Asymmetry of Shocks in Selected ASEAN Countries

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Abstract

In light of recent developments in the region, the purpose of this paper is to study the type, size and frequency of asymmetric disturbances across the largest five economies of the Association of South East Asian (ASEAN) and so to infer their suitability for becoming a currency union. In order to detect a common message, the results of several techniques are reported. First, a bivariate model combining both output growth and inflation is included in order to assess the separate nature of supply and demand shocks. Next, a three variable version of the bivariate model is presented. This trivariate version, by including real effective exchange rates makes it possible to distinguish between supply, monetary and real or demand shocks. The results clearly suggest that the Indonesia is the country less ready for a currency union with the countries under analysis. In addition, strong evidence was found that Singapore and Malaysia are the most synchronised countries in the sample, with Thailand close behind, suggesting they represent the core group in ASEAN. Of the remaining countries, the Philippines is clearly better prepared for a currency union than Indonesia but both can be seen as constituting the periphery of ASEAN.

Keywords; Optimum currency areas; Monetary integration; Asymmetric shocks; Asean.

JEL Classifications: F15; F33; E42

1. Introduction

The current literature on Optimum Currency Areas suggests that the presence of large, frequent and country-specific (i.e., asymmetric) shocks hitting across different economies, without efficient adjustment mechanisms to restore equilibrium (i.e., labour mobility and/or wage flexibility) is a clear indication that a common currency area should not be attempted without an increase in the level of convergence among the countries.

Mundell (1961)'s original argument was that if the impact of output disturbances on particular areas (and not just countries) was similar, a common currency or a fixed exchange rate system was appropriate. If, however, disturbances were asymmetric, the necessary adjustment in relative prices to restore equilibrium could be achieved either through exchange rates (which would not be, however, totally effective if the affected regions did not coincide with a currency area) or through high labour mobility and/or wage flexibility. It is therefore not surprising that a large number of empirical studies on OCA are dedicated to measuring the extent of asymmetries between regions in order to assess their advantages in having a common currency.

Early studies[1] on this matter focused on the correlation across countries of relative prices (as measured by the variability of real exchange rates or real share prices) or on output movements[2] (as measured by their nominal or real GDP's) and argued that countries which tended to move together on those variables had relatively symmetrical shocks.

These approaches have, however, encountered criticism (Bayoumi and Eichengreen (1993)) since correlation of relative prices or output reflect the influence of both disturbances and responses, that is, if relative prices or output move together in two regions it may reflect symmetric disturbances or rapid symmetric responses[3]. Since then, several empirical studies have attempted to isolate disturbances from other components of output (and/or relative price) movements.

Bayoumi and Eichengreen (1993, 1994) were the first to set to distinguish between these two types of disturbances using a structural VAR model of output and prices. Using a decomposition method first used by Blanchard and Quah (1989) they identify permanent and transitory shocks which they associate with aggregate supply and aggregate demand shocks, respectively. This has since become the standard approach to study de asymmetry of shocks amongst any group of countries.

Later studies tried to distinguish a larger number of disturbances. Chamie, DeSerres and Lalonde (1994) use a VAR system that includes measures of industrial production,

[1] For a survey of the early empirical papers see for example Bayoumi and Eichengreen (1993).
[2] This was the view of the famous European Commission (1990)'s "One Market, One Money".
[3] The same criticism was also made of early studies that focused on the responsiveness of labour markets as "high degree of observed labor mobility may reflect either an exceptionally responsive labor market or exceptionally asymmetric regional labor market shocks", p. 10.

consumer price index and M1 monetary aggregate. Then, extending the Blanchard-Quah method, they use long-run restrictions to decompose the VAR reduced-form residuals into three structural innovations: supply shocks and monetary and non-monetary (or real) demand shocks. In a clear demarcation from Bayoumi and Eichengreen approach, they argue that on the demand side, only monetary shocks have no permanent effect on real balances while a real demand shock (like fiscal or consumer preference shocks) may have an important impact on the evaluation of the costs of losing exchange rate flexibility and therefore should be analysed separately. Clarida and Gali (1994) presented a stochastic version of the Mundell-Fleming-Dornbush model in which a third variable was included: real exchange rate. By incorporating monetary neutrality, and thus the assumption that in the long run the real exchange rate (as well as the real GDP) is invariant to monetary shocks, they distinguish between Supply, Demand (or IS) and Monetary (or LM) shocks to output growth level, inflation and real effective exchange rates.

