Is a Monetary Union Feasible for East Asia? An Optimum Currency Area Approach

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Abstract: This paper examines whether forming an optimum currency area (OCA) is viable for the East Asian region by testing the symmetry of underlying structural shocks. We employ the structural vector autoregression (SVAR) method to identify the underlying shocks and to examine the correlation in shocks for specified sample periods. We decompose the variance of shocks and employ impulse response analysis to examine the size and the speed of adjustments to shocks. The results imply that some sub-regions are potential candidates for forming OCAs, as their shocks are correlated and small, and the economies adjust rapidly to such shocks.

Keywords: Optimum currency area; Vector autoregressions; Exchange rate; East Asian region

1. INTRODUCTION

The recent regional financial crisis has eroded the credibility of unilateral fixed exchange rates and correspondingly renewed calls among politicians for greater monetary integration and regional exchange rate stability in East Asia.[1] One of the proposals raised during the 1998 ASEAN Ministerial Meeting in Hanoi was the idea of having a common currency and exchange rate system in the region. The successful launch of the euro in early 1999 makes a common currency a particularly interesting option for both ASEAN and East Asia (EA).

According to Mundell [1961] and McKinnon [1963], the incentive for two economies to peg their bilateral exchange rates rises with the bilateral intensity of trade, flexibility of factor markets, and symmetry of underlying shocks. By doing so, both will be able to forsake nominal exchange rate changes as an instrument of adjustment and to reap the reduction in transactions costs associated with a common currency. The purpose of this paper is to investigate and assess the empirical suitability of the East Asian economies for potential monetary integration in light of the theory of optimum currency area (OCA). In particular, we focus on the symmetric nature of underlying shocks across the East Asian economies as a precondition for forming an OCA.

This paper is structured as follows. Section 2 discusses the theoretical framework and methodology. In section 3, we examine the correlations of the identified shocks, and conduct variance decomposition and impulse response analysis to study the size of shocks and the speed of adjustments to such shocks. The final section concludes the paper.

2. ANALYTICAL FRAMEWORK

Early studies in OCA focused on how the various observable macroeconomic variables are correlated across the economies or the region. Bayoumi and Eichengreen [1993, 1994] employed the Blanchard-Quah [1989] structural VAR method to identify the underlying structural shocks. In this paper, we employ a three-variable VAR open economy model to examine the shock aspect of the OCA literature. Following Clarida and Gali [1994] and Rogers [1998], all variables in the model are in natural logarithms and represent domestic relative to foreign levels. Specifically, the three variables are defined as the domestic output relative to foreign output, $y_t (\equiv y_t^h - y_t^f)$; the bilateral real exchange rate vis-

[1] East Asia is defined as the following 10 economies: Japan, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Indonesia, the Philippines, Thailand and China.

à-vis the US dollar, q_t; and the domestic price level relative to the foreign price level, $p_t (\equiv p_t^h - p_t^f)$, where superscript h and f denote domestic and foreign, respectively. Let $\Delta x_t \equiv [\Delta y_t, \Delta q_t, \Delta p_t]'$ and $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$, where Δ represents the first-difference operator, and ε_{st}, ε_{dt} and ε_{mt} denote supply, demand and monetary shocks, respectively. The structural model can be written as:

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

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

We assume that the structural shocks $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$ are serially uncorrelated and have a covariance matrix normalized to the identity matrix. The model implies that the macroeconomic variables are subject to three structural shocks. To identify structural shocks, we impose the following long run restrictions: (i) only supply shocks affect relative output in the long run; (ii) both supply and demand shocks affect real exchange rates in the long run; and (iii) monetary shocks have no long run effect on either relative output or real exchange rates. These long run restrictions amount to $A_{12}(1) = A_{13}(1) = A_{23}(1) = 0$, which are sufficient to identify the A_t matrices and, hence, the series of structural shocks.

