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Abstract: This study empirically examines whether a group of 12 Asian countries is suitable to form an Asian Monetary Union (AMU). The criteria of suitability are based on the Optimum Currency Area (OCA) literature whereby countries experiencing symmetrical shocks, have smaller size of shock and faster speed of adjustment are considered as potentially good partners in a monetary union. The Blanchard and Quah (BQ) structural vector autoregression (SVAR) methodology is used to identify the demand and supply shocks. The overall finding provides no support for the formation of a full-fledged AMU. Instead, what appears more feasible initially is the formation of smaller sub-groupings within the region.

Keywords: Asian monetary union, structural vector autoregression, optimum currency area

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I. Introduction

This study provides further empirical evidence on the suitability of the creation of an AMU; a timely addition to the literature especially after the onslaught of the East Asian crisis. The crisis has exposed, *inter alia*, the futility of the unilateral adoption of a fixed exchange rate. While countries with de-facto dollar-pegged experienced greater bilateral exchange rate stability, misalignments between major currencies often occurred and were translated into a loss of competitiveness for a country that pegged to an appreciating currency vis-à-vis another that pegged to a depreciating currency. In fact, the sharp depreciation of the yen against the dollar in the run-up to the crisis has often been cited as the possible trigger that precipitated the East Asian crisis.

Against this background, policymakers in the region have had to search for other alternative frameworks of exchange rate policy. The search has largely centred on the hard pegs, such as a currency board, dollarisation (or the adoption of a third party's currency as its own currency) and a common currency arrangement.[1] The latter is the focus of this study with the aim that it will eventually culminate in a single regional currency or a regional monetary union. It is an appealing option because it promises intra-regional exchange rate stability by addressing the problem of currency misalignment, while facilitating trade and capital mobility (Bayoumi and Mauro 1999).[2]

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[1] Fully free-floating regime has never appealed to most Asian countries given their small size and highly open economies.

[2] It also addresses the problem of misalignment between major currencies because the question of choosing between which major currency to peg becomes irrelevant. This is particularly important since most Asian countries have relatively diversified trading partners making the choice of which currency to peg far from obvious.

The study of currency/monetary union is pioneered by Mundell's Nobel Prize winning work on the OCA.[3] In his seminal paper, Mundel (1961) outlines the decision whether a country should form an OCA as dependent on the trade-offs between the benefits and the costs of doing so. The main advantages of joining are the reduction of transaction costs in terms of currencies conversion and foreign exchange hedging, and the increase in price transparency, since all goods and services from different countries are now priced in one single currency, which will in turn further boost competition. The main cost of joining is the loss of a sovereign monetary policy tool, since with a single currency the functions of national central banks will come under the purview of an independent supranational central bank. The loss will be more severe if a country in the union experiences asymmetric shocks compared with other countries in the group, because there is now no opportunity for that country to loosen its monetary policy to counter the adverse effects. In addition, if the size of the shock is large and the speed of adjustment is slow, the loss in that country will be greater. Nonetheless, the loss can be mitigated if workers are free to move to jobs in other countries and wages are flexible to adjust.

This study will examine the suitability of a group of Asian countries[4] in forming an AMU based on the criterion that countries experiencing symmetrical shocks are more suited to form a monetary union.[5] In addition, the size of shocks and the speed of adjustment will also be examined. Unlike previous studies, this study has the

[3] OCA is defined as a geographical area within which it would pay to have a single currency (*The Economist,* www.economist.com).
[4] The countries are Australia (AU), China (CN), Hong Kong (HK), Indonesia (ID), Japan (JP), South Korea (KR), Malaysia (MY), New Zealand (NZ), the Philippines (PL), Singapore (SG), Thailand (TL) and Taiwan (TW).
[5] McKinnon (1963) and Kenen (1969) have also made important contributions to the literature emphasising the degree of openness of economies and diversification of economies, respectively, as other important criteria of OCA.

advantage of having a bigger sample including the East Asian crisis and beyond, which will be particularly interesting considering the rekindled interests among policymakers in common currency arrangements after the crisis. The findings show Asia is not ready for a full-fledged formation of AMU. The next best solution appears to be to start with the formation of smaller sub-groupings within the Association of Southeast Asian Nations (ASEAN) bloc and the Far East Asian bloc; namely between Malaysia and Singapore in the former; and Hong Kong and Taiwan in the latter.

The rest of the paper is structured in the following manner. Section II briefly discusses other empirical studies which have looked at Asia and used the same methodology. Section III delves into the BQ (1989) SVAR model which allows for identification of the demand and supply shocks. Section IV looks at the data used and time series properties of the variables. Section V discusses the estimation issues and diagnostic checks on the VAR models. This is followed by presentation of the results in Section VI. Some caveats are offered in Section VII. Section VIII concludes.

II. Brief Literature Review

One of the earliest articles that looks at Asia and examines the same issues as this paper is Bayoumi and Eichengreen (BE, 1994). Bayoumi and Mauro (1999) is a further extension and includes a larger sample. Nonetheless, most of these studies do not cover the period of the East-Asian crisis, including Yuen's (2001) paper, which ends just before the crisis. A study by Zhang et. al. (2002), looks at a shorter sample after the crisis, but uses a tri-variate SVAR model which includes the monetary shock. The overall findings of these studies do not support the creation of a full-fledged

AMU. Instead, they recommend the creation of smaller sub-groups. The features and more specific findings of these studies are summarised below:

Study	Sample	Methodology	Findings
BE 1994	1969-1989	BQ Bivariate SVAR	Two blocs: Northeast Asian (Japan, Korea and Taiwan); and Southeast Asian (Hong Kong, Indonesia, Malaysia, Singapore and possibly Thailand).
Bayoumi & Mauro (1999)	1968-1998	BQ Bivariate SVAR	Hong Kong, Indonesia, Malaysia and Singapore.
Yuen (2001)	1967-1997	BQ Bivariate SVAR	Regional sub-clusters: Singapore and Malaysia; Japan and South Korea; and Hong Kong and Taiwan.
Zhang et al (2002)	1980Q1-2000Q3	Tri-variate SVAR	Sub-regional groupings are possible, but not a full-fledged AMU (but authors did not specifically identify which countries are in these sub-groups).