Nikolakaki (1997) and more recently Brito (2004) extended Clarida and Gali (1994)'s analysis. The latter, extends the stochastic version of the Mundell-Fleming-Dornbush model to encompass the Balassa-Samuelson-effect[4]that contradicts Clarida and Gali (1994)'s predictions[5] that positive supply shocks induce disinflation and a real depreciation.

Even though there have been a number of studies on the asymmetry of shocks that included Asian countries[6], they did not specifically consider the special case of the Association of South East Asian Nations (ASEAN)[7] countries. In light of recent developments in this region[8], the purpose of this paper is to assess the type, size and

[4] This effect named after Bela Balassa and Paul Samuelson and states that in countries that experience large productivity gains in the external sector and labour mobility between the internal and external sectors of the economy, will lead to wage inflation that will ultimately feed into the price level. Therefore, an asymmetric supply shock across sectors will have the net effect of an increase in the price level and, *ceteris paribus,* a real exchange rate appreciation.

[5] Nikolakaki (1997) also predicts a positive cumulative effect of a supply shock to both the price level and real effective exchange rates.

[6] For example Bayoumi and Eichengreen (1996) and Brito (2004)

[7] The original five members of ASEAN or ASEAN5, Indonesia, Malaysia, Philippines, Singapore and Thailand have since been joined by Brunei Darussalam (1984), Vietnam (1995), Laos and Myanmar (1997) and Cambodia (1999).

[8] Notable initiatives to promote regional financial stability and monetary policy cooperation include the establishment of 'Manila Framework Group' in 1997, the 'ASEAN Surveilance Process' in 1998 and the "Chiang Mai Initiative' in 2000. Recent initiatives to

frequency of asymmetric disturbances across the economies of the ASEAN countries so to infer to their prospects of further monetary cooperation.

The original purpose of this study was to include all ten ASEAN members. A closer look at the available data, however, indicated that such a task was extremely difficult as the data available for some of the smaller members of the ASEAN countries proved to be quite limited. Therefore, the analysis shall be reduced to what can be called the 'big5' economies: Philippines, Malaysia, Indonesia, Singapore and Thailand. Although far from ideal, this choice seems reasonable as these are the largest and more open economies.

This paper will be organised as follows: section 2 will present a bivariate model which identifies supply and demand shocks, section 3 will develop a three variable model which further allows for the distinction between supply, demand (or IS) and monetary (or LM) shocks and section 4 presents the main conclusions.

2. Bivariate analysis: The Bayoumi-Eichengreen model

Bayoumi and Eichengreen (1993) proposed a new framework in order to make it possible to distinguish between supply and demand disturbances. By adapting a decomposition technique first used by Blanchard and Quah (1989), which implies a lower triangular matrix of long run responses, they estimate bivariate autoregressions for real Gross Domestic Product (GDP) and prices, restricting demand disturbances to have permanent effects only on prices since it is assumed that a demand disturbance has no permanent effect on output while allowing supply shocks to have long-run effects on both prices and output.

promote economic integration include the ASEAN Free Trade Area (1992) and the adoption of the so-called "ASEAN's Vision 2020" in 1997 where a timetable was established to create an ASEAN Economic Region.