We estimate the following reduced-form VAR model instead of the structural MA model of equation (1):

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

where u_t is a vector reduced-form disturbance. 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 as $u_t = A_0 \varepsilon_t$. Hence, it is necessary to obtain estimates of A_0 to recover the time series of structural shocks ε_t. As the structural shocks are mutually orthogonal and each shock has a unit variance, the following relationship between the covariance matrices is obtained:

$$C(1)\Sigma C(1)' = A(1)A(1)' \quad (4)$$

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, $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$.

3. EMPIRICAL RESULTS

3. 1 Data

The major data sources used in this paper are *IMF: International Financial Statistics,* CD-ROM, *China Monthly Statistics*, *Hong Kong Monthly Digest of Statistics*, the websites of the Japan and Taiwan statistics authorities, and NUS ESU databank. Real GDP is used as a proxy for real output variables, consumer price index (CPI) as a measure of changes in prices, and the real exchange rate is calculated using CPI and the bilateral nominal exchange rate of the East Asian economies vis-à-vis the US dollar. All data are quarterly and seasonally unadjusted, except real GDP. Data are transformed into the ratio of domestic (EA) relative to foreign (US) levels.

In an open-economy framework, structural shocks estimated by the structural VAR method tend to include the effect of foreign shocks. To the extent that foreign or global shocks have an influence on the East Asian economies, a high correlation of shocks across the economies does not necessarily exhibit a strong correlation of country-specific shocks. Since the economic presence of the USA is substantial for the East Asian economies, we use the transformed variables that represent the ratio of EA levels to the corresponding US levels in order to remove the effects of US shocks.

We have investigated the time series properties of the variables and found that most variables are I(1) based on the result of the Phillips-Perron and KPSS tests. Therefore, we take the first difference of all variables to ensure the stationarity of the variables. For estimation of the VAR, we choose one lag based on SBIC. We use EViews 4 for the empirical analysis.

