ASIAN MONETARY INTEGRATION: A STRUCTURAL VAR 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. A structural vector autoregression (VAR) method is used to identify the underlying shocks and to examine the correlation in shocks for specified sample periods. Decomposition of the variance of shocks and impulse response analysis are used 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 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 [8, 7], 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 an 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. The empirical results are presented in Section 3, including the variability and correlation among the variables, the correlation of the structural shocks, a variance decomposition analysis, and an impulse response analysis, to examine the size

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

of the shocks and the speed of adjustments to such shocks. Concluding remarks are given in Section 4.

2. ANALYTICAL FRAMEWORK

Early studies on OCA focused on how the various observable macroeconomic variables, such as GDP growth rates, inflation rates, exchange rates, interest rates and stock prices, are correlated across the economies or the region. [1, 2] are among the first to identify the underlying structural shocks by using the [3] vector autoregression (VAR) method. In this paper, we employ a three-variable VAR open economy model to examine the shocks according to the OCA literature. Following [4, 12], all the variables in the model are expressed in natural logarithms and represent the 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 relative to 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 superscripts *h* and *f* refer to 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 $A(L) = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{pmatrix}$.

It is assumed 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. In order to identify the structural shocks, the following long run restrictions are imposed: (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_i matrices and, hence, the series of structural shocks.

The reduced-form VAR model for estimation is as follows:

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

where u_t is a vector reduced-form disturbance. A moving average (MA) representation of equation (2) is:

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

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 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:

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

where $\Sigma = Eu_t u_t' = EA_0 \varepsilon_t \varepsilon_t' A_0' = A_0 A_0'$. If H denotes the lower triangular Choleski decomposition of $C(1)\Sigma C(1)'$, then $A(1) = H$ as the long run restrictions imply that $A(1)$ is also lower triangular. Consequently, $A_0 = C(1)^{-1} A(1) = C(1)^{-1} H$. Given an estimate of A_0, the time series of structural shocks, $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$, can be recovered.

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 relative to the US dollar. All

data are quarterly and seasonally unadjusted, except for 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 transformed variables that represent the ratio of EA levels to the corresponding US levels to remove the effects of US shocks.

The time series properties of the variables have been investigated, and it was found that most variables are I(1), based on the Phillips-Perron and KPSS tests. Therefore, the first differences of all variables are used to ensure the stationarity of the variables. For estimation of the VAR, one lag is chosen, based on SBIC. The econometric software package EViews 4 is used for the empirical analysis.

3.2. Variability and Correlation of the Variables

The variability of nominal bilateral exchange rates for the 10 East Asian economies and the USA are examined for the whole sample period 1983-2000, as well as for the sub-periods 1983-1984, 1985-1996 and 1996-2000. Reference is made to the effects of the two regional crises in the 1980s and 1990s, as well as to the separate periods 1983-1993 and 1994-2000 to incorporate the effects of China's unification of its dual exchange rates in early 1994. Due to space limitations, Table 1 reports results for the

whole sample period only (the remaining results are available on request). In view of the whole sample period from 1983 to 2000, exchange rates of the East Asian economies are relatively stable against each other. In all cases, the volatility of exchange rates against each other is below five percent, and against the US dollar the volatility is below four percent, with the exception of the Indonesian Rupiah.

Table 1: Variability of Nominal Exchange Rates, 1983:10-2000:10

	US	JP	CH	HK	ID	KR	MA	PH	SI	TH	TW
US	1.000										
JP	0.030	1.000									
CH	0.033	0.044	1.000								
HK	0.003	0.030	0.033	1.000							
ID	0.073	0.074	0.081	0.073	1.000						
KR	0.032	0.040	0.046	0.032	0.064	1.000					
MA	0.023	0.032	0.038	0.024	0.062	0.030	1.000				
PH	0.027	0.040	0.042	0.027	0.066	0.034	0.026	1.000			
SI	0.013	0.025	0.036	0.013	0.067	0.030	0.018	0.026	1.000		
TH	0.030	0.037	0.044	0.030	0.061	0.029	0.022	0.028	0.024	1.000	
TW	0.013	0.028	0.036	0.013	0.070	0.030	0.022	0.027	0.014	0.027	1.000

Note: US: the United States; JP: Japan; CH: China; HK: Hong Kong; ID: Indonesia; KR: Korea; MA: Malaysia; PH: the Philippines; SI: Singapore; TH: Thailand; TW: Taiwan

The 1997 financial crisis started in Thailand and became a regional crisis shortly thereafter. Indonesia and Korea were hit particularly hard by this crisis, which caused high volatility in their exchange rates against those of their neighbours. The Indonesian Rupiah became the most volatile currency in the region after the crisis, followed by the Korean Won and the Thai Baht. However, the rest of the East Asian economies continued to display low variability relative to each other, even after the East Asian financial crisis. In comparison, the first economic recession in ASEAN in the mid-1980s and China's unification of its dual exchange rates in 1994 did not contribute substantially to the exchange rate volatility in the region.