2.1. The Model

Consider a system where the true model can be represented by an infinite moving average of a (vector) of variables X_t and an equal number of shocks ε_t. Using the lag operator L, this can be written as:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + A_3\varepsilon_{t-3} + ... \quad (1)$$

$$= \sum_{i=0}^{\infty} L^i A_i \varepsilon_t, \quad (2)$$

where the matrices A_i represent the impulse response functions of the shocks to the elements of X. Let X be made up of the change in output and to the change in prices, and let ε_t be demand and supply shocks. The model then becomes

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} . \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \quad (3)$$

where y_t and p_t represent logarithms of output and prices, ε_{dt} and ε_{st} are independent and serially uncorrelated supply and demand shocks, and a_{11i} represents element a_{11} in matrix A_i. Since demand shocks are assumed to have no permanent effects on output (only supply shocks do but both have permanent effects on prices), the cumulative effect of demand shocks on the change of output (Δy_t) must be zero and therefore the model implies the restriction[9]:

$$\sum_{i=0}^{\infty} a_{11i} = 0 \quad (4)$$

Estimating this model using a Vector Autoregression (VAR), and letting B represent these estimated coefficients, the estimating equation becomes

$$X_t = B_1 X_{t-1} + B_2 X_{t-2} + ... + B_n X_{t-n} + e_t \quad (5)$$

$$= \left[\left(I - B(L) \right) \right]^{-1} e_t$$

$$= \left[I + B(L) + B(L)^2 + B(L)^{3 \ldots} + \ldots \right] e_t$$

$$= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots$$

in a equivalent manner:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \end{bmatrix} = \sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} . \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} \qquad (6)$$

where e_t represents the residuals of a regression of lagged values of Δy_t and Δp_t on current values of each in turn, that is, the residuals of the output and price equations, e_{yt} and e_{pt}, respectively.

To convert this reduced form equation into the structural model, the residuals from the VAR, e_t, must be transformed into demand and supply shocks, ε_t.

Combining (3) and (6) we get:

$$\begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} = \left[\left[\sum_{i=1}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \right]^{-1} . \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \right] . \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} = C . \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \qquad (7)$$

To uniquely identify C, in the two by two case described above, four (theoretical) restrictions need to be imposed to reduce the number of unknown structural parameters to be less than or equal to the number of estimated parameters of the variance-covariance matrix Σ of the innovations e_y and e_p. The identification problem of the model is solved, by the use of four restrictions: two normalisation[10] restrictions on the variance of the shocks ε_{st}

[9] For proof see for example Bayoumi and Eichengreen (1994).

[10] The normalisation condition is that the two variances of supply and demand shocks are set equal to one which together with the orthogonality assumption implies that C'C=Σ, where Σ is the variance-covariance matrix of e_y and e_p. Bayoumi and Eichengreen also report results using the normalisation C'C=Γ, where Γ is the correlation matrix of e_y and e_p because they wanted to estimate the variance of shocks themselves.

and ε_{dt}, the orthogonality[11] of supply and demand shocks and the condition that the demand shocks only have short run effects on output.

This last assumption in terms of the VAR implies that the model becomes:

$$\sum_{i=0}^{\infty}\begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix}\begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}=\begin{bmatrix} 0 & . \\ . & . \end{bmatrix} \qquad (8)$$

and allows the matrix C to be uniquely defined and the demand and supply shocks to be (just) identified.

2.2. The Data

The data on both real Gross Domestic Product (GDP) and Consumer Price Index (CPI) comes from IMF's International Financial Statistics and consists of annual real GDP and annual CPI series for all countries both of which have 1995 as the base year. To identify supply and demand disturbances with the model described above, bivariate VARs were estimated for each country in the sample. Since this method requires all variables to be stationary (as estimations are done in levels), the first difference of the log functions of both real GDP and CPI were used. Table A-1 of appendix A shows the results for the Augmented Dickey-Fuller test on all individual series and show that all series were found to be stationary at the 1% level of significancy except for the cases of the Philippines's and Singapore's real GDP time series. When the alternative Phillips-Peron test was estimated, these time series was found to be stationary at the 1% level of significancy. A lag of one was chosen for all VARs as the Likelihood Ratio test clearly indicated that one was the ideal lag length in all of the five models.

[11] The orthogonality of supply and demand shocks means that they are uncorrelated since its covariance matrix is the identity matrix and guarantees that the product of the two vectors is zero.

