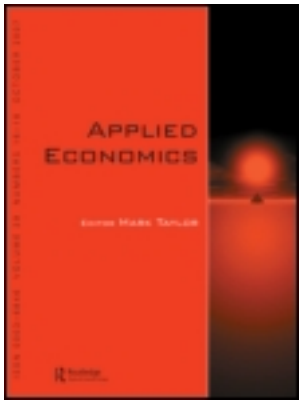

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Is a monetary union feasible for East Asia?

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Is a monetary union feasible for East Asia?

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The empirical suitability of the East Asian economies for potential monetary integration is assessed. The structural vector autoregression (VAR) method is employed to identify the underlying shocks using a three-variable VAR model across the East Asian economies. The estimates of the EEC are used as a benchmark to compare the size of the underlying shocks and the speed of adjustment to shocks in both regions to determine the feasibility of forming an optimum currency area (OCA) in East Asia. The empirical results do not display strong support for forming an OCA in the East Asian region. The results do imply, however, that some small subregions are potential candidates for OCAs, since their disturbances are correlated and small and these economies adjust rapidly to shocks.

I. INTRODUCTION

The recent regional financial crisis has renewed calls among politicians for greater monetary integration and regional exchange rate stability in East Asia.[1] This is because the crisis has eroded the credibility of unilateral fixed exchange rates and correspondingly increased interest in 'harder' pegs. 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. This study intends 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, focus is on the symmetrical nature of underlying shocks across the East Asian economies as one of the precondition of forming an OCA.

Although there seems lack of a formal institutional framework in driving monetary integration, and the economic and financial conditions also differ among the countries, East Asia has experienced rapid and spontaneous regional integration during the past decades as a result of unilateral liberalization of goods and capital markets.[2] Moreover, for the purpose of establishing a well-coordinated economic and financial monitoring system in the region, it is not rare to find evidence of monetary cooperation and foreign exchange arrangements among the East Asian economies. History of monetary cooperation in the region can be traced back to the establishment of an ASEAN Swap Arrangement among ASEAN member countries in 1977. More recently, the monetary authority of Hong Kong and the central banks of Malaysia, Indonesia and Thailand announced repurchase agreements of each other's currency in need in late 1995. Japan, the

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

[2] Zhang (2001, 2003) find evidence of economic convergence and integration in East Asia during 1960–1997.

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Philippines and Singapore participated in the Repurchase Agreements in March 1996. In 2000 ASEAN plus China, Japan and Korea agreed to establish a currency-swap network and to help avert future crisis.[3]

According to the seminal work of 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.[4] 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. In general, the OCA criteria fall into following groups: (i) the symmetry of shocks across economies, (ii) high intraregional trade, (iii) factor mobility and labour market flexibility, (iv) financial market integration, and (v) coordination of macroeconomic policy. Many studies have so far applied the OCA theory to assessing the feasibility of monetary and financial integration largely in the European region, but few for the East Asian economies. This paper studies the shocking aspects of output fluctuations as a measurement of feasibility in forming a currency area.

Most existing studies on OCA in East Asia adopt a straightforward approach to examine the observable macroeconomic variables, such as GDP growth rates, inflation rates, exchange rates, interest rates and stock prices, of the economies in question, and to explore the degree of correlation in these variables (see Ito, 1994; Taguchi, 1994; Tavlas, 1997; and Kwan 1998). Bayoumi and Eichengreen (1993, 1994) are among the first few to estimate the underlying structural shocks by using the Blanchard–Quah (1989) style vector autoregression (VAR) method. In this paper their work is extended by employing a three-variable VAR model in the style of Blanchard and Quah (1989) to identify various types of shocks over two decades of data from East Asia. In particular, with an open macroeconomic setting, real output, real effective exchange rates and prices variables in the VAR are employed to identify the fundamental supply, demand and monetary shocks. For comparison purpose, this model is also applied to the European countries and the correlation results of underlying shocks compared with the East Asian region and the European region.[5] The associated impulse response function analysis is also conducted to measure the size of the underlying shocks and the speed of adjustment to disturbances. Then the effect of global (US) shocks from the estimated underlying shocks of the East Asian economies are removed and the correlation of re-estimated shocks for comparison examined.

The remainder of the paper is organized as follows. Section II discusses the theoretical framework and methodology for this study. In Section III, the characteristics of the variables concerned is first assessed, and then, the underlying structural shocks as well as their sizes and the adjustment speed to shocks estimated by applying an impulse response analysis. Also a comparison of the estimated shocks and the speed of adjustment between the East Asian and the European regions is made, and the robustness of the estimations checked in this section. The final section concludes this study.

II. ANALYTICAL FRAMEWORK

The simplest approach of the literature on the OCA question is to investigate various observable macroeconomic variables (such as real GDP growth rate, inflation rate and exchange rate) of the economies or regions concerned and to explore to what extent the variables are correlated across the economies or the regions. The influential works of Bayoumi and Eichengreen (1993, 1994) go beyond the analysis of simple cross-country correlations of observable macroeconomic variables, and examine the underlying structural shocks that affect the economies or regions in question by using the structural VAR method developed by Blanchard and Quah (1989). The basic idea is that fluctuations of observable macroeconomic variables are subject to underlying shocks. Bayoumi and Eichengreen decompose shocks affecting GDP growth and inflation into underlying supply and demand shocks, and examine the cross-country correlation of each shock among the economies concerned. Recently, several studies, such as Kawai and Okumura (1996), and Bayoumi *et al.* (2000), have applied the OCA theory to the East Asian economies, using a structural VAR method. However, most existing studies employ a two-variable VAR model and their results are also mixed.[6] In this study, an open economy macroeconomic model is set up

[3] In the ASEAN + 3 (China, Japan and Korea) Finance Ministers Meeting on 6 May 2000 at Chiang Mai, participating countries agreed to establish a regional financing arrangement to supplement the existing international facilities through the 'Chiang Mai Initiative'. The Initiative involves an expanded ASEAN Swap Arrangement that would include all ASEAN countries, and a network of bilateral swap and repurchase agreement facilities among ASEAN countries, China, Japan and the Republic of Korea.

[4] For a good survey of OCA, see Kawai (1987), Tavlas (1993) and De Grauwe (2000).

[5] Fourteen EU countries are included in this study only. Owing to data availability, Greece, Ireland and Luxembourg that are member states of the European Union are not included in the analysis.