III. Methodology

To identify the demand and supply shocks[6], this study appeals to the BQ methodology. The theoretical model or what is known as VAR in the primitive form can be written as follows:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = B(L) \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}, \qquad (1)$$

where Δy_t is the real GDP growth rate, Δp_t is the growth in GDP deflator - the proxy for price inflation, and ε_{dt} and ε_{st} are the demand and supply shocks. *B(L)* is the matrix represented by:

$$B(L) = \begin{bmatrix} \sum_{k=0}^{\infty} b_{11}(k) L^k & \sum_{k=0}^{\infty} b_{12}(k) L^k \\ \sum_{k=0}^{\infty} b_{21}(k) L^k & \sum_{k=0}^{\infty} b_{22}(k) L^k \end{bmatrix}, \qquad (2)$$

where L is the lag operator and k is the number of lags. The covariance-variance matrix of demand and supply shocks is assumed to be an identity matrix ie., variance

[6] Demand shocks are generally referred to shocks caused by monetary and fiscal policies, while supply shocks are caused by oil price changes, technological changes and productivity improvements.

of ε_{dt} and ε_{st} are normalised to one and the covariance of ε_{dt} and ε_{st} is zero. A further and most important assumption of the BQ methodology is that the demand shock has no long-run impact on the level of output. Essentially, this implies $\sum b_{11}(k)L^k = 0$ in (2). Note that at lag k=0, equation (1) can be written as follows:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} b_{11}(0) & b_{12}(0) \\ b_{21}(0) & b_{22}(0) \end{bmatrix} \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \qquad (4)$$

or more compactly as $X_t = B(0)\varepsilon_t$. Also note that equation (1) cannot be directly estimated since it is not exactly known what ε_{dt} and ε_{st} are. To do this, it is necessary to turn to the VAR model expressed in the standard form as follows:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = A(L) \begin{bmatrix} \Delta y_{t-1} \\ \Delta p_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}, \qquad (5)$$

where $A(L)$ is the VAR coefficient matrix at various p lags, and e_{1t} and e_{2t} comprise a combination of the primitive demand and supply shocks. The model as expressed in (5) can now be directly estimated since the current and lagged values of output and price are known. Nonetheless, the question remains as to how the demand and supply shocks can be identified. To do this, equation (5) is first rearranged into a VAR written in the moving average form:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = [I - A(L)]^{-1} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}. \qquad (6)$$

Notice that at lag k=0, $\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$, which is the exactly same as equation (4), that is,

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} b_{11}(0) & b_{12}(0) \\ b_{21}(0) & b_{22}(0) \end{bmatrix} \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \qquad (7)$$

or more compactly, $e_t = B(0)\varepsilon_t$. (8)

Note that substituting (8) into (6), gives the theoretical model. But more importantly, the demand and supply shocks can now be retrieved from (8). In order to do that, the four elements in *B(0)* must be identified. This is done by invoking four restrictions: the first three from the identity covariance-variance matrix of the primitive shocks; and the final restriction from the assumption of no long-run impact of the demand shock on the level of output. Post-multiplying (8) by e_t', gives $e_t e_t' = B(0)\varepsilon_t \varepsilon_t' B(0)'$ or simply $e_t e_t' = B(0)B(0)'$, since $\varepsilon_t \varepsilon_t'$ is an identity matrix. Note, $e_t e_t'$ or Ω is the variance-covariance matrix of the standard form where each of its elements (σ) can be estimated from (5). Hence, in scalar form the following three equations from the first three restrictions are obtained:

$$\sigma_{11} = b_{11}^2(0) + b_{12}^2(0) , \qquad (9)$$

$$\sigma_{22} = b_{21}^2(0) + b_{22}^2(0) , \qquad (10)$$

$$\sigma_{12} = b_{11}(0)b_{21}(0) + b_{12}(0)b_{22}(0) . \qquad (11)$$

For the final restriction, it is known that the sum of the top left-hand element of the *B(L)* matrix must be zero, and since substituting (8) into (6) gives $X_t = (I-A(L))^{-1}B(0)\varepsilon_t$, this means that in scalar form:

$$\left[1 - \sum_{k=0}^{p} a_{22}(k)\right] b_{11}(0) + \sum_{k=0}^{p} a_{12}(k) b_{21}(0) = 0 . \qquad (12)$$

Given equations (9) to (12) – there are four equations and four unknowns – *B(0)* can be identified. With that, the respective demand and supply shocks can be obtained from (8): $\varepsilon_t = B(0)^{-1} e_t$. For more details, see Enders (1995), pages 335-336.

IV. Data

The sample period covered in this study spans from 1960 to 2002. Annual GDP in local currency at constant price and GDP deflator (as a proxy of inflation) of 12 Asian-Pacific countries from 1960 to 2000 are obtained from the 2002 World Development Indicators CD-ROM. More recent data in 2001 and 2002 are sourced mainly from the CEIC database, the IMF International Financial Statistics and Datastream (detailed item codes are provided in Appendix I)[7].

The data used are transformed in several ways. First, because the data sources between the earlier series (1960-2000) and the recent series (2001/02) are different, the former cannot be directly stacked on top of the latter. Hence, to maintain consistency as per the original series, the percentage changes for 2001 and 2002 of each variable are first calculated, and then the value of the original series is computed to reflect these changes. Second, both the real GDP and GDP deflator are also transformed into natural logarithm and then the first differences are taken. By taking the first difference of the natural log and multiplied by 100% yields an approximation for the growth rate.

Figure 1 shows the annual average growth rate of real GDP (the upper bar) and the GDP deflator (the lower bar) over the last fifty years. Witness the spectacular output growth rates of the Asian tigers (Hong Kong, Korea, Singapore and Taiwan) followed by the Asian cubs (Indonesia, Malaysia and Thailand). Surprisingly, their inflation rates using the GDP deflator aren't much different from the more developed countries like Australia, Japan and New Zealand. Indonesia in particular had substantially higher inflation due largely to the high-inflationary period of the 1960s.[8]

In terms of volatility of output growth and inflation, the coefficient of variation defined as the ratio of the standard deviation to the annual average in Figure 2, shows that the Asian countries generally have marginally higher volatility in output growth

[7] All data for Taiwan are sourced from the CEIC database.
[8] Excluding the 1960s, Indonesia's average annual inflation rate is still high at 13.5%.

than Australia. But in terms of inflation volatility, most Asian countries exhibit substantially larger swings in inflation rates than Australia.

Fig. 1. Real GDP Growth and GDP Deflator
Annual Average 1960-2002 (%)

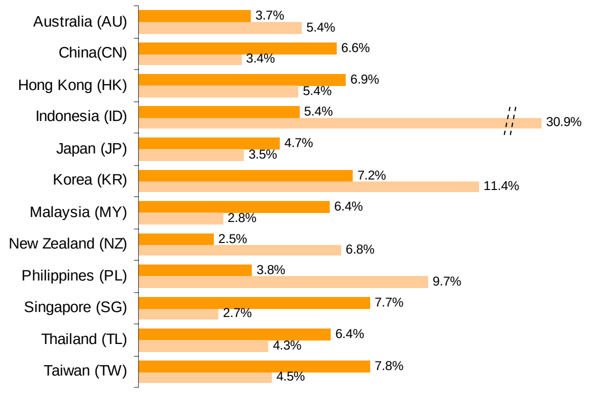
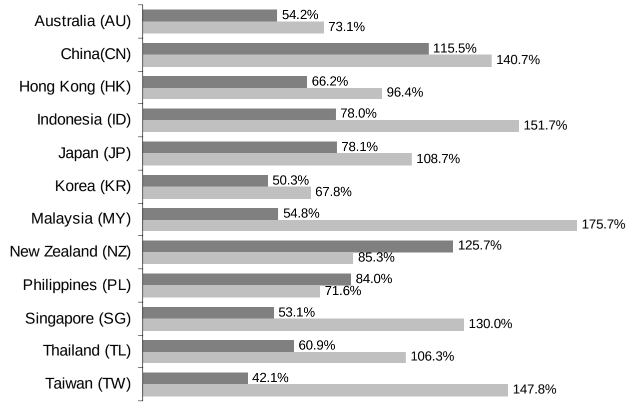


Fig. 2. Real GDP Growth and GDP Deflator
Coefficient of Variation (%)



The theoretical VAR model presented above requires both the sample variables be stationary. Examining the properties of these series using both the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests[9] show that most of the series are non-stationary at levels, with several exceptions[10] (see Table 1). Looking at the plot of each series first (see Appendix II), it would seem more appropriate if the unit root tests were performed with a trend and a constant. In this regard, all series are clearly non-stationary at levels.