2.3. The Results

To identify demand and supply shocks, bivariate VARs were estimated for each country under analysis for the period 1962-2001. As discussed above, this method allows for the distinction of supply and demand disturbances and thus the pattern, size and duration of asymmetric shocks. Following the general aggregate supply and demand model, it is expected that in the long run demand shocks have no effect on the output level while having a positive permanent effect on the price level, while supply shocks are expected to have a positive permanent effect on the output level and a negative effect in the price level.

2.3.1 The Long Run Pattern

The estimated long-run response pattern to structural innovations, which is equivalent to matrix C in 7 above, for the ASEAN countries under analysis for the period 1962-2001 is shown in the table below.

Table 1: Long Run Pattern of Demand and Supply Shocks – Data Range: 1962-2001

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Expected Sign
Demand shock to output§	0	0	0	0	0	0
Demand shock to prices	0.8444*	0.0478*	0.0768*	0.0663*	0.0897*	+
Supply shock to output	0.0641*	0.0381*	0.0056*	0.0502*	0.0684*	+
Supply shock to prices	-0.5891*	0.0281*	-0.0371	0.0221**	0.0057	-

Notes:

§ = the long run effect of a demand shock to output is zero by imposition of the model.
* and ** = significant at the 1% and 5% level respectively
Expected sign = Expected sign of the variable from the theory

As predicted by the aggregate supply and demand model, both demand shocks to prices and supply shocks to output were found to be positive and highly significant (at the 1% level of significancy) in all countries. However, the coefficient of supply shock to prices in the case of Malaysia and Singapore and Thailand yielded the opposite signs to what was expected[12].

Table 1 also shows that in terms of demand and supply shocks to prices, Indonesia has an atypical behaviour as both coefficients yield much higher values than the average thus suggesting that it experiences more volatile movements in the price level and output growth than the other economies under analysis. Of the remaining four countries, and even though their long run pattern is similar, Singapore and Malaysia, seem to form a subgroup.

2.3.3. Correlation and Size of Shocks

The Structural VAR model described above also allows for the identification of the correlation of shocks amongst ASEAN countries. The more correlated shocks are between two countries the less they have to lose from have a common currency. Table 2 presents the correlation of demand shocks in ASEAN.

Table 2: Correlation of Demand Shocks in ASEAN. Data Range: 1962-2001

	Indonesia	Malaysia	Philippines	Singapore
Indonesia				
Malaysia	-0.494			
Philippines	0.067	0.188		
Singapore	0.123	0.433	0.387	
Thailand	0.115	0.397	0.299	0.706

The main finding, in terms of the correlation of demand shocks is that all pairs involving Indonesia have the lowest correlations of the sample, with Indonesia's correlation of demand shocks with Malaysia being almost 50 percent negative. Of the remaining pairs, the three highest coefficients are for Singapore-Thailand (0.71), Singapore-Malaysia (0.43) and Malaysia-Thailand (0.40). Next, the correlations of supply shocks are presented in Table 3.

[12] It is only unexpected in terms of the Bayoumi and Eichengreen (1993) model. As will be discussed in section 3 the expected sign of

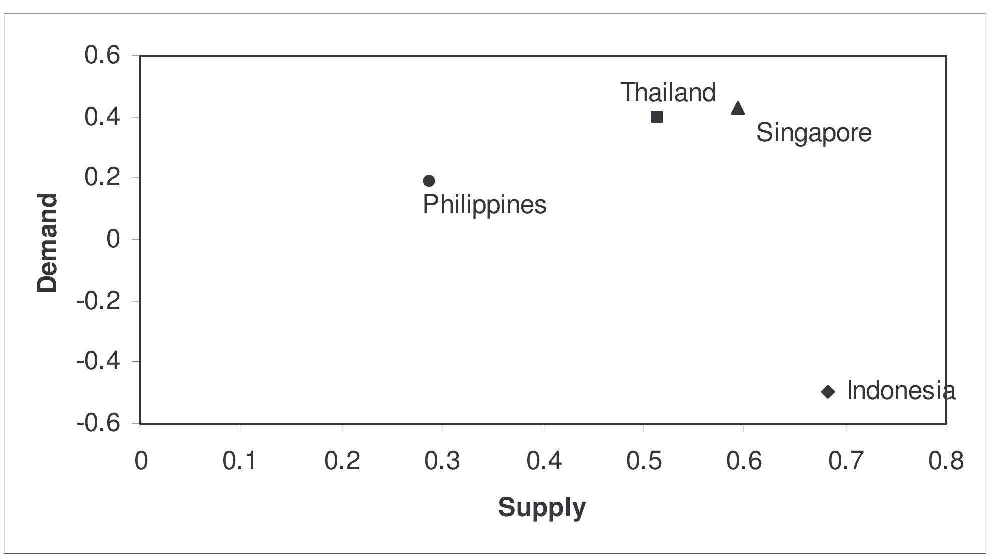
Table 3: Correlation of Supply Shocks in ASEAN.- Data Range: 1962-2001