[6] Chow and Kim's (2000) study is different from the previous literature: they use a three-variable VAR model, assuming that domestic output is subject to three types of shocks (global, regional and country-specific shocks).

with three variables of output, exchange rate and the price level to examine the underlying shocks that affect the region.[7]

Three macroeconomic variables are used, home output (y_t), real effective exchange rate (q_t) and home price level (p_t) to identify the fundamental supply, demand and monetary shocks.[8] 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 denotes the first-difference operator and ε_{st}, ε_{dt}, and ε_{mt} denote supply, demand and monetary shocks, respectively. The structural model can be compactly written,

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

or

$$\begin{pmatrix} \Delta y_t \\ \Delta q_t \\ \Delta p_t \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{pmatrix} \begin{pmatrix} \varepsilon_{st} \\ \varepsilon_{dt} \\ \varepsilon_{mt} \end{pmatrix} \qquad (2)$$

where $A_{ij}(L) = a_{ij}^{o} + a_{ij}^{1}L + a_{ij}^{2}L^2 + \cdots$, and it is assumed that the structural shocks $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$ are serially uncorrelated and have a variance–covariance matrix normalized to the identity matrix. The model implies that the macroeconomic variables are subject to the three structural shocks, i.e., the supply, demand and monetary shocks.

To identify the structural A_i matrices, the Blanchard–Quah approach is followed and impose the following long-run restrictions: (i) that only supply shocks (ε_{st}) are expected to affect output in the long-run, (ii) that both supply and demand shocks (ε_{st} and ε_{dt}) influence real effective exchange rates in the long-run, and (iii) that monetary shocks (ε_{mt}) have no long-run effect on either output or real effective exchange rates. Thus, the restriction (i) requires $A_{12}(1) = A_{13}(1) = 0$, and the restrictions (ii) and (iii) require $A_{23}(1) = 0$. These long-run restrictions are sufficient to identify the structural A_i matrices and the time series of structural shocks $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$.

To identify the structural A_i matrices, the following reduced-form VAR model is estimated:

$$\Delta x_t = B(L)\Delta x_{t-1} + u_t \qquad (3)$$

where u_t is a vector reduced-form disturbance. A MA representation of Equation (3) is:

$$\Delta x_t = C(L)u_t \qquad (4)$$

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 4, the relationship between the structural and reduced-form disturbances is obtained: $u_t = A_0\varepsilon_t$. Hence, it is necessary to obtain estimates of A_0 to recover the time series of structural shocks ε_t. Since the structural shocks are mutually orthogonal and each shock has unit variance, the following relationship between the variance-covariance matrices is obtained: $C(1)\Sigma C(1)' = A(1)A(1)'$ where $\Sigma = Eu_tu_t' = EA_0\varepsilon_t\varepsilon_t'A_0' = A_0A_0'$. Letting H denote the lower triangular Choleski decomposition of $C(1)\Sigma C(1)'$, $A(1) = H$ is obtained since the long-run restrictions imply that $A(1)$ is also lower triangular. Consequently, $A_0 = C(1)^{-1}A(1) = C(1)^{-1}H$ is obtained. Given an estimate of A_0, the time series of structural shocks, $\varepsilon_t \equiv [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$ can be recovered.

Assessing some major characteristics of this study are now considered. First, the structural decomposition using the Blanchard–Quah technique does not necessarily identify purely stochastic disturbances. The estimated demand and monetary disturbances tend to include the effect of macroeconomic policies, whereas supply disturbances are assumed to be less likely to include the impact of policies implemented.[9] This implies that supply disturbances are more informative for evaluating the symmetry of shocks, and hence the feasibility of OCAs, than other disturbances. This is the standard approach in the OCA literature.

Second, in the open-economy framework, estimated structural shocks tend to include the effect of foreign shocks.[10] For example, even though a high correlation of demand shocks across the economies is obtained, the technique cannot distinguish whether the result simply reflects the correlation of local shocks or the correlation is affected by global shocks. To test the robustness of the empirical results, the seemingly unrelated regression (SUR) method is employed by removing the effect of global (US) shocks on the structural local shocks.

Third, asymmetric shocks would not cause a great deal of trouble to countries if the size of shocks were much smaller and if an economy responded more quickly to disturbances. In the later section, the size of shocks and the speed of adjustment between the East Asian economies and the European countries will be investigated and compared.

[7] The present model draws on Clarida and Gali (1994) that attempt to identify the source of real exchange rate fluctuations using a three-variable VAR model in the manner of Obstfeld (1985). Obstfeld developed a stochastic version of the two-country open macro model under rational expectations. See also Rogers (1998) and Demertzis *et al.* (2000) for similar studies on the European countries.

[8] Lowercase variables are natural logarithms so that the first-difference of variables can be interpreted as a growth rate.

[9] One possible way to overcome this problem is to include extra policy variables in the VAR system. However, the more variables in the VAR system, the more difficult to identify structural shocks, unless we can get obvious identifying restrictions from economic theory are obtained. Demertzis *et al.* (2000) investigate whether the symmetry of structural shocks for European countries is policy-induced by investigating correlations between identified shocks and policy variables.

[10] Kawai and Okumura (1996) focus on this issue and attempt to remove the effect of global shocks in calculating correlation of underlying shocks, while Chow and Kim (2000) attempt to identify three types of shocks: global, regional and country-specific shocks.

Table 1. *The variability of nominal exchange rates (1983:10–2000:10 and 1983:10–1984:12)*

	USA	JP	CH	HK	ID	KR	MA	PH	SI	TH	TW
USA		0.018	0.020	0.010	0.006	0.004	0.009	0.059	0.008	0.039	0.010
JP	0.030		0.020	0.021	0.017	0.014	0.013	0.059	0.010	0.047	0.022
CH	0.033	0.044		0.020	0.017	0.019	0.019	0.065	0.017	0.039	0.023
HK	0.003	0.030	0.033		0.011	0.012	0.013	0.059	0.012	0.039	0.011
ID	0.073	0.074	0.081	0.073		0.006	0.010	0.060	0.008	0.040	0.013
KR	0.032	0.040	0.046	0.032	0.064		0.006	0.059	0.005	0.040	0.012
MA	0.023	0.032	0.038	0.024	0.062	0.030		0.057	0.006	0.040	0.013
PH	0.027	0.040	0.042	0.027	0.066	0.034	0.026		0.058	0.068	0.059
SI	0.013	0.025	0.036	0.013	0.067	0.030	0.018	0.026		0.041	0.013
TH	0.030	0.037	0.044	0.030	0.061	0.029	0.022	0.028	0.024		0.038
TW	0.013	0.028	0.036	0.013	0.070	0.030	0.022	0.027	0.014	0.027	

Note: Top panel presents the variability of the exchange rates in 1983–1984, and the bottom panel for the whole sample period from 1983:10–2000:10.

In addition, asymmetric shocks would not generate large costs of adjustment for the economies concerned, if country-specific policies can stabilize national output by mitigating real-side shocks, and if factor mobility mitigates the impact of shocks. These issues call for the analysis of other OCA criteria, for instance, the factor mobility and labour market flexibility. These issues are not taken up in this paper.