Equivalently, at first difference when the estimations are done without a trend but with a constant, all the series are stationary with the exceptions of Australia and

[9] For completeness, unit root tests have been carried out at levels with a constant and (i) with a trend and (ii) without a trend. Accordingly, at first difference, the transformation of the tests at levels becomes one which is estimated (i) without a trend and (ii) without a trend and without a constant, respectively. For example, if a unit root test is performed at levels with a constant and with a trend; at first difference, the test becomes a regression estimated without a trend but with a constant.
[10] These are Japan and Taiwan's real GDP and Japan's GDP deflators estimated without a trend, and Indonesia's GDP deflator (see Table 1). However, for Indonesia, when the sample is estimated from 1970, the result shows that the series is non-stationary at levels. For Taiwan, looking at the plot suggests that the series can in fact be trend stationary.

Korea's GDP deflators, and Japan's real GDP and GDP deflator. Detrended Australia's GDP deflator however exhibits stationarity at first difference.[11]

Table 1. Unit Root Tests[1,2]

Variable[3]	Levels				First Differences			
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
	With Trend		Without Trend		Without Trend		Without Trend & Constant	
laup[4]	-0.94	-0.72	-1.72	-0.97	-2.11	-1.85	-1.16	-0.95
lauy	-2.27	-2.26	-1.89	-1.90	-5.72*	-5.76*	-2.03**	-1.65***
lcnp	-2.28	-1.44	-0.46	0.48	-2.96*	-2.85***	-2.18**	-2.75*
lcny	-1.50	-4.20*	1.44	2.03	-8.04*	-8.42*	-3.58*	-3.73*
lhkp	-1.14	-1.43	-1.20	-0.61	-2.51^{5}	-2.36^{5}	-1.75***	-1.75**
lhky	0.27	-0.55	-2.06	-4.01*	-2.64***	-4.67*	-2.18**	-2.41**
lidp	-4.32^{*,6}	-2.72	-5.19^{*,6}	-4.31^{*,6}	-2.91***	-2.88***	-2.37**	-2.37**
lidy	-1.98	-1.67	-0.54	-0.51	-4.34*	-4.34*	-2.43**	-2.26**
ljpp	-0.04	0.27	-2.14	-3.07**	-2.28^{7}	-2.24^{7}	-2.01**	-1.87**
ljpy	-1.50	-1.81	-3.56**	-6.84*	-1.28^{7}	-2.45^{7}	-2.10**	-2.04**
lkrp	-0.19	0.51	-3.10**	-3.97*	-2.21^{8}	-1.99^{8}	-2.04**	-1.22
lkry	-0.95	-1.03	-1.25	-1.25	-6.01*	-6.01*	-2.02**	-1.59***
lmyp	-2.84	-2.89	0.49	0.33	-5.67*	-5.67*	-4.38*	-4.49*
lmyy	-1.72	-2.15	-0.93	-0.90	-5.35*	-5.32*	-2.17**	-1.84***
lnzp	-1.25	-0.53	-1.70	0.96	-3.53*	-3.60*	-1.96**	-1.68***
lnzy	-2.71	-2.68	-1.55	-1.49	-5.16*	-5.16*	-3.71*	-3.70*
lplp	-1.98	-2.00	0.11	0.05	-4.61*	-4.52*	-2.26**	-1.99**
lply	-2.15	-1.68	-1.53	-1.78	-3.71*	-3.45**	-2.05**	-1.95***
lsgp	-1.60	-0.88	-1.34	-1.09	-3.31*	-3.17**	-2.36**	-2.41**
lsgy	-0.72	-0.74	-2.16	-1.88	-4.68*	-4.85*	-2.14**	-1.95***
ltlp	-2.37	-1.87	-0.52	-0.32	-3.81*	-3.69*	-2.64*	-2.53**
ltly	-2.93	-0.91	-1.53	-1.58	-3.61*	-3.66*	-1.70***	-1.46^{9}
ltwp	-0.96	-0.73	-1.14	-1.38	-4.56*	-4.56*	-3.62*	-3.56*
ltwy	1.42	2.19	-3.58**	-4.16*	-3.87*	-3.84*	-1.46^{10}	-1.31^{10}

Notes:
1. *, ** and *** refer to the significance of the test statistics at the 1%, 5% and 10% levels respectively.
2. Lag differences included in the ADF tests are chosen automatically based on Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) with a restriction of a maximum of four lags being imposed. For the PP test, the bandwidth is automatically chosen based on the Newey-West method.
3. The first letter *l* denotes natural logarithm, the next two letters denote country of origin, and the final letter denotes type of variable, *p* for GDP deflator and *y* for real GDP.
4. Detrended *laup* however exhibits stationarity at the first difference but not at levels (with and without a constant). The ADF and PP test statistics are -2.08** and -1.84*** respectively (estimated without a trend and without a constant).
5. The ADF test statistic is significant at the 12% level and the PP test statistic at the 16% level. However, if the sample ends in 1997, both statistics are significant at the 10% and 5% levels respectively.
6. Excluding the period of high inflation in the 1960s, both ADF and PP tests at levels are statistically insignificant ie., the series is non-stationary at levels.
7. At first differences, with a trend and a constant included, both the test statistics are significant at the 10% level (for *ljpp*) and 1% level (for *ljpy*).
8. Likewise, *lkrp* also exhibits a similar pattern and with a trend included, it is significant at the 1% level.
9. Statistically significant at the 13% level.
10. The ADF and PP test statistics are statistically significant at 13.3% and 17% respectively.

[11] The most basic method of detrending is done whereby the detrended GDP deflator is simply the difference between the actual and predicted GDP deflator. The predicted value is obtained by performing a regression with the actual value on a constant plus a time trend.

For Japan, the continued slowdown of the Japanese economy since the early 1990s is evident in the shapes of both the variables which have turned concave. When a trend is included with the existing constant, both the test statistics are significant at the conventional test level. The same applies for Korea's GDP deflator. In sum, all series are largely stationary at first difference.

