{45}(L) \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) \end{pmatrix}.$$

Δy^* and Δp^* denote the changes in the logarithms of foreign output and prices, respectively. For domestic variables, we use the first-difference of the logarithm of price (Δp) instead of real effective exchange rates (Δq). By including foreign variables in the model, we identify supply and demand shocks conditional on foreign output and price shocks, as well as the domestic monetary policy. It is assumed that domestic shocks have no impacts on foreign variables in the long run, while foreign shocks have long run effects 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, it is assumed that shocks to the foreign price will have no long run impacts on foreign output ($A_{12}(1)=0$). In addition, $A_{34}(1)=A_{35}(1)=A_{45}(1)=0$. Thus, the $A(1)$ matrix is lower triangular and these long run restrictions are sufficient to identify the time series of structural shocks.

Again, we stack the Δy equations for each country for SUR estimation, and repeat the procedure for the Δp and Δm equations. 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 then formulate 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.

3. DATA

Real GDP, consumer price index (CPI) and narrow money (M1)[1] are used as proxies for real output, price and money supply, respectively. Real effective exchange rates are based on the relative CPI. All data are quarterly, are expressed in natural logarithms, and are seasonally adjusted, except for the exchange rate series.[2] The sample period covers 1981Q1-1996Q4 for the East Asian economies and the USA, and 1980Q1-1997Q4 for the European countries.

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, and the ICSEAD database (details of the data sources are available upon request).

4. EMPIRICAL RESULTS

We investigate the stationarity of each of the variables using the augmented Dickey-Fuller (ADF) test and the Kwiatkowski et al. (1992) (KPSS) test. Based on the results of both unit root tests, we use the first-difference of each variable 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 the Schwarz Bayesian Information Criterion, SBIC. We present the results of the cross-country correlations in supply, exchange rates and demand shocks in the following sub-sections. It is presumed that, if the correlation of structural shocks is positive, the shocks are symmetric, and if negative and/or insignificant, the shocks are asymmetric.

4.1 Cross-Country Correlations in Shocks

The results of cross-country correlations in supply and exchange rate shocks among the East Asian economies are reported in Table 1. Supply shocks are correlated significantly only among a few ASEAN economies (namely Singapore, Malaysia and Indonesia) and Asian NIEs (namely Korea, Taiwan and Hong Kong). For the rest of the East Asian economies, asymmetric shocks seem to prevail (see Panel A of Table 1). It should be noted that the East Asian economies have no significant correlations in supply shocks with Japan and the USA. This finding contrasts with previous studies which found that there were significant positive correlations in supply shocks between Japan and the Asian NIEs. Moreover, the supply shocks are far less symmetric in East Asia than in Europe, where they are significantly correlated among France, Italy, United Kingdom, Sweden and Finland (see Panel A of Table 2).

[1] For some European countries, a consistent M1 series is not available, so that other data are used. 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.

[2] The software package EViews 4.1 was used for the empirical analysis. Seasonality is adjusted using Census X-11 (multiplicative).