Finally, Frankel and Rose (1998) argue that more international trade will produce more highly correlated business cycles, which implies that the correlation of underlying (supply) shocks is likely to increase as trade integration progresses. This critique in light of the so-called endogeneity issue also applies to this study as time-invariant VARs are used and the analysis focuses on just one condition of the OCA criteria. Further investigation into the effect of regime changes on correlation of shocks would be necessary.

III. EMPIRICAL RESULTS

Data

Real GDP is used as a proxy for real output variable, and consumer price index (CPI) as a measure of changes in prices. Real effective exchange rates are calculated as a trade weighted geometric average of real exchange rates with 29 major trading partners of each individual economy. All data are quarterly, in natural logarithm and seasonally unadjusted except for real GDP series.[11] Data for the East Asian economies and the USA span from 1980Q1 to 2000Q3 (for China and Hong Kong, from 1986Q1 and 1983Q1, respectively), and for EU countries, the sample period covers 1980Q1–1998Q4 except for Belgium (1985Q1–1998Q4) and Denmark (1988Q1–1998Q4).

The major data sources used in this study 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,[12] and the ICSEAD database.

Correlation of underlying structural shocks

The variability of nominal bilateral exchange rates and the correlations in growth and inflation of the ten East Asian economies are examined for specified periods, with a particular reference to the effects of the two regional crises in the middle of the 1980s and the late 1990s, as well as China's unification of its dual exchange rates in early 1994 (due to space limitations, in Tables 1–3 are reported the results for exchange rates variable only. The rest are available on request). The exchange rates of the East Asian economies are found relatively stable. In all cases, the volatility of exchange rate against each other is within 5% and against the US dollar below 4%, with the exceptions of the Indonesian Rupiah, the Korea Won and Thai Baht during the recent financial crisis. The low variability of bilateral exchange rates in East Asia is, to a certain extent, the result of its financial market integration (Phylaktis, 1997, 1999), and also a reflection of the symmetric effects of shocks originated from the region and the rest of the world. On the other hand, 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.

The examination of correlations of the structural shocks is now undertaken. The time series properties of the

[11] *EViews 4* is used for the empirical examination below. Seasonal adjustment is conducted using Census X-11 (multiplicative).
[12] The authors are grateful to Tilak Abeysinghe for providing us with the real GDP series for some East Asian economies.

Table 2. *The variability of nominal exchange rates (1985:01–1996:12 and 1997:01–2000:10)*

	USA	JP	CH	HK	ID	KR	MA	PH	SI	TH	TW
USA		0.030	0.038	0.001	0.022	0.008	0.011	0.015	0.010	0.006	0.008
JP	0.032		0.048	0.030	0.036	0.029	0.028	0.037	0.025	0.025	0.029
CH	0.000	0.033		0.038	0.045	0.039	0.036	0.041	0.040	0.039	0.040
HK	0.000	0.032	0.000		0.022	0.008	0.011	0.015	0.010	0.006	0.011
ID	0.148	0.143	0.148	0.148		0.024	0.025	0.027	0.023	0.023	0.026
KR	0.032	0.068	0.067	0.067	0.129		0.014	0.018	0.012	0.009	0.011
MA	0.045	0.046	0.045	0.045	0.123	0.060		0.019	0.011	0.010	0.015
PH	0.036	0.043	0.036	0.036	0.127	0.057	0.029		0.020	0.018	0.019
SI	0.020	0.028	0.020	0.020	0.134	0.059	0.032	0.026		0.007	0.013
TH	0.058	0.058	0.058	0.058	0.120	0.055	0.037	0.035	0.044		0.012
TW	0.018	0.028	0.019	0.019	0.140	0.060	0.037	0.030	0.014	0.049	

Note: Top panel of Table 2 presents the variability of the exchange rates in 1985–1996, and the bottom presents the variability in 1997–2000.

Table 3. *The variability of nominal exchange rates (1983:10–1993:12 and 1994:01–2000:10)*

	USA	JP	CH	HK	ID	KR	MA	PH	SI	TH	TW
USA		0.028	0.022	0.003	0.024	0.007	0.010	0.026	0.011	0.015	0.011
JP	0.032		0.036	0.028	0.035	0.028	0.026	0.040	0.023	0.027	0.029
CH	0.045	0.053		0.023	0.033	0.022	0.024	0.032	0.026	0.025	0.024
HK	0.000	0.032	0.045		0.025	0.008	0.011	0.026	0.011	0.015	0.011
ID	0.111	0.110	0.120	0.111		0.026	0.026	0.036	0.025	0.028	0.028
KR	0.050	0.054	0.067	0.050	0.097		0.013	0.027	0.012	0.016	0.011
MA	0.035	0.040	0.052	0.035	0.092	0.046		0.027	0.010	0.016	0.014
PH	0.029	0.040	0.054	0.029	0.095	0.044	0.025		0.028	0.029	0.027
SI	0.016	0.027	0.047	0.016	0.101	0.044	0.025	0.022		0.015	0.014
TH	0.044	0.047	0.063	0.044	0.090	0.042	0.029	0.028	0.033		0.018
TW	0.016	0.027	0.049	0.016	0.105	0.045	0.031	0.026	0.013	0.037	

Note: The top panel of Table 3 presents the variability of the exchange rates in 1983–1993, and the bottom presents the variability in 1994–2000.

variables were first investigated and it was found that most variables are I(1) based on the result of the Phillips–Perron and KPSS tests (the results are available on request). Therefore, the first differences of all variables are used to ensure the stationarity of the variables. For estimation of the VAR, one lag based on SBIC was chosen. 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.

Correlation analysis: the East Asian economies and the USA. The results of correlations of the three identified shocks among the East Asian economies for 1980Q1–1997Q1 and 1980Q1–2000Q3 are reported in Tables 4 and 5.[13] In the top panel of Table 4, it is found that supply shocks are correlated significantly only among a few ASEAN countries and the Asian NIEs. It is interesting to note that the regional financial crisis improved the number of significant correlations of supply shocks in these economies, especially among the economies that have been hit mostly by the crisis (the top panel in Table 5). 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. There are no significant correlations of supply shocks between the USA and the region, as well as between Japan and the rest of East Asia prior to the financial crisis. Although the financial crisis has improved the correlation coefficients of Japan with some economies, Malaysia is the only country showing a significant correlation with Japan at the 5% level. This finding seems against the casual observation.

[13] The significance levels of correlation coefficients are assessed using the 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 estimated correlation coefficient. Asymptotically, the mean of z is zero and the standard deviation is approximately $(n-3)^{-1/2}$, under the null hypothesis is that correlation coefficient is zero, where n denotes the sample size. A concise explanation is given in Rodriguez (1982).