3. 2 Correlation of Structural Shocks

Table 1. Correlation of Structural Shocks Across the East Asian Economies

	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
	Panel A: Supply Shocks (1980Q3-1997Q1)										*Panel D: Supply Shocks (1980Q3-2000Q3)*									
Japan	1.00										1.00									
Korea	0.22	1.00									0.32	1.00								
Taiwan	0.28	0.48	1.00								0.33	0.40	1.00							
Hong Kong	0.27	0.18	0.47	1.00							0.25	0.34	0.49	1.00						
Singapore	0.07	0.19	0.31	0.10	1.00						0.20	0.29	0.42	0.20	1.00					
Malaysia	0.27	0.27	0.22	-0.01	0.45	1.00					0.36	0.53	0.80	0.13	0.51	1.00				
Indonesia	0.08	0.24	0.18	-0.14	0.23	0.45	1.00				0.27	0.50	0.87	0.15	0.38	0.50	1.00			
Thailand	0.08	0.34	0.20	-0.02	0.25	0.27	0.28	1.00			0.13	0.40	0.19	0.05	0.26	0.42	0.35	1.00		
Philippines	0.32	0.23	0.21	0.32	0.20	0.22	0.11	0.06	1.00		0.25	0.25	0.19	0.31	0.22	0.24	0.21	0.11	1.00	
China	0.00	0.03	0.23	0.25	0.20	0.17	0.14	-0.09	0.13	1.00	0.15	0.17	0.29	0.27	0.26	0.20	0.27	0.14	0.20	1.00
	Panel B: Demand Shocks (1980Q3-1997Q1)										*Panel E: Demand Shocks (1980Q3-2000Q3)*									
Japan	1.00										1.00									
Korea	0.23	1.00									0.03	1.00								
Taiwan	0.26	0.42	1.00								0.41	0.43	1.00							
Hong Kong	-0.09	0.27	0.00	1.00							-0.11	0.21	-0.19	1.00						
Singapore	0.44	0.16	0.24	0.18	1.00						0.67	0.22	0.47	0.02	1.00					
Malaysia	0.28	0.01	0.07	0.20	0.65	1.00					0.15	0.37	0.37	0.09	0.50	1.00				
Indonesia	0.20	0.19	0.02	0.03	0.13	0.03	1.00				0.16	0.42	0.31	-0.07	0.27	0.27	1.00			
Thailand	0.40	-0.06	0.07	-0.09	0.27	0.39	-0.04	1.00			0.09	0.27	0.19	0.05	0.20	0.43	0.07	1.00		
Philippines	-0.01	0.23	0.19	0.15	0.08	0.05	0.00	0.00	1.00		0.00	0.30	0.27	0.08	0.18	0.15	0.11	0.13	1.00	
China	-0.08	0.10	-0.12	0.11	-0.25	0.23	0.12	-0.11	0.21	1.00	-0.14	0.21	-0.05	0.03	-0.15	0.17	0.00	0.01	0.20	1.00
	Panel C: Monetary Shocks (1980Q3-1997Q1)										*Panel F: Monetary Shocks (1980Q3-2000Q3)*									
Japan	1.00										1.00									
Korea	0.06	1.00									0.02	1.00								
Taiwan	0.07	0.23	1.00								0.12	0.25	1.00							
Hong Kong	0.13	0.09	0.10	1.00							0.00	-0.05	-0.04	1.00						
Singapore	0.25	0.22	-0.02	-0.02	1.00						0.22	0.21	-0.01	-0.24	1.00					
Malaysia	0.15	0.24	0.14	-0.04	0.55	1.00					0.16	0.30	0.16	-0.18	0.52	1.00				
Indonesia	0.11	0.24	0.19	-0.16	0.16	0.35	1.00				0.03	0.26	0.25	0.01	0.22	0.37	1.00			
Thailand	0.32	0.18	0.09	0.49	0.29	0.19	-0.12	1.00			0.36	0.19	0.11	0.38	0.23	0.24	0.25	1.00		
Philippines	-0.01	-0.15	0.04	0.29	-0.08	-0.16	-0.01	-0.03	1.00		0.00	-0.01	0.10	0.22	0.11	-0.04	0.18	0.09	1.00	
China	-0.24	0.33	-0.02	0.06	0.12	0.58	0.15	0.07	-0.23	1.00	-0.26	0.32	-0.07	0.21	0.03	0.27	0.08	0.19	-0.10	1.00

Notes: The sample period starts from 1983Q3 for Hong Kong and from 1986Q3 for China. Painted figures denote positive and significant at the 5 percent level. Significance levels are assessed using the Fisher's variance-stabilizing transformation, and the null hypothesis is that correlation coefficient is zero (Rodriguez [1982]).

We estimated the underlying shocks by the structural VAR approach for the East Asian economies for 1980Q1-1997Q1 and 1980Q1-2000Q3. It is assumed that if the correlation of structural shocks is positive, the shocks are considered to be symmetric, and if negative and/or insignificant, they are asymmetric.

Results of correlations of the three identified shocks among the East Asian economies for 1980Q1-1997Q1 and 1980Q1-2000Q3 are reported in Table 1. Painted figures indicate that the correlation coefficient is positive and significant at the 5 percent level. It is found that, for 1980Q1-1997Q1 (Panel A of Table 1), supply shocks are correlated significantly among Singapore, Malaysia, Indonesia and Thailand. Japan and Korea are positively and significantly correlated with some ASEAN economies. Correlations are also high among Japan, Korea, Taiwan and Hong Kong. This result is similar to Bayoumi and Eichengreen [1994]. However, demand shocks and monetary shocks are less correlated among these economies during the sample period (Panels B and C of Table 1).