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

	Model 1: 3-Variable Model									Model 2: 5-Variable Model							
	US	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Jp	Kr	Tw	HK	Si	Ml	Id	Th
	Panel A: Supply Shocks (1981Q1-1996Q4)									*Panel C: Supply Shocks (1981Q1-1996Q4)*							
United States	1.00																
Japan	-0.05	1.00								1.00							
Korea	-0.05	0.04	1.00							0.09	1.00						
Taiwan	0.16	-0.07	0.32 *	1.00						-0.07	0.32 *	1.00					
Hong Kong	0.00	0.00	0.12	0.50 *	1.00					-0.01	0.13	0.50 *	1.00				
Singapore	0.03	-0.08	-0.02	0.10	0.17	1.00				-0.08	-0.01	0.08	0.22	1.00			
Malaysia	-0.03	0.04	-0.01	0.04	-0.03	0.33 *	1.00			0.11	0.07	0.03	-0.07	0.30 *	1.00		
Indonesia	0.15	-0.08	-0.03	-0.01	-0.07	0.06	0.36 *	1.00		-0.17	-0.01	-0.05	-0.16	0.04	0.29 *	1.00	
Thailand	0.18	-0.25	0.12	-0.02	-0.05	0.15	0.19	0.15	1.00	-0.18	0.10	-0.06	-0.06	0.14	0.22	0.18	1.00
	Panel B: Exchange Rate Shocks (1981Q1-1996Q4)									*Panel D: Demand Shocks (1981Q1-1996Q4)*							
United States	1.00																
Japan	-0.73	1.00								1.00							
Korea	0.68 **	-0.55	1.00							0.11	1.00						
Taiwan	0.61 *	-0.45	0.66 *	1.00						-0.06	0.37 *	1.00					
Hong Kong	0.42 *	-0.30	0.30 *	0.34 *	1.00					0.06	0.14	0.19	1.00				
Singapore	0.33 *	-0.27	0.32 *	0.14	0.46 *	1.00				0.04	0.28	-0.14	0.32 *	1.00			
Malaysia	0.55 *	-0.60	0.27	0.28	0.21	0.17	1.00			0.08	0.09	-0.08	0.23	0.45 *	1.00		
Indonesia	0.30 *	-0.30	0.29 *	0.10	0.19	-0.14	0.16	1.00		-0.06	-0.11	0.06	0.04	0.21	0.06	1.00	
Thailand	0.42 *	-0.46	0.29 *	0.33 *	0.35 *	0.08	0.31 *	0.08	1.00	-0.10	0.08	-0.10	0.27	0.29 *	0.10	0.02	1.00

Notes: Significance levels for correlation coefficients are assessed using Fisher's variance-stabilizing transformation (see Rodriguez, 1982). Painted figures denote significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.209); * denotes not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.288); ** denotes significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.665).

Table 2. Correlation of Structural Shocks between European Countries (3-Variable Model)

	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: Painted figures denote significantly greater than zero at the 5 percent level (one-tailed test: critical value 0.197); * denotes not significantly less than 0.5 at the 5 percent level (two-tailed test: critical value 0.302); ** denotes significantly greater than 0.5 at the 5 percent level (two-tailed test: critical value 0.657).

Panel B of Table 1 shows a very different correlation pattern in exchange rate shocks across the East Asian region as compared with supply shocks. There are significant positive correlations in exchange rate shocks between the USA and the East Asian economies, with the exception of Japan, but negative correlations between Japan and the other East Asian economies. Demand shocks are highly correlated among ASEAN and other East Asian economies. These findings are important in their implications for monetary integration.

For the European countries in Panel B of Table 2, it is found that exchange rate shocks are significantly correlated within two sub-groups of countries, namely Germany, the Netherlands, Switzerland and France, and also Italy, United Kingdom, Sweden, Finland and Norway. These significant correlations appear to reflect the close macroeconomic policy coordination of these countries, as well as their exchange rate policies. Although Germany has significant correlations with several other European countries, Japan does not exhibit any significant correlations in both supply and exchange rate shocks with other East Asian economies.

Table 3. The Size of Shocks and Speed of Adjustment to Shocks (3-Variable Model)

	Supply Shocks		*Exchange Rate Shocks*	
	Size	Speed	Size	Speed
Panel A: US and the EA Economies (1981Q1-1996Q4)				
United States	0.010	0.987	0.043	0.995
Japan	0.008	0.995	0.066	0.989
Korea	0.011	0.995	0.037	0.994
Taiwan	0.010	1.003	0.036	1.005
Hong Kong	0.018	1.000	0.039	1.000
Singapore	0.017	0.998	0.027	0.987
Malaysia	0.015	0.990	0.032	0.976
Indonesia	0.009	1.001	0.073	0.995
Thailand	0.013	1.002	0.035	0.993
Average	0.013	0.998	0.043	0.992
Panel B: European Countries (1980Q1-1997Q4)				
Germany	0.014	0.995	0.021	0.988
Netherlands	0.007	1.000	0.018	1.000
Switzerland	0.008	1.006	0.027	1.008
France	0.006	0.999	0.018	0.994
Italy	0.006	1.000	0.034	0.988
United Kingdom	0.009	1.007	0.042	1.007
Sweden	0.011	0.984	0.046	0.986
Finland	0.015	0.984	0.031	0.978
Norway	0.010	0.999	0.020	0.986
Spain	0.010	0.655	0.024	1.001
Portugal	0.017	0.997	0.026	0.999
Average	0.010	0.966	0.028	0.994

Note: In Panel A, the average of 8 East Asian economies (including Japan) is reported.