Table 4. *Correlation of structural shocks between the USA and the East Asian economies before the financial crisis*

	USA	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
Panel A: Supply shocks (1980Q3–1997Q1)											
USA	1.00										
Japan	0.07	1.00									
Korea	−0.02	−0.03	1.00								
Taiwan	0.11	−0.06	0.31*	1.00							
Hong Kong	0.03	0.09	0.10	0.49*	1.00						
Singapore	−0.03	−0.08	−0.08	0.14	0.07	1.00					
Malaysia	−0.09	−0.03	−0.03	0.00	−0.03	0.30*	1.00				
Indonesia	0.12	−0.20	0.01	0.03	−0.16	0.06	0.32*	1.00			
Thailand	0.08	−0.18	0.15	0.01	−0.11	0.05	0.06	0.16	1.00		
Philippines	−0.01	0.16	0.01	0.07	0.24	0.12	0.02	−0.05	−0.03	1.00	
China	−0.05	−0.20	−0.18	0.00	0.12	0.17	−0.02	−0.04	−0.16	0.05	1.00
Panel B: Demand shocks (1980Q3–1997Q1)											
USA	1.00										
Japan	−0.63	1.00									
Korea	0.66*	−0.49	1.00								
Taiwan	0.58*	−0.33	0.62*	1.00							
Hong Kong	0.50*	−0.22	0.39*	0.36*	1.00						
Singapore	0.31*	−0.23	0.21	0.18	0.31*	1.00					
Malaysia	0.46*	−0.44	0.21	0.31*	0.16	0.18	1.00				
Indonesia	0.28*	−0.21	0.23	0.08	0.12	−0.08	0.10	1.00			
Thailand	0.49*	−0.39	0.31*	0.32*	0.40*	0.09	0.24	0.13	1.00		
Philippines	0.46*	−0.49	0.45*	0.40*	0.16	0.26*	0.44*	0.29*	0.31*	1.00	
China	0.36*	−0.29	0.30	0.21	−0.38	−0.27	0.33*	0.32*	0.22	0.24	1.00
Panel C: Monetary shocks (1980Q3–1997Q1)											
USA	1.00										
Japan	0.16	1.00									
Korea	0.24	0.08	1.00								
Taiwan	0.33*	0.24*	0.12	1.00							
Hong Kong	0.14	0.33*	0.08	0.18	1.00						
Singapore	−0.09	0.19	0.17	0.06	0.18	1.00					
Malaysia	0.05	0.14	0.19	0.10	−0.05	0.46*	1.00				
Indonesia	0.05	−0.03	0.27*	0.19	−0.11	0.22	0.29*	1.00			
Thailand	0.21	0.45*	0.13	0.14	0.22	0.05	0.13	−0.14	1.00		
Philippines	0.04	−0.08	0.02	0.24*	0.13	0.25*	0.17	0.20	−0.18	1.00	
China	0.15	−0.19	0.37*	−0.06	−0.15	−0.12	0.48*	0.17	0.08	−0.04	1.00

Notes:
1. Sample period is from 1980Q3 to 1997Q1 for all economies except China (from 1986Q3 to 1997Q1) and Hong Kong (from 1983Q3 to 1997Q1).
2. Significance levels are assessed using the Fisher's variance-stabilizing transformation. See the text for more details.
3. The sample size is 67 for all economies except Hong Kong (55) and China (43), and the critical value at the 5% significance level (two-tailed test) is +/−0.240, +/−0.265 and +/−0.300, respectively. *Positive correlation coefficients at the 5% level.

In contrast, demand shocks and monetary shocks are highly correlated among the economies concerned (Panel B in Tables 4 and 5). In particular, the USA was significantly and positively correlated in demand shocks with almost all the East Asian economies except Japan prior to the crisis, which reflects the similarity of their macroeconomic policy pursued during the period. Japan exhibited a high negative correlation of demand shocks with the rest of East Asia. As Japan is the major source of imports for the rest of East Asia,[14] an increase in Japan's price level driven by her demand shocks would spur a negative impact on the demand of the other East Asian economies.

Demand shocks are significantly correlated among the Asian NIEs in the periods both including and excluding the crisis. The financial crisis has increased the number of significant correlations in the region, especially for the most-hit economies by the crisis. In particular, the ASEAN economies have become significantly correlated with Korea and Taiwan as well as among themselves since the crisis. China has also increased its correlation

[14] According to ICSEAD (2001), Japan accounted for roughly about 20–30% of other East Asia's total imports in the 1980s and 1990s.

Table 5. *Correlation of structural shocks between the united states and the East Asian economies including the post-financial crisis period*

	USA	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
Panel A: Supply shocks (1980Q3–2000Q3)											
USA	1.00										
Japan	−0.07	1.00									
Korea	−0.17	0.22	1.00								
Taiwan	0.05	0.00	0.28*	1.00							
Hong Kong	0.03	0.16	0.22	0.44*	1.00						
Singapore	−0.10	−0.03	0.11	0.23*	0.16	1.00					
Malaysia	−0.19	0.22*	0.37*	0.18	0.16	0.32*	1.00				
Indonesia	−0.04	0.05	0.45*	0.20	0.03	0.18	0.44*	1.00			
Thailand	0.05	0.09	0.30*	−0.05	0.09	0.06	0.17	0.31*	1.00		
Philippines	−0.05	0.12	0.13	0.07	0.21	0.12	0.08	0.16	0.04	1.00	
China	−0.06	−0.03	−0.04	−0.01	0.20	0.17	0.04	0.06	0.02	0.04	1.00
Panel B: Demand shocks (1980Q3–2000Q3)											
USA	1.00										
Japan	−0.53	1.00									
Korea	0.30*	−0.07	1.00								
Taiwan	0.23*	0.24*	0.63*	1.00							
Hong Kong	0.28*	−0.09	0.31*	0.27*	1.00						
Singapore	0.15	0.24*	0.42*	0.64*	0.28*	1.00					
Malaysia	0.20	0.03	0.54*	0.59*	0.14	0.51*	1.00				
Indonesia	0.09	0.04	0.52*	0.39*	0.05	0.33*	0.45*	1.00			
Thailand	0.18	0.01	0.49*	0.48*	0.23	0.41*	0.54*	0.29*	1.00		
Philippines	0.32*	−0.26	0.45*	0.40*	−0.03	0.28*	0.55*	0.41*	0.27*	1.00	
China	0.33*	0.06	0.37*	0.40*	−0.05	0.35*	0.39*	0.17	0.33*	0.20	1.00
Panel C: Monetary shocks (1980Q3–2000Q3)											
USA	1.00										
Japan	−0.03	1.00									
Korea	0.20	−0.03	1.00								
Taiwan	0.23*	0.18	0.11	1.00							
Hong Kong	0.08	0.10	−0.01	0.30*	1.00						
Singapore	−0.07	0.15	0.15	0.11	0.26*	1.00					
Malaysia	−0.02	−0.02	0.33*	0.26*	0.16	0.47*	1.00				
Indonesia	−0.01	−0.10	0.15	0.23*	0.04	0.06	0.35*	1.00			
Thailand	0.06	0.24*	0.13	0.07	0.19	0.11	0.24*	0.06	1.00		
Philippines	−0.01	0.02	0.05	0.23*	0.19	0.28*	0.30*	0.08	−0.16	1.00	
China	0.14	−0.18	0.36*	0.03	0.12	0.15	0.35*	0.16	0.27*	0.11	1.00