As a preliminary analysis to identify the potential country groupings, the correlations of output growth, and inflation, between pairs of countries are calculated and presented in Tables 2 and 3.[12] Although, a strong positive correlation coefficient between output growths is not the same as being affected symmetrically by shocks, some general implications can still be drawn. From Table 2, two broad regional groupings are apparent.[13] The major ASEAN countries in one group namely Indonesia, Malaysia, Singapore, Thailand and potentially with Hong Kong and Korea[14]; plus another group of Japan and Taiwan, and Hong Kong and Taiwan. Australia, China, the Philippines and New Zealand do not appear to fit into any group.

In terms of correlations of inflation rates, there appears to be two distinct groups comprising the core ASEAN members namely Indonesia, Malaysia, Singapore and Thailand, and the Far East Asian countries of Japan, Korea, and Taiwan. China and the Philippines continue to remain outside of any group. Australia and New Zealand

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[12] Hereafter, in order to remove to the outlying behaviour of the period of high inflation, the sample for Indonesia is set to start from 1970. Thus, only the correlation coefficients of Indonesia and other countries are based on this smaller sample.

[13] The decision to assign countries in a group is arbitrarily set at 0.5. If two countries exhibit a correlation of equal or greater than that magnitude, the are paired together in a group. BE use a more technical approach whereby they adjust the correlation coefficient to account for international business cycles. This approach is all good and well, but since the interest is only on the broad picture, plus the fact that the correlations of output and inflation are anyway not representative of the demand and supply shocks, a simpler approach has been decided upon.

[14] Hong Kong are correlated with Indonesia and Malaysia, and Korea with Indonesia and Thailand, but not the rest of the countries in the group.

have strong inflation correlation, and so does Australia with several Asian countries, but not in the case for New Zealand with other Asian countries.

Table 2. Correlations of Output Growth Between Countries

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	0.12	1.00										
HK	0.09	-0.19	1.00									
ID	-0.07	-0.02	0.55	1.00								
JP	0.36	-0.35	0.46	0.43	1.00							
KR	0.10	0.13	0.35	0.60	0.33	1.00						
MY	-0.10	-0.06	0.52	0.75	0.18	0.48	1.00					
NZ	0.16	0.08	0.24	0.04	0.05	0.17	0.20	1.00				
PL	0.01	-0.29	0.35	0.26	0.26	0.19	0.39	0.05	1.00			
SG	0.03	-0.16	0.35	0.55	0.41	0.36	0.61	0.15	0.37	1.00		
TL	0.00	0.04	0.43	0.80	0.41	0.66	0.67	-0.06	0.29	0.44	1.00	
TW	0.36	0.02	0.69	0.34	0.57	0.36	0.32	-0.01	0.22	0.47	0.40	1.00

Table 3. Correlations of Inflation Between Countries

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	-0.22	1.00										
HK	0.54	0.28	1.00									
ID	0.24	-0.39	0.12	1.00								
JP	0.62	-0.27	0.34	0.37	1.00							
KR	0.47	-0.25	0.36	0.29	0.75	1.00						
MY	0.42	-0.06	0.47	0.61	0.25	0.12	1.00					
NZ	0.63	-0.13	0.42	-0.08	0.22	0.29	0.11	1.00				
PL	0.36	0.04	0.43	0.22	0.31	0.09	0.41	0.10	1.00			
SG	0.66	0.06	0.63	0.34	0.62	0.47	0.56	0.12	0.39	1.00		
TL	0.54	0.10	0.48	0.59	0.48	0.29	0.64	0.06	0.31	0.74	1.00	
TW	0.56	-0.04	0.43	0.47	0.71	0.52	0.35	0.07	0.37	0.75	0.65	1.00

Broadly speaking, this simple analysis highlights the potential grouping within the core ASEAN members together with Hong Kong and possibly Korea. Nonetheless, whether their responses to demand and supply shocks are the same, thereby satisfying the OCA criterion of interest is another matter. This will be the subject of investigation in the ensuing section.

V. Estimation and Diagnostic Checks

The first step in estimating a VAR model (equation (5) and in turn equation (1)) is to identify the optimal lag periods to be specified in the system. To do this, the lag order selection criteria of Akaike and Schwarz have been relied upon. As can be seen from

Table 3, the optimal lag order recommended ranges from 0 to 3-period, 1-period being the most common. So, as a start, the VAR models are estimated with a 1-period lag. However, when tests are performed to determine the white noise properties of the systems, numerous cases of serial correlation and heteroscedasticity at the conventional test levels are found. To mitigate this problem, 2-period lag models are estimated. Now, most systems exhibit the white noise properties, but there still exists a handful of problematic cases. For these systems, a 3-period model is estimated and as expected, the results show no signs of autocorrelation and heteroscedasticity.

To ensure consistency across systems, a call has to be made to determine whether all the systems are estimated with a 2 or 3-period lag. The trade-off is between the loss of the degree of freedom, which can be more serious in a VAR model, and the complete attainment of the white noise properties. Given that most systems are already serially uncorrelated and homoscedastic at 2-period lag, weighing on the greater loss of degrees of freedom considering the smallish sample size, and the lag chosen in past empirical studies has normally been two (Yuen 2001 and BE 1994), a decision is made to work with 2-period lag plus a constant term. (It makes more practical sense to include the constant because excluding it would imply, in the absence of the demand and supply shocks, output growth and inflation would be zero). Each model is estimated by taking the first differences in the log of real GDP and the log of GDP deflator as per the theoretical VAR specification.

The stability of the systems is also checked by examining the impulse response function (IRF) of each variable. The pattern looked for is one in which the output and inflation responses stabilise at a long-run constant state following a standard deviation demand shock and supply shock. As an example, please see Figure 3 for the case of Australia and Singapore. For all other countries, the VAR systems are also stable[15].

Table 3. VAR Specification/Diagnostic Checks[1]