The low variability of bilateral exchange rates in East Asia reflects the progress of its financial market integration [9, 10]. It also reflects to a certain extent the symmetric effects of shocks originating from the region and the rest of the world. To this end, the low variability may imply the possibility of further regional monetary integration.

We now turn to the examination of the correlations in growth and inflation of the East Asian economies for specified periods (see Tables 2 and 3)[2]. Overall, the East Asian economies display a less obvious pattern in GDP growth compared with inflationary movements, even though the former has become more correlated after the financial crisis. It is interesting to note that the recent financial crisis has changed the correlation patterns of economic growth and inflation among the economies concerned. After the crisis, the number of significant correlations in GDP growth has increased among the East Asian countries, and between the USA and the region. However, the financial crisis has changed a number of significant and positive correlations in inflation to insignificant and negative. These findings have implications for forming an OCA in the East Asian region.

3. 3. Correlation of Structural Shocks

The underlying shocks were estimated 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.

[2] In Tables 2 and 3, GDP growth rates and CPI inflation rates are calculated as a percentage change over the corresponding period in the previous year.

Table 2: Correlation of GDP Growth Rates Across the USA and the East Asian Economies

	US	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
					Panel A: 1981Q1-2000Q3						
United States	1.00										
Japan	-0.06	1.00									
Korea	-0.03	0.44	1.00								
Taiwan	0.38	0.27	0.45	1.00							
Hong Kong	0.21	0.25	0.63	0.68	1.00						
Singapore	0.00	0.17	0.34	0.22	0.52	1.00					
Malaysia	-0.10	0.28	0.54	0.07	0.45	0.75	1.00				
Indonesia	-0.03	0.43	0.65	0.31	0.58	0.54	0.79	1.00			
Thailand	-0.16	0.57	0.70	0.26	0.45	0.53	0.70	0.77	1.00		
Philippines	-0.20	0.04	0.12	-0.10	0.14	0.40	0.35	0.20	0.22	1.00	
China	0.27	-0.01	0.11	0.25	0.17	-0.11	-0.11	0.10	0.08	-0.54	1.00
					Panel B: 1981Q1-1997Q1						
United States	1.00										
Japan	0.09	1.00									
Korea	0.07	0.20	1.00								
Taiwan	0.50	0.12	0.53	1.00							
Hong Kong	0.31	0.00	0.41	0.73	1.00						
Singapore	0.04	-0.05	0.01	0.11	0.35	1.00					
Malaysia	-0.06	-0.08	-0.13	-0.20	0.02	0.70	1.00				
Indonesia	0.30	-0.10	-0.17	0.09	0.23	0.35	0.50	1.00			
Thailand	-0.04	0.30	0.14	0.07	0.04	0.50	0.47	0.22	1.00		
Philippines	-0.25	0.06	0.00	-0.12	0.05	0.38	0.36	0.23	0.37	1.00	
China	0.41	-0.26	-0.02	0.16	0.11	-0.24	-0.37	-0.36	-0.33	-0.57	1.00
					Panel C: 1997Q2-2000Q3						
United States	1.00										
Japan	0.24	1.00									
Korea	0.46	0.72	1.00								
Taiwan	0.17	0.52	0.48	1.00							
Hong Kong	0.68	0.70	0.84	0.69	1.00						
Singapore	0.47	0.65	0.77	0.80	0.91	1.00					
Malaysia	0.46	0.73	0.91	0.72	0.93	0.93	1.00				
Indonesia	0.44	0.61	0.85	0.74	0.90	0.95	0.97	1.00			
Thailand	0.60	0.60	0.96	0.30	0.81	0.68	0.83	0.77	1.00		
Philippines	0.35	0.55	0.80	0.70	0.84	0.92	0.92	0.97	0.72	1.00	
China	-0.08	-0.08	-0.17	-0.11	-0.01	0.03	-0.15	-0.06	-0.12	0.03	1.00

Notes:

1. Quarterly data are used for the real GDP growth rate.
2. GDP growth rates denote the percentage change over the corresponding period in the previous year.