Notes:
1. Sample period is from 1980Q3 to 2000Q3 for all economies except Japan (from 1980Q4 to 2000Q3), China (from 1986Q3 to 2000Q3) and Hong Kong (from 1983Q4 to 2000Q3).
2. Significance levels are assessed using the Fisher's variance-stabilizing transformation. See the text for more details.
3. The sample size is 81 for all economies except Japan (80), Hong Kong (69) and China (57), and the critical value at the 5% significance level (two-tailed test) is +/−0.218, +/−0.220, +/−0.237 and +/−0.261, respectively. *Positive correlation coefficients at the 5% level.

with the USA, the NIEs and ASEAN. The correlation coefficients of Japan with the rest of East Asia have mostly turned to positive, though remained insignificant except with Taiwan and Singapore.

Monetary shocks reflect internal monetary disturbances, whether policy-induced or purely stochastic. The results show that monetary shocks are less correlated than demand shocks in East Asia in both sample periods (Panel C in Tables 4 and 5). Although the regional financial crisis improved the number of significant correlations of monetary shocks among the NIEs and ASEAN countries, it reduced the number of significant correlations of Japan with the rest of East Asia. The US economy maintained significant correlation of shocks with Taiwan in the periods both including and excluding the crisis. However, caution is required since including the post-crisis period in the sample may cause structural breaks in the series, which would affect estimation.[15]

[15] 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 as in the 1980s.

It is argued that supply shocks are often 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) often are symmetric shocks encountered, the greater (lesser) are the correlations in supply shocks, and the more feasible does it become for these economies to establish an OCA. As the identified supply shocks are not highly correlated and asymmetric shocks seem prevail in the region, the results do not suggest that the OCA is feasible in the entire East Asian region, but highly possible in some subregions or group of countries.

Comparison with the European countries. To test for robustness of the model, the same method is employed to estimate the three structural shocks in the EU countries and to compare the results with that in East Asia. The results are reported in Table 6.

First, it is noted that symmetric supply shocks prevail only in subgrouped EU countries and are not uniformly observed across the European countries. This is the case even in the so-called 'core' countries and in the Euro area.[16] For instance, Germany, which is typically considered as the regional lead country, is significantly correlated in supply shocks only with Austria and Italy.[17] These results suggest that supply shocks are far less symmetric in the EU countries than to be expected. This contrasts with the earlier conclusion for the East Asian region.

Then, the correlations of demand shocks show a similar pattern to that of supply shocks in the East Asian countries. They are significantly correlated only within subgrouped countries. In the core countries, symmetric demand shocks prevail and the significance of correlations is high, reflecting their close macroeconomic policy coordination. In particular, Germany is found to be positively and significantly correlated of demand shocks with the core countries and Switzerland. In contrast, the leading economy of Japan does not exhibit a significant correlation of demand shocks with other East Asian economies. Finally, similar to the case of East Asia, the symmetric pattern of monetary shocks in the EU countries is found less clear and undetermined. This finding is consistent with Demertzis *et al.* (2000) that the symmetry in Europe observed from correlation analysis of structural shocks is created by policy interventions rather than some natural symmetry in the underlying shocks.

In sum, the results show that the underlying structural shocks are less symmetric in the East Asian region than in the European region, and the leading economy (Germany versus Japan) also displays very different influence on other economies in the respective region. This finding is consistent with the earlier conclusion that it is less feasible for the entire East Asian region to form an OCA, but very possible in some subgroups, such as among some NIEs and ASEAN countries where the underlying shocks are positively and significantly correlated.

Size of disturbances and speed of adjustment

Having analysed the correlation features of the underlying shocks, an investigation of the size of shocks and the speed of adjustment to shocks are now considered for the economies concerned. Since the estimated structural shocks are assumed to have unit variances in the structural VAR method, their size and adjustment speed can be inferred by analysing the associated impulse response functions (Bayoumi and Eichengreen, 1994). In this study, the long-run (20-quarter horizon) effect of a unit shock on changes in real GDP is used as a measure of the size of supply shocks, and choose the 1-quarter impact on the changes in real exchange rates and CPI, respectively, to estimate the size of demand and monetary shocks. The speed of adjustment is measured by the response after 4-quarters in its long-run effect (that is, the response after a 20-quarter horizon).[18] 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 and renouncing the monetary sovereignty and policy autonomy.

Table 7 reports the results of the impulse response function analysis. It is found that the size of supply shocks is the largest in the most open economies, such as Hong Kong, Singapore, Malaysia and the Philippines. For demand and monetary shocks, the sizes appear to be the largest in the Philippines, China, Indonesia and Taiwan. It is also noted that the recent Asian financial crisis has, in general, increased considerably the sizes of supply and demand shocks, in particular for those economies hit

[16] Conventionally, the 'core' countries include Austria, the Benelux, Denmark, France and Germany, while Luxembourg is not taken up in this paper. Euro area consists of the 12 countries: Austria, Benelux, Finland, France, Germany, Greece, Ireland, Italy, Portugal and Spain, though Greece, Ireland and Luxembourg are not taken up due to the data availability.

[17] With a different setting and data source, Bayoumi and Eichengreen (1994) find that Germany's supply shocks are significantly correlated with those of France, Netherlands, Belgium, Denmark, Austria and Switzerland. Demertzis *et al.* (2000, Table 2) also show that significant correlations of supply shocks with Germany are observed in France, Belgium, Denmark, Luxembourg, Netherlands, United Kingdom, Sweden and Italy.

[18] Choice of the 1-quarter impact in calculating the size of demand and monetary shocks is somewhat arbitrary. However, choosing longer horizons for demand and monetary shocks as a measure will not change the conclusion.