	Indonesia	Malaysia	Philippines	Singapore
Indonesia				
Malaysia	0.683			
Philippines	0.276	0.287		
Singapore	0.409	0.594	0.344	
Thailand	0.613	0.515	0.346	0.452

In terms of the correlation of supply shocks, one immediate conclusion is that the lowest correlation coefficients are all those pairs involving the Philippines with coefficients varying from 27% to 35%. For the remaining country pairs, the correlation coefficients range from 41% to 68%.

One useful exercise might to be juxtapose the correlation coefficients of demand shocks and the correlation coefficients of supply shocks with an anchor area. For the purpose of this exercise, Malaysia was chosen as the anchor area as it was shown to have the lowest long-run pattern of shocks to both output and prices. The result is presented in Figure 1.

Figure 1: Correlation of Demand and Supply Shocks with Malaysia (1962-2001)



this coefficient is ambiguous and basically depends on the existence of a dynamic and external sector exposed to international

Figure 1 shows that Thailand and Singapore have highly correlated supply and demand shocks with Malaysia and can be seen as forming a core of countries characterised by relatively symmetric behaviour and a periphery comprised by the Philippines and Indonesia whose disturbances are less symmetric with those experienced by the core[13].

The size of shocks can be measured by the standard deviations (per annum) of demand and supply shocks observed in each country. The smaller the size of underlying shocks the easier it will be to maintain a fixed exchange rate and therefore the stronger the case for a monetary union. The estimated size of demand and supply shocks in ASEAN for the period of 1962-2001 are presented in Table 4.

Table 4: Size of Demand Shocks in ASEAN.- Data Range: 1962-2001

	Demand Shocks	Supply Shocks
Indonesia	0.013119	0.015475
Malaysia	0.016856	0.023541
Philippines	0.020251	0.01202
Singapore	0.01358	0.018742
Thailand	0.010704	0.012131

Several conclusions can be made from the data on Table 4. First, with the exception of the Philippines, demand shocks are larger than supply shocks for all ASEAN members. Second, the size of both demand and supply shocks in ASEAN are relatively similar, with all the standard deviations in the range of 1-2 percent[14]. Finally, the size of both supply shocks and demand shocks in ASEAN is quite similar to the size of supply shocks found in the EU core and the U.S regions found in previous studies[15]. It seems reasonable to

competition.

[13] These results fit nicely with those of Bayoumi and Eichengreen (1993) on their study of the EU. In fact, in their study, the EU core was identified by the countries which had correlation coefficients of supply shocks of at least 50% and simultaneously correlations coefficients of demand shocks of at least 17%.

[14] As all variables are measured in log form, the standard deviation coefficients are percentages.

[15] Bayoumi and Eichengreen (1993) found that supply shocks to the EU core and the U.S. were within the range of 1-2 percent and the EU periphery in the range of 2-3 percent. Similarly, Brito (2004) found the standard deviation of supply shocks to the Euro-zone for the time span of 1979-1998 to be 2.13%.

conclude, therefore, that in this score at least, the aspirations of a currency area in ASEAN are as legitimate as those of other existing monetary unions.