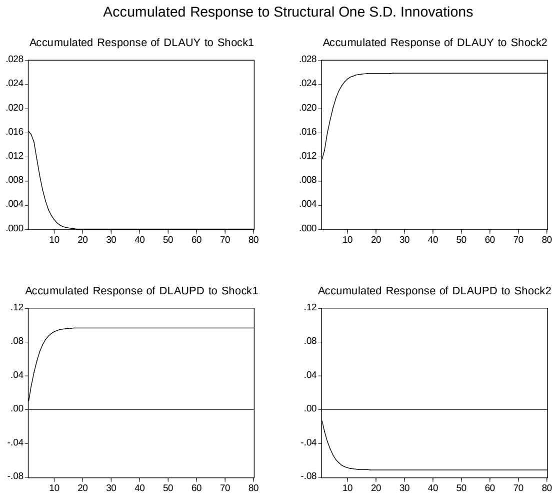
System[2]	Lag Order Selection		Lag 1			Lag 2		
				White Hetero. Test			White Hetero. Test	
	AIC	SIC	Auto-r LM Test[3]	No Cross Terms[4]	With Cross Terms[5]	Auto-r LM Test[3]	No Cross Terms[4]	With Cross Terms[5]
varau1	1	1	4.36	11.02	11.19	5.40	17.95	34.61
varau2	1	1	4.64	12.03	12.48	6.14	20.52	33.26
varcn1	2	3	10.28**	15.28	27.37**	1.95	28.56	46.48
varcn2	1	1	7.53	19.44***	29.37**	3.50	26.25	50.45
varhk1	1	1	2.77	19.57***	20.00	3.40	21.79	36.50
varhk2	1	0	2.89	21.46**	27.95**	4.86	22.70	48.53
varid1	1	3	4.80	15.36	17.94	1.28	18.77	38.85
varid2	1	1	8.27***	21.22**	24.80***	0.89	24.89	49.71
varjp1	2	2	10.23**	21.43**	41.92*	6.50	32.55	72.38*
varjp2	1	1	7.58	21.03**	36.74*	4.17	28.84	61.35**,5
varkr1	1	1	3.54	15.62	16.86	8.51***,6	22.04	34.23
varkr2	1	1	4.05	16.42	16.77	5.13	28.12	40.33
varmy1	0	0	1.77	7.12	9.15	3.70	16.54	38.06
varmy2	0	0	6.42	12.35	17.16	2.21	30.41	50.76
varnz1	2	1	9.57**	19.58***	23.17***	1.62	39.53**,5	54.25***,5
varnz2	1	0	7.77	16.18	19.66	1.22	32.87	48.48
varpl1	1	3	7.14	15.93	16.41	2.61	21.78	35.37
varpl2	1	1	8.12***	19.08***	19.67	2.95	21.12	38.77
varsg1	2	1	2.86	24.63**	26.36**	0.83	38.26**,5	50.03
varsg2	1	1	1.61	22.51**	23.41***	0.82	31.59	48.39
vartl1	1	1	2.71	17.65	23.23***	3.53	24.52	59.79**,5
vartl2	1	1	3.21	18.49	24.70***	2.85	31.79	53.92
vartw1	3	3	11.35**	11.09	18.45	11.95**,5	17.12	58.05***,5
vartw2	1	1	7.07	7.74	15.79	8.29***,5	15.22	49.51

Notes:
1. *, ** and *** refer to the significance of the test statistics at the 1%, 5% and 10% levels respectively. For a discussion on the Autocorrelation LM test and White Heteroscedasticity Test, please refer to Ch.20 of EViews 4 manual, pages 524-526.
2. The system here refers to the VAR model (the first three letters) for the different countries (the next two letters). For example, *varau* refers to the VAR model for Australia. The last digit refers to the estimation period for the entire sample period (*1*) and up to the East Asian Crisis in 1996 (*2*).
3. The LM statistics presented here is for 1-period lag. Tests are carried out up to 4-period lag. These results are not presented because generally second period lag is unlikely to be significant when the first period lag is insignificant. The *insignificance* of the LM statistic at the conventional test levels implies the absence of serial correlation.
4. No Cross Terms uses only the levels and squares of the original regressors, while With Cross Terms includes all non-redundant cross-products of the original regressors in the test equation. The statistic presented here is the chi-square value of the joint test between the residual of equation 1 and itself, the residual of equation 2 and itself, and the residuals of equations 1 and 2. The *insignificance* of this statistic at the conventional test levels implies homoscedasticity.
5. When a 3-period lag VAR model is estimated, these statistics become statistically insignificant.
6. Insignificant at 6-period lag.

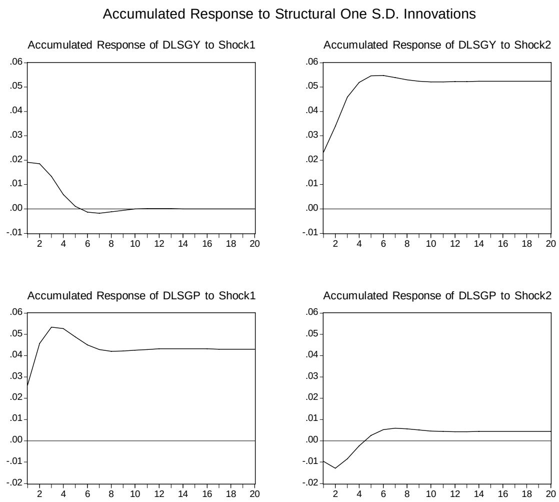
[15] Due to space constraint, impulse responses of other countries are not presented.

Fig. 3. IRF of Output Growth and Inflation due to Demand Shock (1) and Supply Shock (2): Australia (Panel A) and Singapore (Panel B)

Panel A



Panel B



VI. Results

Recall from equation (8) by inverting the matrix *B(0)*, the demand and supply shocks for each country can be obtained. If two countries are affected by a shock in the same way, the shock is symmetric. If they are affected in different ways, it is asymmetric. Hence, a symmetric shock between two countries is evidence of a **strong positive correlation,** implying they would be suitable partners in a monetary union. Conversely, an asymmetric shock is evidence of a weak and statistical insignificant positive correlation or a negative correlation, suggesting the two countries would be poor partners in a monetary union. To test the significance of the correlation coefficient, the Pearson test statistic is employed.[16]

[16] Essentially, this involves performing a simple regression between country A's shock adjusted by its own standard deviation on country's B shock adjusted by country A's standard deviation, and an intercept term. A straightforward derivation will show that the regression coefficient is in fact the correlation coefficient of a shock between the two countries. The Pearson method is just the t-test on the regression coefficient.

Supply Shocks[17]

Examining the supply shocks for the sample period from 1960 to 1996 (the period preceding the East Asian crisis), highlights several significant positive correlations among the ASEAN members and the Far East Asian countries (see Table 4). In the ASEAN bloc, are Indonesia and Malaysia, Malaysia and Singapore, plus Singapore and Thailand. In the Far East Asian bloc, are Hong Kong and Taiwan, plus Japan and Taiwan. In addition, Singapore and Taiwan are also significantly correlated. For other countries, namely Australia, China, New Zealand and the Philippines, asymmetric shocks are more prevalent.

Table 4. Correlations of Supply Shocks between Countries (1960-1996)

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	-0.01	1.00										
HK	0.02	0.02	1.00									
ID	0.13	-0.20	0.24	1.00								
JP	0.32	0.14	-0.10	-0.14	1.00							
KR	-0.03	0.16	0.24	-0.07	0.32	1.00						
MY	-0.04	-0.16	0.23	0.38**	-0.14	0.00	1.00					
NZ	-0.17	0.14	0.04	0.03	-0.11	0.13	0.09	1.00				
PL	-0.23	-0.29	0.05	-0.08	0.06	-0.02	-0.02	-0.06	1.00			
SG	0.25	0.03	0.04	0.16	0.19	0.18	0.36*	-0.10	-0.05	1.00		
TL	0.21	0.08	0.03	0.25	0.33	0.29	0.28	-0.25	0.08	0.38*	1.00	
TW	0.23	0.08	0.45*	0.16	0.44*	0.31	0.01	-0.17	0.13	0.37*	0.29	1.00

Note: * and ** refer to 1% and 5% test levels respectively.