Table 6. *Correlation of structural shocks between the European countries*

	Ger	Aus	Bel	Den	Fra	Net	Swi	UK	Ita	Por	Spa	Nor	Swe	Fin
Panel A: Supply shocks (1980Q3–1998Q4)														
Germany	1.00													
Austria	0.31*	1.00												
Belgium	0.22	0.22	1.00											
Denmark	−0.03	−0.09	0.29	1.00										
France	0.23	0.31*	0.50*	0.28	1.00									
Netherlands	0.03	0.15	0.29*	0.23	0.20	1.00								
Switzerland	−0.12	0.18	0.30*	0.08	0.15	0.26*	1.00							
UK	0.05	0.10	0.14	0.10	0.11	−0.05	0.11	1.00						
Italy	0.29*	0.16	0.27	0.17	0.40*	0.09	0.16	0.12	1.00					
Portugal	−0.04	0.06	0.39*	0.18	0.38*	−0.04	0.24*	0.03	0.13	1.00				
Spain	−0.04	0.30*	0.13	0.41*	0.14	−0.01	0.14	0.04	0.27*	0.14	1.00			
Norway	0.11	−0.08	0.20	0.18	0.34*	0.15	0.21	0.07	0.33*	0.01	0.09	1.00		
Sweden	0.03	0.20	0.38*	0.16	0.50*	0.01	0.02	0.31*	0.39*	0.07	0.15	0.27*	1.00	
Finland	−0.06	0.01	0.26	0.32*	0.34*	0.10	0.00	0.19	0.32*	−0.08	0.13	0.10	0.44*	1.00
Panel B: Demand shocks (1980Q3−1998Q4)														
Germany	1.00													
Austria	0.82*	1.00												
Belgium	0.71*	0.66*	1.00											
Denmark	0.67*	0.72*	0.73*	1.00										
France	0.43*	0.53*	0.46*	0.70*	1.00									
Netherlands	0.82*	0.85*	0.64*	0.69*	0.53*	1.00								
Switzerland	0.47*	0.43*	0.49*	0.55*	0.39*	0.51*	1.00							
UK	−0.32	−0.39	−0.26	−0.31	−0.32	−0.29	−0.27	1.00						
Italy	−0.05	−0.13	0.12	−0.10	0.12	0.07	−0.07	0.22	1.00					
Portugal	0.12	0.20	0.20	0.34*	0.12	0.01	0.00	−0.13	0.02	1.00				
Spain	0.12	0.15	0.21	0.35*	0.15	0.06	−0.04	−0.04	0.18	0.25*	1.00			
Norway	0.10	0.15	0.33*	0.28	0.12	0.04	−0.05	0.21	0.09	0.18	0.05	1.00		
Sweden	−0.27	−0.23	0.23	0.05	−0.04	−0.23	−0.26	0.21	0.31*	0.02	0.18	0.26*	1.00	
Finland	−0.02	0.00	0.29*	0.22	−0.07	−0.04	−0.05	0.15	0.18	0.21	0.14	0.41*	0.51*	1.00
Panel C: Monetary shocks (1980Q3–1998Q4)														
Germany	1.00													
Austria	0.38*	1.00												
Belgium	0.53*	0.59*	1.00											
Denmark	0.03	−0.14	0.04	1.00										
France	0.00	0.03	−0.06	0.36*	1.00									
Netherlands	0.17	0.22	0.09	0.03	0.03	1.00								
Switzerland	0.46*	0.14	0.19	0.38*	0.16	0.06	1.00							
UK	−0.03	0.11	−0.03	0.61*	0.45*	0.23*	0.20	1.00						
Italy	0.24*	−0.13	−0.18	0.31*	−0.03	0.16	0.37*	0.11	1.00					
Portugal	0.24*	0.19	−0.16	0.24	0.18	−0.18	0.26*	0.14	0.10	1.00				
Spain	0.21	0.41*	0.26	−0.03	0.14	−0.25	0.14	−0.02	0.09	0.52*	1.00			
Norway	0.13	0.13	−0.35	0.37*	0.05	−0.05	0.22	0.04	0.06	0.43*	0.29*	1.00		
Sweden	0.20	0.18	0.07	0.08	0.25*	−0.01	0.38*	0.11	0.42*	0.39*	0.17	0.27*	1.00	
Finland	0.29*	0.19	0.16	0.15	0.35*	−0.02	0.20	0.30*	0.20	0.33*	0.17	0.19	0.50*	1.00

Notes:
1. Sample period is from 1980Q3 to 1998Q4 for all countries except Belgium (from 1985Q3 to 1998Q4) and Denmark (from 1988Q3 to 1998Q4).
2. Significance levels are assessed using the Fisher's variance-stabilizing transformation. See the text for more details.
3. The sample size is 74 for all countries except Belgium (54) and Denmark (42), and the critical value at the 5% significance level (two-tailed test) is +/−0.229, +/−0.268 and +/−0.304, respectively. *Positive correlation coefficients at the 5% level.

mostly by the crisis, such as Korea, Thailand, Indonesia and Malaysia. In comparison, the average size of the three underlying shocks is much larger in East Asia than that in the EU countries.

In contrast, it is interesting to note that the speed of adjustment to shocks 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: on average, 96% or more of adjustment is completed within a 4-quarter horizon before the crisis. The regional financial crisis does not change much the pattern of adjustment. One possible explanation to this difference is that the labour market and

Table 7. *The size of shocks and the speed of adjustment to shocks across different economies*

	Supply shocks		Demand shocks		Monetary shocks	
	Size	Speed	Size	Speed	Size	Speed
Panel A: United States and the East Asian economies (1980Q3–1997Q1)						
USA	0.009	0.981	0.030	0.987	0.004	0.922
Japan	0.009	0.990	0.042	0.984	0.006	0.996
Korea	0.013	0.975	0.026	0.984	0.009	0.889
Taiwan	0.012	1.015	0.027	1.002	0.010	0.959
Hong Kong	0.022	0.994	0.030	0.967	0.006	0.951
Singapore	0.018	0.997	0.016	0.963	0.005	0.962
Malaysia	0.018	0.972	0.022	0.951	0.006	0.980
Indonesia	0.010	0.999	0.052	0.995	0.013	1.000
Thailand	0.014	1.000	0.026	0.998	0.007	0.997
Philippines	0.023	0.952	0.044	1.023	0.015	0.884
China	0.015	1.002	0.061	0.997	0.021	0.991
Average	0.016	0.990	0.035	0.986	0.010	0.961
Panel B: United States and the East Asian economies (1980Q3–2000Q3)						
USA	0.009	0.972	0.029	0.994	0.004	0.899
Japan	0.011	0.871	0.056	0.980	0.005	0.716
Korea	0.020	1.000	0.044	1.000	0.010	0.946
Taiwan	0.011	1.012	0.041	0.993	0.010	0.971
Hong Kong	0.025	1.004	0.024	0.695	0.005	0.640
Singapore	0.019	1.001	0.027	0.981	0.005	0.948
Malaysia	0.027	0.956	0.035	0.987	0.007	0.997
Indonesia	0.030	0.995	0.072	1.044	0.018	1.045
Thailand	0.027	0.979	0.048	0.998	0.008	0.990
Philippines	0.021	0.962	0.044	1.017	0.015	0.901
China	0.015	0.986	0.070	0.992	0.021	0.973
Average	0.021	0.977	0.046	0.969	0.010	0.913
Panel C: European countries (1980Q3–1998Q4)						
Austria	0.008	1.000	0.010	0.995	0.007	0.997
Belgium	0.008	0.998	0.011	0.990	0.004	1.000
Finland	0.016	0.963	0.018	0.938	0.005	0.785
France	0.008	0.904	0.012	0.745	0.003	0.433
Germany	0.015	1.002	0.016	0.992	0.006	0.986
Italy	0.008	0.914	0.022	0.949	0.005	0.457
Netherlands	0.008	0.997	0.014	1.012	0.004	1.000
Portugal	0.019	0.931	0.021	0.987	0.013	0.678
Spain	0.017	0.445	0.019	1.011	0.008	0.917
Denmark	0.011	1.006	0.015	0.994	0.004	1.005
Norway	0.011	0.952	0.014	0.948	0.005	0.801
Sweden	0.010	0.985	0.030	1.003	0.009	0.920
Switzerland	0.009	0.985	0.021	1.000	0.007	0.968
United Kingdom	0.010	0.953	0.033	0.987	0.009	0.997
Average	0.011	0.931	0.018	0.968	0.006	0.853