It is interesting to note that the regional financial crisis improved the number of significant correlations of shocks in these economies (Panels D-F of Table 1). Those ASEAN economies and NIEs that displayed high correlations in their growth patterns are likely to have similar supply shocks which tend to be permanent. For the rest of East Asia, asymmetric shocks seem to prevail. However, one should be cautious as including the post-crisis period in the sample may cause structural breaks in the series, which would affect estimation.[2]

According to the OCA literature, supply shocks are considered to be more informative for evaluating the symmetry of shocks, because estimated demand and monetary shocks using the structural VAR tend to include the effects of macroeconomic policies as well as purely stochastic disturbances [Bayoumi and Eichengreen, 1994; Kawai and Okumura, 1996; and Demertzis et al., 2000]. The more (less) symmetric shocks encountered, the higher (lower) are the correlations in supply shocks, and the more feasible it becomes for these economies to establish

[2] We have estimated the underlying shocks by the structural VAR approach using data from the 1980s and 1990s prior to the financial crisis. The number of significant correlations of the three identified shocks among the East Asian economies in the 1990s do not change as much in the 1980s.

an OCA. Therefore, our results do not display strong support for forming an OCA in the entire East Asian region. However, they do suggest that the OCA is feasible in some sub-regions, such as among some Asian NIEs and ASEAN countries.

3. 3 Variance Decomposition Analysis

Variance Decomposition (VD) analysis is performed to identify the contribution of each shock to the three variables. We decompose variation in the percentage change of the forecast error variance of changes in real output, exchange rate and prices that are due to each shock at the 1 through 20 quarter horizons. Due to space limitations, we report in Table 2 the VD results of real exchange rates only (the remaining results are available on request).

Table 2. Variance Decomposition of the Change in Real Exchange Rate

	Supply Shocks	Demand Shocks	Monetary Shocks
	Panel A: 1980Q3-1997Q1		
Japan	15.3 / 14.1	84.1 / 84.6	0.6 / 1.2
Korea	3.5 / 16.0	90.3 / 80.2	6.2 / 3.8
Taiwan	3.4 / 14.2	87.2 / 78.1	9.5 / 7.7
Hong Kong	0.0 / 0.5	98.8 / 98.6	1.1 / 0.9
Singapore	11.0 / 10.1	82.0 / 78.7	7.0 / 11.2
Malaysia	0.2 / 2.7	99.7 / 97.2	0.1 / 0.1
Indonesia	13.7 / 14.9	80.4 / 75.4	5.8 / 9.7
Thailand	2.1 / 2.3	97.3 / 96.9	0.6 / 0.8
Philippines	3.2 / 3.6	96.8 / 96.3	0.0 / 0.1
China	0.2 / 3.9	69.7 / 61.6	30.1 / 34.5
	Panel B: 1980Q3-2000Q3		
Japan	5.5 / 5.3	93.9 / 93.6	0.6 / 1.1
Korea	54.1 / 48.8	42.8 / 47.6	3.1 / 3.6
Taiwan	5.2 / 13.8	88.0 / 80.0	6.8 / 6.2
Hong Kong	0.0 / 2.3	83.6 / 87.7	16.4 / 10.0
Singapore	14.8 / 14.9	83.4 / 82.2	1.8 / 2.9
Malaysia	31.8 / 29.3	68.2 / 70.7	0.0 / 0.0
Indonesia	62.5 / 59.8	21.0 / 21.5	16.5 / 18.7
Thailand	39.4 / 39.0	60.4 / 60.6	0.2 / 0.3
Philippines	4.8 / 5.1	94.6 / 93.8	0.6 / 1.1
China	1.3 / 6.6	81.5 / 72.7	17.2 / 20.7

Notes: Entries indicate the percentage of the forecast error variance of change in real exchange rate vis-à-vis the US dollar that is due to each shock at the 1-quarter and 20-quarter horizons. The sample period starts from 1983Q3 for Hong Kong and from 1986Q3 for China.

It is found that the supply shocks in both sample periods are the predominant shocks accounting for the variability of real output in all East Asian economies. The supply shocks account for over 85 percent at all horizons for the sample period prior to the crisis and 64 percent by including the post-crisis period. It is interesting to note that the financial crisis has reduced the influence of the supply shocks on real output in most East Asian economies, but has increased the influence in Japan. The economies most hit by the recent financial crisis displayed an increasing effect of the demand and monetary shocks on real output.