With a larger sample size extending beyond the East Asian crisis period to 2002, more cases of statistically significant positive correlations are evident (see Table 5). This would have been expected given the far-reaching effects of the crisis. A point further reinforced by the statistically significant positive correlation coefficient of the most

[17] It is common in the literature to emphasise the correlations of the supply shocks more than the demand shocks because the former "*are unaffected by changes in demand management policies and are more likely to be invariant with respect to alternative international arrangements*" (BE pg. 24). Put it differently, demand shocks such as changes in fiscal and monetary policies, are more country specific factors and are less likely to have regional-wide implications. Hence, they are less relevant to the interest of this study. The same route is followed here.

severely affected countries with each other (Indonesia, Korea, Malaysia and Thailand), which is absent in the first sample period. Now, the major ASEAN countries (Indonesia, Malaysia, Thailand and Singapore) represent viable candidates for a monetary union - each country is significantly correlated with the others. In the Far East Asian bloc, the results are less obvious, with potential partners to include Hong Kong and Korea, Hong Kong and Taiwan, and Japan and Korea. Notwithstanding this, there is widespread overlapping of correlations between countries in both blocs. For example, Singapore can be in a group with Hong Kong and Taiwan, and Hong Kong can be in a sub-ASEAN bloc with Malaysia, Singapore and Thailand. On the other hand, it is clear that Australia, China and New Zealand do not fit into any groupings (the Philippines is now correlated with Thailand).

Table 5. Correlations of Supply Shocks between Countries (1960-2002)

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	-0.05	1.00										
HK	-0.13	-0.01	1.00									
ID	-0.14	-0.03	0.56*	1.00								
JP	0.13	0.16	0.10	0.23	1.00							
KR	-0.07	-0.08	0.38**	0.66*	0.38**	1.00						
MY	-0.26	-0.09	0.56*	0.78*	0.10	0.42*	1.00					
NZ	-0.05	0.15	0.02	0.07	-0.02	0.21	0.20	1.00				
PL	-0.20	-0.28	0.20	0.34	0.11	0.24	0.25	-0.01	1.00			
SG	0.00	0.08	0.40**	0.48*	0.17	0.21	0.56*	0.03	0.17	1.00		
TL	-0.07	0.11	0.46*	0.70*	0.36**	0.57*	0.63*	0.03	0.32*	0.45*	1.00	
TW	0.17	0.10	0.57*	0.32	0.23	0.27	0.21	-0.10	-0.04	0.50*	0.33**	1.00

Note: * and ** refer to the significance of the correlation coefficient at the 1% and 5% test levels respectively.

To summarise, the results from Tables 4 and 5 provide little evidence for the formation of a full-fledged AMU. What seems more plausible initially is the formation of different regional sub-groupings. Two clear sub-groups are that between **Malaysia and Singapore**; and also between **Hong Kong and Taiwan**[18]. If the regional economies have fundamentally changed in a way that has made them more

[18] Yuen (2001) points out that this union may not be feasible because of China's stance on Taiwan.

symmetrical in the aftermath of the crisis, more countries can join either sub-group. In this case, a larger ASEAN bloc comprising the major ASEAN countries of **Indonesia, Malaysia, Singapore and Thailand including Hong Kong** can be formed. Another notable result is that Australia, China, New Zealand and, to some extent the Philippines, appear to remain outside of any group, plausibly because of the differences in their economic structures and policy responses to shocks vis-à-vis the region as a whole.

Demand Shocks

For the sample period from 1960 to 1996, a similar pattern of statistically significant positive correlations between the major ASEAN countries is observed (see Table 6). In fact, Japan can also be in this group - each of these countries is also significantly positively correlated with Japan. The Far East Asian bloc now can be made up of Japan, Korea and Taiwan. When the sample is expanded, there are more cases of significant correlations, but generally the two sub-groups identified in the smaller sample remain largely the same (see Table 7). It is also interesting to note that China again shows no symmetrical responses with all other countries, while Australia shows some significant correlations in the smaller sample but not in the larger one.

Table 6. Correlations of Demand Shocks between Countries (1960-1996)

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	0.05	1.00										
HK	0.16	0.16	1.00									
ID	0.40**	0.05	0.58*	1.00								
JP	0.37**	0.07	0.13	0.55*	1.00							
KR	0.52*	0.18	0.07	0.29	0.48*	1.00						
MY	0.23	0.10	0.58*	0.79*	0.39**	0.15	1.00					
NZ	0.18	-0.19	0.26	0.17	-0.21	-0.28	0.29	1.00				
PL	0.29	0.12	0.45*	0.42**	0.33	0.14	0.47*	0.18	1.00			
SG	0.23	0.25	0.37**	0.60*	0.35**	0.06	0.59*	0.08	0.44*	1.00		
TL	0.23	0.18	0.16	0.40**	0.49*	0.12	0.49*	-0.06	0.17	0.63*	1.00	
TW	0.29	-0.08	0.23	0.24	0.31	0.43**	0.28	0.09	0.28	0.23	0.16	1.00

Note: * and ** refer to the significance of the correlation coefficient at the 1% and 5% test levels respectively.

Table 7. Correlations of Demand Shocks between Countries (1960-2002)

	AU	CN	HK	ID	JP	KR	MY	NZ	PL	SG	TL	TW
AU	1.00											
CN	0.08	1.00										
HK	-0.02	0.17	1.00									
ID	0.32	0.04	0.18	1.00								
JP	0.26	0.12	0.01	0.63*	1.00							
KR	0.14	0.14	0.13	0.51**	0.46*	1.00						
MY	0.19	0.05	0.28	0.71*	0.39**	0.10	1.00					
NZ	0.18	-0.13	-0.02	0.02	-0.17	-0.28	0.08	1.00				
PL	0.30	0.20	0.33**	0.28	0.44*	0.02	0.32**	0.18	1.00			
SG	0.23	0.30	0.04	0.59*	0.54*	0.17	0.52*	0.07	0.45*	1.00		
TL	0.31	0.07	-0.11	0.56*	0.55*	0.16	0.56*	0.01	0.16	0.67*	1.00	
TW	0.08	0.07	0.05	0.49*	0.53*	0.45*	0.31	-0.06	0.33**	0.41*	0.23	1.00

Note: * and ** refer to the significance of the correlation coefficient at the 1% and 5% test levels respectively.

Size of Shocks

The size of shock is also an important measure of whether a country is suitable to join a monetary union. The larger the size of the shock, the more disruptive the disturbance on the economy, hence the greater the need to have an independent monetary policy tool to mitigate adverse effects. Similarly, the slower the speed of adjustment in the economy, the greater the premium placed in having a sovereign monetary policy.

In order to measure the size of the shock and the speed of adjustment, the information as contained in the IRF is utilised.[19] Specifically, for the supply shock, the size is measured as the long-run impact of the supply shock on output, that is, the shift in the long-run AS curve given the shock on output.[20] For the demand shock, the size is measured as the sum of first period impulse responses of output and prices due to the demand shock.