Table 3: Correlation of Inflation Rates Across the USA and the East Asian Economies

	US	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
					Panel A: 1981Q1-2000Q3						
United States	1.00										
Japan	0.76	1.00									
Korea	0.83	0.71	1.00								
Taiwan	0.75	0.61	0.90	1.00							
Hong Kong	0.53	0.61	0.64	0.53	1.00						
Singapore	0.81	0.68	0.77	0.67	0.67	1.00					
Malaysia	0.63	0.54	0.75	0.74	0.40	0.74	1.00				
Indonesia	-0.07	-0.01	0.16	0.08	-0.18	-0.13	0.34	1.00			
Thailand	0.62	0.59	0.86	0.77	0.49	0.68	0.73	0.26	1.00		
Philippines	0.30	0.41	0.07	0.02	0.26	0.24	0.17	0.05	-0.07	1.00	
China	0.27	-0.01	0.18	0.38	0.53	0.31	0.15	-0.30	0.07	0.08	1.00
					Panel B: 1981Q1-1997Q1						
United States	1.00										
Japan	0.80	1.00									
Korea	0.87	0.71	1.00								
Taiwan	0.74	0.61	0.91	1.00							
Hong Kong	0.53	0.50	0.61	0.54	1.00						
Singapore	0.80	0.67	0.79	0.67	0.85	1.00					
Malaysia	0.70	0.57	0.76	0.76	0.71	0.83	1.00				
Indonesia	0.56	0.46	0.53	0.49	0.46	0.46	0.59	1.00			
Thailand	0.76	0.58	0.89	0.85	0.47	0.77	0.75	0.45	1.00		
Philippines	0.25	0.37	0.00	-0.04	0.17	0.20	0.13	0.27	-0.15	1.00	
China	-0.13	-0.34	-0.22	0.01	-0.01	-0.12	0.15	-0.04	-0.20	-0.16	1.00
					Panel C: 1997Q2-2000Q3						
United States	1.00										
Japan	-0.49	1.00									
Korea	-0.59	0.53	1.00								
Taiwan	-0.16	0.14	0.51	1.00							
Hong Kong	-0.56	0.85	0.79	0.24	1.00						
Singapore	0.43	0.49	-0.01	-0.28	0.35	1.00					
Malaysia	-0.86	0.19	0.72	0.43	0.47	-0.63	1.00				
Indonesia	-0.76	-0.01	0.50	0.41	0.24	-0.80	0.93	1.00			
Thailand	-0.63	0.62	0.94	0.40	0.90	0.08	0.70	0.48	1.00		
Philippines	-0.90	0.25	0.59	0.33	0.46	-0.62	0.94	0.94	0.63	1.00	
China	0.27	0.65	0.16	0.10	0.56	0.81	-0.39	-0.54	0.25	-0.39	1.00

Notes:
1). Quarterly data are used for the CPI inflation rate.
2). CPI inflation rates denote the percentage change over the corresponding period in the previous year.
3). The Hong Kong data start from 1984Q1 and the China data start from 1987Q1.

Table 4. 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	0.30	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	0.37	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		0.27	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						0.57	0.22	0.47	0.02	1.00					
Malaysia	0.28	0.01	0.07	0.20	0.58	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	0.36	-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	0.53	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. The painted figures denote positive and significant at the 5 percent level. Significance levels are assessed using Fisher's variance-stabilizing transformation, and the null hypothesis is that the correlation coefficient is zero [11].

Results of correlations of the three identified shocks among the East Asian economies for 1980Q1-1997Q1 and 1980Q1-2000Q3 are reported in Table 4. 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 4), 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 those in [2]. However, demand shocks and monetary shocks are less correlated

among these economies during the sample period (Panels B and C of Table 4).

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 4). 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.[3]

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 method tend to include the effects of macroeconomic policies, as well as purely stochastic disturbances [2, 6, 5]. The more (less) often are symmetric shocks encountered, the greater (lesser) are the correlations in the supply shocks, and the more feasible does it become for these economies to establish 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. 4. Variance Decomposition Analysis

[3] The underlying shocks have been estimated 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.