4.2 Correlations after Removing the Effects 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 results for East Asia are reported in Table 1.

According to Panel C of Table 1, the number of significant correlations in supply shocks improves slightly among the East Asian economies, whereas Japan still exhibits no significant correlations with the rest of East Asia.[3] Panel D of Table 1 shows a different pattern of cross-country correlations in demand shocks as compared with exchange rate shocks. The degree of symmetry in demand shocks declines considerably among the East Asian economies. In particular, for Korea and Taiwan, the number of significant correlations in demand shocks with the other economies has decreased. In contrast, Singapore has improved the number of significant correlations with the ASEAN economies. Japan has no significant correlations in demand shocks with the other economies, even when the US variables are included.[4]

Finally, we also estimate Model 2 including the post-crisis period (the results for 1981Q2-2001Q3 are available on request). By including this period, the degree of correlation in supply shocks improves substantially across the East Asian economies. Demand shocks became significantly correlated among the crisis-hit economies. In addition, Japan has substantially improved the degree of correlation in supply shocks, and shows significant correlations with Korea and Malaysia. However, one should be cautious with the inclusion of the post-crisis period in the sample as it may cause structural breaks in the series, and hence affect the estimates.

4.3 The Size of Shocks and Their 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 a significant impact on economies if the size of shocks were much smaller and if an economy responded more quickly to shocks. The approach of Bayoumi and Eichengreen (1994) is used to investigate these issues, namely impulse response function analysis.[5] We use the long-run impact 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 is measured by the response after 4-quarters as a share of the long-run effect.[6]

Table 3 reports the results of the impulse response function analysis for the 3-variable model. On average, the sizes of supply shocks and exchange rate shocks are smaller in Europe than in East Asia. On the other hand, the speed of adjustment to supply shocks is much faster in East Asia than

[3] In estimating Model 2, it is assumed that East Asia comprises small open economies, which are affected appreciably by the US economy. However, this assumption is not necessarily applicable to Japan.

[4] The 5-variable model was also estimated for European countries, with the USA being the source of foreign shocks. The correlation pattern of supply shocks is very similar to that reported in Table 2, but the correlation of demand shocks deteriorates in comparison with those in Table 2.

[5] Since 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.

[6] Although the choice of time horizon for calculating the size and the adjustment speed is arbitrary, choosing other horizons does not affect the conclusions appreciably.

in Europe, but is slightly slower in East Asia for exchange rate shocks.[7]

5. CONCLUDING REMARKS

In this paper we have applied two VAR models with three and five variables to assess some shocking aspects of the OCA literature. The results show that OCA is less suitable for the whole East Asian region to form an OCA than has been suggested in previous studies. This conclusion holds even when we compare the results of correlation analysis between East Asia and Europe. The results also show that Japan has no significant correlation in supply, exchange rate or demand shocks with the East Asian economies, which contrasts with the results for Europe.

The impulse response function analysis concludes that, although the average size of the underlying shocks is larger, the speed of adjustment to shocks in East Asia is faster than in Europe. This may be due to the fact that the labour market and wage rates in most East Asian economies are relatively more flexible, and hence, it is easier for these economies to make internal adjustments in response to shocks.

Although the results do not suggest an OCA for the entire East Asian region, they do imply that some sub-groups of these economies, such as the NIEs and some ASEAN countries, are better candidates as their underlying shocks are correlated and symmetric, and their speed of adjustment to shocks is faster.

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[7] We also calculated the size and speed of adjustment of shocks for a 5-variable model for both East Asia and Europe. The speed of adjustment to supply and demand shocks was estimated to be much faster in East Asia than in Europe, but the size of demand shocks was smaller in East Asia (the results are available on request).

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