[19] The size of shock and the speed of adjustment is measured in exactly the same way as in BE's study.
[20] To identify this, the accumulated IRF plot of output is examined (eg. in Fig. 3) to identify where the line reaches its long-run steady state. The level at which the line reaches its stable state is the size of the supply shock that is reported in Table 8 below. (Obviously, different countries will reach their steady paths at a different time, and hence the long-run size of the shock shock reported corresponds with the different time taken by each country to reach its steady state).

Table 8. Size and Speed of Adjustment to Shocks

Country	Supply		Demand	
	Size	Adjustment Speed	Size	Adjustment Speed
Sample: 1960-1996				
AU	0.030	0.357	0.028	0.528
CN	0.060	1.034	0.012	0.430
HK	0.039	1.245	0.049	0.776
ID	0.020	0.999	0.076	1.098
JP	0.113	0.334	0.024	0.410
KR	0.029	1.014	0.064	0.471
MY	0.038	0.795	0.060	1.276
NZ	0.047	0.669	0.048	0.617
PL	0.068	0.684	0.056	0.901
SG	0.052	0.647	0.045	1.489
TL	0.034	0.907	0.044	1.144
TW	0.033	1.191	0.051	0.642
Average	0.047	0.823	0.047	0.815
Sample:1960-2002				
AU	0.026	0.505	0.027	0.450
CN	0.054	1.037	0.013	0.442
HK	0.061	0.907	0.029	0.311
ID	0.061	0.900	0.092	1.081
JP	0.168	0.208	0.019	0.292
KR	0.045	0.750	0.033	0.248
MY	0.038	1.127	0.050	1.049
NZ	0.042	0.695	0.045	0.525
PL	0.059	0.756	0.054	0.879
SG	0.071	0.678	0.042	1.113
TL	0.065	0.864	0.039	0.983
TW	0.106	0.402	0.051	0.548
Average	0.066	0.736	0.041	0.660
EU Average*	0.030	0.684	0.022	0.417

* Comprises 15 Western European countries from 1969 to 1989 originally used by BE (1994) namely Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Holland, Norway, Portugal, Spain, Sweden, Switzerland and the UK.

As a comparison, the EU average as calculated by BE is also included. This is particularly useful because their sample of 1969 to 1989 is fairly close to this study, but more importantly because their sample coincided roughly with the signing of the Maastricht Treaty in 1991 (the road map for the establishment of the European Monetary Union). In other words, using their numbers allow the comparison of like with like, ie., the situation of the European countries before the EMU, and similarly of the Asian countries before the "AMU".

From Table 8, the size of the supply shock and the demand shock are generally larger than that of the EU. This suggests it would be more valuable for the Asian countries to retain the sovereignty of their monetary policies. For example, in the case of the supply shock, it would be least beneficial for Japan and Taiwan to surrender their monetary policy tools. Another notable result is that the impact of the East Asian crisis appears to have manifested itself in the larger size of the supply shock in the longer sample period. For the demand shock, the larger size of the shock is consistent with the greater variability in output growth and inflation compared to the EU. (The EU average standard deviations of output and price are 2.2% and 3.5% respectively, compared with the Asian averages of 3.9% and 5.7% respectively).

Speed of Adjustment

The speed of adjustment is measured as the sum of the impulse response after two years over the long-run impact. For the supply shock, this is simply the ratio of the second period accumulated impulse response on output and the long-run effect of the supply shock (column two of Table 8). For the demand shock, it is the sum of the second period accumulated impulse response on output and price over the long-run effect of the demand shock on output and price.[21]

In contrast to the EU, the speed of adjustment to the demand and the supply shocks in the Asian countries is generally faster; despite being reduced somewhat by the crisis. A more flexible workforce and wage rates in the Asian countries vis-à-vis Europe have often been attributed by economists as the main explanation for the faster speed of adjustment in the Asian countries. Again focusing on the supply shocks, for the

[21] The long-run effect of the demand shock on output and price is measured just like the long-run impact of the supply shock, whereby the sum of the level at which each impulse response of output and price reaches its long-run steady path is taken as the long-run impact of the demand shock.

larger sample, Japan and Taiwan have the slowest speed of adjustment which means they would benefit the least in renouncing their monetary independence.

VII. Caveats

The pattern of the IRF is also often used to assess the validity of the BQ methodology and by extension the validity of the structural interpretation of the VAR model. Recall in Section III, a restriction is placed on the impact of the demand shock on output, that is, it must not have a long-run effect on the level of output. But, there is no restriction placed on the impact of the demand and supply shocks on prices. This flexibility allows for inspection of whether the estimated VAR models behave in a manner consistent with the AS and AD framework. In particular, the requirement is whether a positive demand shock leads to an increase in output in the short-run and an increase in prices in the long-run, while a positive supply shock leads to an increase in output but a decline in prices in the long-run.

Examining the smaller sample first (1960-1996), perverse results are obtained for China, Japan and the Philippines where a positive demand shock is associated with a reduction in output level in the short-run, though prices increase overtime. For a positive supply shock, perverse results are found for China, Indonesia, Japan, Malaysia and Singapore - output increases are associated with higher prices overtime. Similar results are also found by BE for Indonesia, Malaysia and Singapore. They argue that for Indonesia and Malaysia, being major oil-exporters/raw-materials producers, this finding is not unexpected, because higher oil prices increase the incentive to produce more oil, thereby boosting aggregate demand through the improvement of the terms of trade, which in turn boosts income and hence, puts upward pressure on prices. Singapore is highlighted as a major entrepot for trading in commodities. In the larger sample, the problem becomes more acute, suggesting the weakness of the VAR models in handling the crisis events. Without being sidestepped too far, suffice to say the BQ methodology has limitations because of its low-dimension (an economy is only affected by two types of shock) and the assumption of a distinct and separate effect of the demand and supply shocks, which in many occasions could be a mixture of both, like the example of the oil-producing countries mentioned above.[22] One approach to overcome this is by estimating a VAR model with a higher dimension such as a tri-variate model.[23]

Another weakness of this study has its root in the work done by Frankel and Rose (1998), who maintain that any methodology that uses historical data to identify the suitability of countries for a monetary union based on the OCA criteria suffers from the Lucas critique. The reason is because the OCA criteria are jointly endogenous. Put simply, the fact that countries don't exhibit close symmetry in business cycles *ex-ante*, before entering into a monetary union, is not a cause for concern, because *ex-post* countries will tend to exhibit closer symmetry due to closer intra-regional trade links, which will make the establishment of a monetary union even more likely and attractive. This observation is made based on their empirical study of a panel of bilateral trade and business cycle data of 20 developed countries over 30 years.[24] Rose

[22] Gottschalk and Zandweghe (2001) examine the consistency of four bi-variate SVAR models to test whether the demand and supply shocks commingle. The significance of the correlations of the demand shock of a model with the supply shock of another model indicates commingling. Using German data, their findings suggest there is commingling.

[23] Zhang et. al. (2002) use a tri-variate SVAR but their conclusion is largely similar to our bi-variate model.