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 rates and prices that are due to each shock at the 1 through 20 quarter horizons. Due to space limitations, Table 5 reports the VD results of real exchange rates, output and prices at the 1-quarter and 20-quarter horizons only (the remaining results are available on request).

In both sample periods, supply shocks are found to be the predominant shocks accounting for the variability of real output in all East Asian economies. The supply shocks account for over 85 percent of the variability at all horizons for the sample period prior to the crisis, and 64 percent when the post-crisis period is included. 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 hardest hit by the recent financial crisis displayed an increasing effect of 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 for 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.

Table 5. Variance Decomposition of the Changes in Output, Exchange Rate and Price

	Real Output			Real Exchange Rate			Price		
	Supply Shock	Demand Shock	Monetary Shock	Supply Shock	Demand Shock	Monetary Shock	Supply Shock	Demand Shock	Monetary Shock
	Panel A: 1980Q3-1997Q1			*Panel A: 1980Q3-1997Q1*			Panel A: 1980Q3-1997Q1		
Japan	95.5 / 94.3	4.5 / 5.7	0.0 / 0.1	15.3 / 14.1	84.1 / 84.6	0.6 / 1.2	3.5 / 3.3	1.3 / 1.1	95.2 / 95.6
Korea	95.4 / 93.0	0.1 / 0.2	4.5 / 6.9	3.5 / 16.0	90.3 / 80.2	6.2 / 3.8	5.5 / 5.1	7.5 / 7.0	87.0 / 87.8
Taiwan	99.1 / 98.9	0.0 / 0.0	0.9 / 1.1	3.4 / 14.2	87.2 / 78.1	9.5 / 7.7	1.6 / 2.6	9.3 / 8.9	89.0 / 88.5
Hong Kong	98.4 / 97.4	0.4 / 0.9	1.2 / 1.7	0.0 / 0.5	98.8 / 98.6	1.1 / 0.9	1.7 / 2.5	52.8 / 48.8	45.5 / 48.7
Singapore	93.4 / 90.0	3.1 / 3.7	3.5 / 6.3	11.0 / 10.1	82.0 / 78.7	7.0 / 11.2	1.6 / 4.0	25.8 / 25.1	72.6 / 71.0
Malaysia	96.2 / 93.9	0.4 / 0.5	3.4 / 5.5	0.2 / 2.7	99.7 / 97.2	0.1 / 0.1	3.1 / 6.2	5.8 / 9.9	91.2 / 83.9
Indonesia	91.7 / 85.6	5.5 / 10.3	2.7 / 4.1	13.7 / 14.9	80.4 / 75.4	5.8 / 9.7	3.4 / 3.4	2.4 / 2.5	94.2 / 94.0
Thailand	99.1 / 98.6	0.0 / 0.2	0.8 / 1.2	2.1 / 2.3	97.3 / 96.9	0.6 / 0.8	0.2 / 0.3	21.8 / 22.5	78.0 / 77.2
Philippines	92.3 / 89.7	1.2 / 1.8	6.5 / 8.5	3.2 / 3.6	96.8 / 96.3	0.0 / 0.1	0.0 / 3.4	89.0 / 84.9	11.0 / 11.7
China	96.8 / 93.5	2.1 / 3.0	1.1 / 3.5	0.2 / 3.9	69.7 / 61.6	30.1 / 34.5	1.0 / 1.0	34.5 / 34.5	64.5 / 64.6
	Panel B: 1980Q3-2000Q3			*Panel B: 1980Q3-2000Q3*			*Panel B: 1980Q3-2000Q3*		
Japan	99.9 / 99.8	0.1 / 0.1	0.1 / 0.1	5.5 / 5.3	93.9 / 93.6	0.6 / 1.1	8.4 / 8.6	2.8 / 4.0	88.8 / 87.4
Korea	80.2 / 72.1	18.0 / 23.5	1.8 / 4.3	54.1 / 48.8	42.8 / 47.6	3.1 / 3.6	8.7 / 7.9	3.5 / 7.3	87.7 / 84.7
Taiwan	96.8 / 95.7	2.7 / 3.4	0.5 / 0.9	5.2 / 13.8	88.0 / 80.0	6.8 / 6.2	0.9 / 1.7	11.1 / 10.7	88.0 / 87.6
Hong Kong	98.8 / 98.6	0.5 / 0.6	0.7 / 0.7	0.0 / 2.3	83.6 / 87.7	16.4 / 10.0	0.7 / 3.6	88.7 / 78.4	10.6 / 18.1
Singapore	91.2 / 88.8	6.3 / 7.4	2.5 / 3.8	14.8 / 14.9	83.4 / 82.2	1.8 / 2.9	0.8 / 4.0	7.4 / 7.3	91.8 / 88.7
Malaysia	70.7 / 70.6	29.1 / 29.1	0.2 / 0.2	31.8 / 29.3	68.2 / 70.7	0.0 / 0.0	0.2 / 0.9	1.4 / 3.7	98.4 / 95.4
Indonesia	63.7 / 69.0	20.7 / 11.9	15.6 / 19.1	62.5 / 59.8	21.0 / 21.5	16.5 / 18.7	21.8 / 58.4	13.0 / 7.9	65.2 / 33.7
Thailand	70.7 / 76.2	17.8 / 14.1	11.5 / 9.6	39.4 / 39.0	60.4 / 60.6	0.2 / 0.3	7.1 / 15.0	3.7 / 6.5	89.3 / 78.5
Philippines	87.4 / 83.6	3.2 / 4.3	9.4 / 12.1	4.8 / 5.1	94.6 / 93.8	0.6 / 1.1	0.0 / 3.2	79.8 / 76.8	20.2 / 20.1
China	92.3 / 87.5	0.4 / 0.6	7.3 / 11.9	1.3 / 6.6	81.5 / 72.7	17.2 / 20.7	9.1 / 12.8	24.6 / 22.6	66.3 / 64.5