Notes:
1. The size of supply, demand and monetary shocks is inferred from the associated impulse response functions that trace out the effect of a unit shock on changes in real GDP, real effective exchange rates and CPI, respectively. See the text for details.
2. The speed of adjustment is summarized by the response after 4-quarter horizon as a share of the long-run effect (20-quarter horizon).
3. In Panels A and B, the average of 10 East Asian economies is reported.

wage rates in most East Asian economies are relatively more flexible, and hence, it is much easier for these economies to adjust internally in response to shocks.

Thus, the results lend support to the proposal of forming a common currency arrangement in some East Asian countries. Those with a high correlation and small size of shocks and a fast pace of adjustment would be better candidates for such arrangement.

Robustness: removing the effects of global shocks

As mentioned earlier, in the open-economy framework, estimated structural shocks obtained by the structural

Table 8. *Correlation of structural shocks between the East Asian economies after removing the US shocks*

	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
Panel A: Supply shocks (1980Q3–1997Q1)										
Japan	1.00									
Korea	−0.09	1.00								
Taiwan	−0.08	0.33*	1.00							
Hong Kong	0.06	0.02	0.52*	1.00						
Singapore	−0.13	−0.03	0.07	0.00	1.00					
Malaysia	−0.06	−0.10	−0.08	−0.05	0.28*	1.00				
Indonesia	−0.38	−0.13	−0.08	−0.17	0.10	0.29*	1.00			
Thailand	−0.18	0.06	−0.07	−0.16	0.05	0.06	0.17	1.00		
Philippines	0.16	0.04	0.11	0.24	0.10	0.06	0.07	−0.04	1.00	
China	−0.25	−0.10	−0.03	0.13	0.18	0.13	0.07	−0.13	0.12	1.00
Panel B: Demand shocks (1980Q3–1997Q1)										
Japan	1.00									
Korea	−0.06	1.00								
Taiwan	−0.03	0.45*	1.00							
Hong Kong	0.15	0.04	0.10	1.00						
Singapore	−0.10	0.02	0.10	0.14	1.00					
Malaysia	−0.17	−0.07	−0.04	−0.12	−0.02	1.00				
Indonesia	−0.05	0.04	−0.15	−0.13	−0.18	−0.06	1.00			
Thailand	−0.14	−0.09	0.04	0.22	−0.02	0.08	−0.04	1.00		
Philippines	−0.27	0.30*	0.27*	−0.13	0.22	0.29*	0.17	0.12	1.00	
China	−0.07	0.07	0.01	−0.68	−0.37	0.16	0.18	−0.11	−0.10	1.00
Panel C: Monetary shocks (1980Q3–1997Q1)										
Japan	1.00									
Korea	0.01	1.00								
Taiwan	0.28*	0.07	1.00							
Hong Kong	0.29*	0.10	0.12	1.00						
Singapore	0.08	0.18	0.18	0.18	1.00					
Malaysia	−0.03	0.16	−0.08	−0.08	0.37*	1.00				
Indonesia	−0.06	0.19	0.10	0.01	0.17	0.27*	1.00			
Thailand	0.33*	−0.13	0.01	0.34*	−0.07	−0.10	−0.26	1.00		
Philippines	−0.08	0.02	0.11	0.02	0.16	0.10	−0.01	−0.26	1.00	
China	−0.20	0.35*	−0.09	−0.10	−0.15	0.48*	0.15	−0.01	−0.05	1.00

Notes:
1. The sample period starts from 1981Q2 for Japan and Malaysia; from 1981Q3 for Korea, Taiwan, Singapore, Indonesia, Thailand and the Philippines; from 1983Q3 for Hong Kong; and from 1986Q3 for China.
2. The sample size is 64 for Japan and Malaysia, 63 for Korea, Taiwan, Singapore, Indonesia, Thailand and the Philippines, 55 for Hong Kong, and 43 for China, and the critical value at the 5% significance level (two-tailed test) is +/−0.246, +/−0.248, +/−0.265 and +/−0.300, respectively. *Positive correlation coefficients at the 5% level.

VAR method tend to include the effect of global shocks as well as local shocks. In other words, even if underlying shocks are significantly correlated across the economies, it does not necessarily ensure a significant correlation of local shocks. It is possible that such significant correlation of shocks is due to the effect of global shocks (see Kawai and Okumura, 1996). In this section, a robustness test of the empirical findings is conducted by investigating the correlations of underlying shocks after removing the effect of global shocks.

It is assumed the US shocks to be the global shocks affecting the East Asian economies. First the respective shocks of the East Asian economies on the three types of US shocks is regressed (i.e., supply, demand and monetary shocks) with four lags by OLS:[19]

$$\varepsilon^{j}_{i,t} = \text{const} + \sum_{k=0}^{4} \alpha_k \varepsilon^{US}_{s,t-k} + \sum_{k=0}^{4} \beta_k \varepsilon^{US}_{d,t-k} + \sum_{k=0}^{4} \gamma_k \varepsilon^{US}_{m,t-k}$$

where s, d, and m stand for supply, demand and monetary shocks, respectively; $i = s,\ d,\ m$; $k = 0,\ 1, \ldots, 4$; and the superscript j denotes a country of East Asia. Then, the equation is re-estimated by including the US shocks that are statistically significant at least at the 5% level in the first-stage OLS regression. In particular, a system of three equations is estimated for each economy, where supply, demand and monetary shocks of the economy are on the

[19] Kawai and Okumura (1996) regard both US and Japanese shocks as global shocks. Since Japan is included in the East Asian economies in this study, it is assumed that only US shocks to be exogenous to the East Asian economies.

left-hand side of the equations and the US shocks that are significant at the first-stage estimation are on the right-hand side. Seemingly unrelated regression (SUR) is used to allow for possible contemporaneous correlation in the residuals across the equations. The residuals obtained by SUR can be regarded as the structural shocks after removing the effect of global (US) shocks. The SUR results for the period of 1980–1997 are reported in Table 8.