In contrast to real output, monetary shocks in both sample periods are the predominant shocks for the variability of the price level for all East Asian economies, except Hong Kong and the Philippines. The demand shocks predominate in Hong Kong and the Philippines, accounting for over 50 and 85 percent, respectively. By accommodating the financial crisis, these effects have become enhanced substantially in Hong Kong, but become weakened in the Philippines. By including the post-crisis period, supply shocks become the predominant shocks after a two-quarter horizon in Indonesia, and are not influential in the rest of East Asia.

The fluctuations in real exchange rates were predominantly caused by the demand shocks at all horizons for all East Asian economies before the financial crisis. The crisis has changed the effects of demand shocks, especially in the economies worst hit by the crisis. Supply shocks become the predominant cause of the variability in real exchange rates after the crisis in Indonesia, Korea and Thailand. These effects remain strong at all horizons. This has important policy implications for the exchange rate regimes in these countries.

3. 4 Impulse Response Function Analysis

Since the estimated structural shocks are assumed to have unit variances in the structural VAR, their size and adjustment speed can be inferred by analyzing the associated impulse response functions [see Bayoumi and Eichengreen, 1994]. For the size of supply shocks, we use the long run (20-quarter horizon) effect of a unit shock on changes in real GDP. For demand and monetary shocks, we choose the 1-quarter impact on changes in real exchange rates and CPI as a measure of size. The speed of adjustment is measured by the share of the response after 4-quarters in its long run effect (the response after a 20-quarter horizon). The larger the size of the shocks, the more disruptive the effects an economy will encounter. Similarly, the slower the adjustment to disturbances, the larger will be the cost of maintaining a fixed exchange rate system. Table 3 reports the size of shocks and the speed of adjustments to shocks.

The dynamic impulse responses of real output and exchange rates with respect to the identified shocks are consistent with the results using variance decomposition analysis. As seen in Table 3, the size of the supply shocks is the largest in the most open economies, such as Singapore, Hong Kong, Malaysia, Thailand and the Philippines. For demand and monetary shocks, China, Indonesia and the Philippines have the biggest size. The recent

financial crisis has, in general, increased the size of disturbances. In comparison, the average size of the supply shocks in East Asia almost doubles that of 14 European countries during a similar time period [Sato, Zhang and McAleer, 2001].

Table 3. Size of Shocks and Speed of Adjustment to Shocks

	Supply Shocks		Demand Shocks		Monetary Shocks	
	Size	Speed	Size	Speed	Size	Speed
Panel A: 1980Q3-1997Q1						
Japan	0.013	0.999	0.051	0.997	0.006	0.981
Korea	0.015	0.977	0.014	0.734	0.009	0.966
Taiwan	0.012	1.000	0.019	0.920	0.011	0.981
Hong Kong	0.021	1.000	0.010	0.937	0.005	0.989
Singapore	0.020	0.994	0.018	0.997	0.005	0.998
Malaysia	0.020	0.989	0.023	0.993	0.007	0.995
Indonesia	0.012	0.999	0.045	0.999	0.013	1.000
Thailand	0.019	0.998	0.023	0.990	0.007	0.999
Philippines	0.027	0.984	0.116	1.001	0.036	0.960
China	0.016	1.000	0.055	0.987	0.021	0.984
Average	0.018	0.994	0.037	0.956	0.012	0.985
Panel B: 1980Q3-2000Q3						
Japan	0.014	1.000	0.055	0.996	0.006	0.991
Korea	0.022	1.002	0.031	1.008	0.010	1.006
Taiwan	0.013	0.983	0.023	0.921	0.010	0.974
Hong Kong	0.025	0.991	0.009	0.765	0.003	0.675
Singapore	0.022	0.990	0.021	0.996	0.006	1.000
Malaysia	0.026	0.996	0.029	1.001	0.008	0.999
Indonesia	0.030	1.065	0.048	1.093	0.019	1.085
Thailand	0.033	0.939	0.036	0.997	0.008	0.990
Philippines	0.025	0.984	0.107	1.000	0.045	0.970
China	0.016	1.000	0.053	0.996	0.020	0.986
Average	0.022	0.995	0.041	0.977	0.013	0.968