[24] They use an instrumental variable technique whereby the regression in which they seek to estimate is the one which has the correlations (of real GDP, industrial production, employment or unemployment rate) between country i and j as the dependent variable, and bilateral trade as the independent variable. In order to identify the instruments for bilateral trade, they rely on the gravity model. The instruments

has also written other papers in this area, each tackling different angles of the same issue, with other authors. The overriding conclusion of his other studies is that a currency union improves trade between countries leading to improvements in income and welfare.[25]

Last but not the least, one final qualification that has to be made is that, this paper has only examined one component of the OCA criteria. It has not looked at the different cultural, social and political aspects of the economies, which may be equally important, if not even more so.[26] In fact, it is safe to say that most, if not all, of the studies which have examined the economic aspects of an AMU, have made reference to these issues, particularly the political will, as the major stumbling block in the formation of an all encompassing AMU. To quote an example from BE (1999):

> "*Even if one decides on economic grounds in favour of a common basket peg [common currency arrangement], there remains the question of whether Asia possess the political wherewithal to operate it successfully….. The danger, then is that putting the economic cart so far ahead of the political horse will create an Asian analogue not the EMS but to the Snake, an unstable and unsatisfactory arrangement*". (pgs. 364-365)

VIII. Conclusions

This paper has empirically examined whether the 12 Asian countries (Australia, China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, New Zealand, the Philippines, Singapore, Thailand and Taiwan) are suitable to form an AMU. The criterion of suitability is based on whether the countries exhibit symmetrical supply shocks, whether the size of the shock is small and whether the speed of adjustment of the economy to the shock is relatively fast. The sample used in this study is

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are: distance between business centres of the two countries; a dummy for common border; and a dummy for common language.

[25] See Grubel (2003) for a review of Rose's empirical studies, or for more details visit his website at www.haas.berkeley.edu/~arose.

[26] See, for example, papers by Wyplosz (2001) and Wilson (2002) which have examined a host of other issues.

substantially larger than BE's original paper, as it includes data from 1960 to the East Asian crisis and up to 2002. Using the BQ SVAR methodology with a 2-lag period, it has been possible to retrieve the demand and supply shocks and calculate the correlations between countries, with a statistically significant positive correlation indicating the suitability of two countries to form a monetary union. However, several caveats would be well-placed. The assumption that an economy is affected by only two types of shock is often far too simplified, while more recent research has shown the OCA criteria are in fact jointly endogenous, meaning countries tend to exhibit more symmetrical shocks *ex-post*.

To a large extent, the findings in this paper parallel that of previous studies, particularly in identifying smaller sub-groupings such as Malaysia and Singapore, and Hong Kong and Taiwan as potential candidates for a monetary union. (These sub-groupings are consistent with the close trade, historical, social/cultural and linguistic links between the countries). Such smaller groupings would be a start and would eventually be expanded into a larger grouping as evident from the results using the entire sample size. This larger group could include the major ASEAN countries plus Hong Kong.

Neither the results here nor those of previous studies support the establishment of a full-fledged AMU at this juncture. This point is very clear despite having left-out other factors which would be equally pertinent, such as historical, social and political differences, in determining the creation of a successful monetary union. Having said that, the results here provide no grounds to prevent the Asian countries from fostering greater monetary and exchange rate cooperation to address the regional problems faced during the crisis, to alleviate the effects of future crises and ultimately set the platform for a future Asian Monetary Union.

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Appendix I

Data Description and Sources

Data from 1960 to 2000 are obtained from the 2002 World Development Indicators CD-ROM. Data for 2001 and 2002 are obtained from various sources as listed below. Note that for the recent data, when GDP deflator cannot be obtained, the CPI is used instead. Also, if the series is of monthly frequency particularly the CPI, transformation is done into annual data by taking the monthly average following the standard practice in the compilation of annual CPI.

Country	Output	Price
Australia (AU)	ABS: Table 1. Gross Domestic Product, Chain Volume Measures and Associated Statistics: GDP	IMF IFS August 2003: GDP Deflator (1995=100)
China (CN)	Table CN.A06: GDP: By Industry: Real: 1978=100 (Annual) CN: GDP: Real: 1978=100	Table CN.I02: Consumer Price Index: PY=100 CN: Consumer Price Index
Hong Kong (HK)	Table HK.A20. GDP: by Expenditure: 2000 Price (Annual) HK: Gross Domestic Product (GDP): 2000p	Table HK.I07: Composite Consumer Price Index: 10/99-9/00=100 HK: Composite Consumer Price Index (CPI)
Indonesia (ID)	Table ID.A06: Gross Domestic Product: By Expenditure: 1993 Price (Annual) ID: Gross Domestic Product (GDP): 1993p	Table ID.I01: Consumer Price Index: 43 Cities, Excluding East Timor ID: Consumer Price Index
Japan (JP)	Table JP.AA07: SNA 93: GDP by Industry: 1995 Price (Annual) JP: Gross Domestic Product : 1995 Market Price (SNA 93)	Table JP.AA14: SNA 68: GDP: Deflators: 1990=100 JP: GDP: Deflators
Korea (KR)	Table KR.A19: GDP by Expenditure: 1995 Price (Annual) KR: Gross Domestic Product (GDP): 1995p	Table KR.A15: GDP: Deflator: 1995 Price Kr: GDP Deflator: Industries
Malaysia (MY)	Table MY.A06: GDP by Expenditure: 1987 Price (Annual) MY: Gross Domestic Product: 1987p	Table MY.A14: GDP Implicit Price Deflator: 1987=100 (Annual) MY: GDP: Implicit Price Deflators (IPD)
New Zealand (NZ)	Datastream: NZ GDP CONN NZGD....C	IMF International Financial Statistics August 2003: GDP Deflator (1995=100)
Philippines (PL)	Table PH.A18: GDP by Expenditure: 1985 Price (Annual) PH: Gross Domestic Product (GDP): 1985p	Table PH.I22: Implicit Price Index: 1995=100 PH: Implicit Price Index: Gross Domestic Product
Singapore (SG)	Table SG.A03: 2000 SSIC: GDP by Expenditure: 1995 Price (Annual) SG: Gross Domestic Product: 95p	GDP Deflators by Industry at http://www.singstat.gov.sg/keystats/economy.html#prices

Country	Output	Price
Thailand (TL)	Table TH.A11: Gross Domestic Product: By Expenditures: 1988 Price (Annual) TH: Gross Domestic Product: 1988p	Table TH.I01: Consumer Price Index: 1998=100 TH: Consumer Price Index
Taiwan (TW)	Table TW.A02: GDP by Expenditure: 1996 Price TW: Gross Domestic Product (GDP): 1996p	Table TW.I02: Consumer Price Index: 1996=100 TW: Consumer Price Index

Appendix II

Plots of each variable in natural logarithm overtime for each country.

Note that the first letter indicates that the variable is in natural log, the second and third letter indicates the country of origin, and the third indicates the type of data: *p* being GDP deflator and *y* being real GDP.