Notes: Entries indicate the percentage change of the forecast error variance in the real exchange rate, output and price that is due to each shock at the 1-quarter and 20-quarter horizons below each shock. The first column below each shock reports the VD results of the corresponding shock at the 1-quarter horizon, and the second column reports the results at the 20-quarter horizon. The sample period starts from 1983Q3 for Hong Kong and from 1986Q3 for China.

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 hardest hit by the crisis. Supply shocks became the predominant cause of the variability in real exchange rates after the crisis in Indonesia, Korea and Thailand, and remain strong for all horizons. This finding has important policy implications for the exchange rate regimes in these countries.

3. 5. 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 [2]). For the size of supply shocks, the long run (20-quarter horizon) effect of a unit shock on changes in real GDP is used. For demand and monetary shocks, the 1-quarter impact on changes in real exchange rates and CPI is chosen as a measure of size. The speed of adjustment is measured as the share of the response after 4-quarters in its long run effect (that is, the response after a 20-quarter horizon).[4] The larger is the size of the shocks, the more disruptive will be the effects on an economy. Similarly, the slower is the adjustment to disturbances, the larger will be the cost of maintaining a fixed exchange rate system. Table 6 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

[4] Our choice of the time horizon in calculating the size of shocks and the speed of adjustment is somewhat arbitrary. However, choosing different horizons as a measure will not change the conclusion.

the identified shocks are consistent with the results using variance decomposition analysis. As seen in Table 6, 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 sizes. The recent financial crisis has, in general, increased the size of disturbances. As a comparison, the average size of the supply shocks in East Asia is almost double that of 14 European countries for a similar time period (see [13]).

Table 6. 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. One possible explanation is that the labour market in most East Asian countries is very flexible, so that it is much easier for these economies to adjust internally in response to shocks.[5] These findings support the proposal for a common currency arrangement. 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

This paper used a three-variable VAR model to identify various types of shocks, using more than two decades of quarterly data from East Asia. The results showed that the exchange rates of the East Asian economies are relatively stable. However, these economies display a less coherent pattern in GDP growth than that of inflation, though the former has become more correlated after the financial crisis. 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 the findings in [2]. However, demand shocks and monetary shocks were less correlated among these economies during the sample period.

[5] One of the popular measures used in these economies during the financial crisis was to freeze or cut salaries to reduce labour costs and maintain their competitiveness. This measure would possibly be difficult to implement in countries with strong labour unions.

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 were 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 greater (lesser) are the symmetric shocks that the economies encounter, the higher (lower) are the correlations in supply shocks, and the more feasible does it become 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 for Hong Kong and the Philippines. For the latter, demand shocks are predominant for 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 for all horizons in East Asia economies before the financial crisis. Those economies hardest hit by the financial crisis show that the supply shocks become the predominant cause of the variability in real exchange rates after the crisis, and such effects remain strong for 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.

Overall, 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.

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