However, the speed of adjustment to disturbances in East Asia is much faster than in Europe. Most of the East Asian countries take less than one year to complete the adjustment to shocks. The pace became even more rapid during the financial crisis. A possible explanation is that the labour market in most East Asian countries is very flexible, and it is therefore much easier for these economies to adjust internally in response to shocks. The findings support the proposal of a common currency arrangement as, according to the OCA literature, countries are better candidates for a currency arrangement if their disturbances are correlated and small, and if these countries adjust rapidly to shocks.

4. CONCLUDING REMARKS

In this paper we used a three-variable VAR model to identify various types of shocks using over two decades of quarterly data from East Asia. The results show that, prior to the recent financial crisis, supply shocks were correlated significantly among some ASEAN countries (such as Singapore, Malaysia, Indonesia and Thailand) and East Asian countries (such as Hong Kong, Japan, Korea and Taiwan). This result is similar to Bayoumi and Eichengreen [1994]. However, demand shocks and monetary shocks are less correlated among these economies during the sample period. It is interesting to note that the regional financial crisis improved the number of significant correlations of shocks in these economies. Those economies that displayed high correlations in their growth patterns are likely to have similar supply shocks which tend to be permanent. For the rest of East Asia, asymmetric shocks seem to prevail. According to the OCA literature, supply shocks are considered to be more informative for evaluating the symmetry of shocks. The more (less) symmetric shocks that the economies encounter, the higher (lower) are the correlations in supply shocks, and the more feasible it becomes for these economies to establish an OCA.

The results from VD analysis show that the supply shocks in the two sample periods are the predominant shocks for the variability of real output in all the East Asian economies. Interestingly the financial crisis has reduced the influence of the supply shocks on real output in most East Asian economies, but has increased the influence in Japan. The economies most hit by the financial crisis displayed an increasing effect of the demand and monetary shocks on real output. In contrast, monetary shocks are the predominant shocks for the variability of the price level for all East Asian economies, except Hong Kong and the Philippines. For the latter, demand shocks predominate at all horizons. By including the post-crisis period, supply shocks become the predominant shocks after a two-quarter horizon only in Indonesia. The fluctuations in real exchange rates were predominantly caused by the demand shocks at all horizons in East Asia economies before the financial crisis. The economies most hit by the financial crisis show that the supply shocks become the predominant cause of the variability in real exchange rates after the crisis. These effects remain strong at all horizons. This has important policy implications for the exchange rate regimes in these countries.

The dynamic impulse responses of real output and exchange rates with respect to the identified shocks are consistent with the results using VD analysis. Although the size of the underlying shocks is larger than in Europe, the speed of adjustments to shocks in East Asia is much faster, taking less than one year in most countries. It is clear that the flexible labour markets in these economies have facilitated the internal adjustment process.

Thus, the empirical results do not display strong support for forming an optimum currency area in the East Asian region. However, they do imply that some sub-regions are better candidates for a

currency arrangement as their disturbances are correlated and small, and these countries adjust rapidly to shocks.

5. ACKNOWLEDGEMENTS

We would like to thank Paul De Grauwe, Harry Bloch, Ian Kerr, Ken Clements, Mansur Masih, Edward Lim and seminar participants at UWA, Curtin University and Edith Cowan University for helpful comments and suggestions. We are grateful to Tilak Abeysinghe for providing the real GDP series for some East Asian economies. The third author wishes to acknowledge the financial support of the Australian Research Council.

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