As seen in Panel A of Table 8, the correlation pattern of supply shocks using SUR is almost the same as that reported in Table 4, which implies that the underlying supply shocks estimated by the structural VAR method are not affected by the US shocks. As monetary shocks are concerned, both the SUR and VAR methods have generated very similar results, implying a weak impact of global shocks. However, the SUR method produced a very different result for demand shocks from that of the structural VAR method. After removing the effect of the global shocks, only four significant correlations of demand shocks are identified (Panel B in Table 8). This result indicates that the US economy has a dominant influence on the demand side of the East Asian economies.[20]

IV. CONCLUDING REMARKS

In this paper a three-variable VAR model was employed to identify various types of shocks using more than two decades of quarterly data from East Asia. The results show that the exchange rates of the East Asian economies are relatively stable. However, their growth patterns are less coherent, even though they tend to be more correlated after the financial crisis. It is also interesting to note that the recent regional financial crisis improved the number of significant correlations of supply shocks in these economies, especially among the economies that have been hit mostly by the crisis, in comparison with the period prior to the crisis. The US economy is not significantly correlated with the region, and so is Japan. In contrast, demand shocks and monetary shocks are highly correlated among the East Asian economies and also between the USA and the region. Japan exhibits a high negative correlation of demand shocks with the rest of East Asia. These results are affirmed by the robustness test using the SUR method.

In comparison with the EU countries, it is found that the underlying structural shocks are less symmetric and the average size of the underlying shocks is larger in the East Asian countries. However, the speed of adjustment to shocks in East Asia is much faster than in Europe, on average taking 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, and hence, it is much easier for these economies to adjust internally in response to shocks.

Although the empirical results do not display strong support for forming an optimum currency area in the entire East Asian region, they do imply that some subregions, such as some Asian NIEs and ASEAN countries, 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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REFERENCES

Bayoumi, T. and Eichengreen, B. (1993) Shocking aspects of European monetary integration, in *Adjustment and Growth in the European Monetary Union* (Eds) F. Torres and F. Giavazzi, Cambridge University Press, Cambridge, pp. 193–229.

Bayoumi, T. and Eichengreen, B. (1994) One money or many? Analyzing the prospects for monetary unification in various parts of the world, *Princeton Studies in International Finance*, **76**.

Bayoumi, T., Eichengreen, B. and Mauro, P. (2000) On regional monetary arrangements for ASEAN, *Journal of the Japanese and International Economies*, **14**, 121–48.

Blanchard, O. J. and Quah, D. (1989) The dynamic effects of aggregate demand and supply disturbances, *American Economic Review*, **79**, 655–73.

Chow, H. K. and Kim, Y. B. (2000) A common currency peg in East Asia? Perspectives from Western Europe, Seminar paper, National University of Singapore.

Clarida, R. and Gali, J. (1994) Sources of real exchange-rate fluctuations: how important are nominal shocks?, *Carnegie-Rochester Conference Series on Public Policy*, **41**, 1–56.

[20] It is noted that oil price fluctuations may also affect the underlying shocks. To determine the possible impact of the second oil crisis on these results, the correlation of underlying shocks for the period of 1982–1997 were re-estimated by removing the effect of the second oil crisis, and found very similar results to that in Table 4, implying little influence of the oil crisis on the empirical findings. The results are available upon request.

De Grauwe, P. (2000) *Economics of Monetary Union*, 4th Edn, Oxford University Press, Oxford and New York.

Demertzis, M., Hallett, A. H. and Rummel, O. (2000) Is the European union a national currency area, or is it held together by policy makers?, *Weltwirtschaftliches Archiv*, **136**, 657–79.

Frankel, J. A. and Rose, A. K. (1998) The endogeneity of the optimum currency area criteria, *The Economic Journal*, **108**, 1009–25.

International Centre for the Study of East Asian Development (ICSEAD) (2001) *East Asian Economic Perspectives: Recent Trends and Prospects for Major Asian Economies*, ICSEAD, Kitakyushu.

Ito, T. (1994) On the possibility of a yen bloc, in *Exchange Rate Policy and Interdependence: Perspectives from the Pacific Basin* (Eds) R. Glick and M. Hutchison, Cambridge University Press, Cambridge, pp. 317–43.

Kawai, M. (1987) Optimum currency areas, in *The New Palgrave: A Dictionary of Economics* (Eds) J. Eatwell, M. Milgate, and P. Newman, Macmillan Press, Ltd., London, pp. 740–43.

Kawai, M. and Okumura, T. (1996) Higashi ajia ni okeru makuro keizai-teki sougo izon [macro economic interdependence in the East Asian Region], in *Ajia no Kin-yu Shihon Shijo [Financial and Capital Markets in Asia]* (Ed.) M. Kawai, Nihon Keizai Shinbunsha, Tokyo, pp. 217–37 (in Japanese).

Kwan, C. H. (1998) The theory of optimum currency areas and the possibility of forming a yen bloc in Asia, *Journal of Asian Economics*, **9**, 555–80.

McKinnon, R. I. (1963) Optimum currency areas, *American Economic Review*, **53**, 717–25.

Mundell, R. A. (1961) A theory of optimum currency areas, *American Economic Review*, **51**, 657–65.

Obstfeld, M. (1985) Floating exchange rates: experience and prospects, *Brookings Papers on Economic Activity*, **2**, 369–450.

Phylaktis, K. (1997) Capital market integration in the Pacific-basin region: an analysis of real interest rate linkages, *Pacific-Basin Finance Journal*, **5**, 195–213.

Phylaktis, K. (1999) Capital market integration in the Pacific-Basin region: an impulse response analysis, *Journal of International Money and Finance*, **18**, 267–87.

Rodriguez, R. N. (1982) Correlation, in *Encyclopedia of Statistical Sciences* (Eds) S. Kotz and N. L. Johnson, **2**, John Wiley & Sons, New York, pp. 93–204.

Rogers, J. H. (1998) Monetary shocks and real exchange rates, *International Finance Discussion Papers*, Number 612, Board of Governors of the Federal Reserve System, Washington D. C.

Taguchi, H. (1994) On the internationalization of the Japanese yen, in *Macroeconomic Linkage* (Eds) T. Ito and A. O. Krueger, University of Chicago Press, Chicago, pp. 335–55.

Tavlas, G. S. (1993) The 'new' theory of optimum currency areas, *The World Economy*, **16**, 663–85.

Tavlas, G. S. (1997) The international use of the US Dollar: an optimum currency area perspective, *The World Economy*, **20**, 709–47.

Zhang, Z. Y. (2001) Trade liberalization, economic growth and convergence: evidence from East Asian Economies, *Journal of Economic Integration*, **16**, 147–64.

Zhang, Z. Y. (2003) Can the rest of East Asia catch up with Japan: some empirical evidence, *Japan and the World Economy*, **15**, 91–110.