2.3.2 Impulse Response Functions

The dynamics (and especially the short run effects) of the system can be observed by analysing the impulse response functions depicted in Figure A-1 of Appendix A. The impulse-response coefficients trace the effect of a one standard-deviation of each shock on each of the endogeneous variables. If the type and magnitude of the responses of the endogenous variables to the structural shocks are similar across countries, then a common monetary policy can be effective to address each country's economic needs. If however, the responses to shocks are quite diverse, a common monetary policy will not be effective in adjusting to shocks. One immediate conclusion is that supply shocks are larger for the countries under analysis than demand shocks and that the responses functions of the endogenous variables to both types of shocks are quite similar across countries.

In terms of shocks to output, supply shocks are clearly much more important in the short run than demand shocks (in the long run, the effect of demand shocks on the output level are in the model specification restricted to be zero). Also, all countries have similar patterns of adjustment to the effect of a one standard-deviation of shocks with Singapore and Malaysia having the faster adjustment period to shocks in the sample and the more similar adjustment path.

In terms of shocks to prices, the differences are more pronounced. Indonesia stands out as having the largest and more persistent responses to both demand and supply disturbances of all countries[16]. Singapore, Malaysia and the Philippines have the fastest (less costly) adjustment to demand shocks while Thailand, Singapore and Malaysia have the smallest supply shocks to prices. Finally, Singapore and Malaysia have the fastest

[16] As all variables are in log form, the left axis reads as a percentage, that is, 0.02 is equal to 2% of either real GDP or inflation level.

adjustment to supply shocks, which presumably reflects greater factor mobility in those countries.

The speed of adjustment to shocks can better be seen in Table 2 below which reports the proportion of the long run adjustment accomplished in the first three years after the occurrence of a structural shock. The speed of adjustment to disturbances is crucial to the assessment of the feasibility of a currency union. As pointed out by Brito (2004), if the deviations that follow a shock are quickly eliminated, the costs of forsaking policy independence are bound to be smaller even in situations where countries experience asymmetric shocks and divergent responses to those shocks. The results in Table 2 present the percentage of adjustment after three years[17].

Table 5: Speed of Adjustment to Shocks (1962-2001)

Country	Demand Shocks	Supply Shocks
Indonesia	0.882	0.793
Malaysia	0.952	0.894
Philippines	0.995	0.782
Singapore	0.993	0.804
Thailand	0.906	0.548

Table 5 reveals that full-adjustment to the occurrence of demand shocks are faster than those of supply shocks in all cases. That is not surprising seen that the absorption of supply shocks is more difficult as it normally requires some form of structural adjustment. Nevertheless, the percentage of full-adjustment to supply shocks after three years is in the range of 80% for all countries with the exception of Thailand which has a 55% coefficient.

The impulse response functions confirm that of the five countries, Singapore and Malaysia have the most synchronized behaviour: not only are the adjustment path and size of both output and prices to supply and demand shocks the most similar of the sample, their speed of adjustment is also clearly the fastest of the countries under analysis. Indonesia's

[17] Following Brito (2004), the speed of adjustment is measured as the average across the endogeneous variables of one minus the adjustment remaining. The adjustment remaining is calculated as the absolute value of one minus the ratio of the response after three

adjustment of the price levels to both demand and supply shocks is quite atypical and presents the longest period of adjustment to demand shocks in the sample.

2.3.3. Variance Decomposition

Variance decomposition provides an alternative method of depicting the system dynamics. While impulse response functions trace the effects of a shock to an endogenous variable on the variables in the VAR, variance decomposition decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR and therefore gives information about the relative importance of each random innovation to the variables in the VAR.

In terms of the variance decomposition of output, the main finding (see table B-1 of appendix B) is that supply shocks account for most of the variability of output levels in all cases (which is not surprising given the restrictions of the model). Also, Singapore has the lowest value of supply shocks at about 90% whilst Malaysia has the highest proportion at about 99%. In terms of inflation, we find that demand shocks account for most of the variance of inflation with Singapore and Malaysia having the highest proportion of demand shocks to supply shocks in the sample (around 97% in the first year).

One serious limitation of Bayoumi and Eichengreen's approach is that aggregate demand shocks include both nominal shocks and real shocks. This will be dealt with in the following section.

3. Trivariate Analysis: A IS-LM analysis

The bivariate model can be easily extended to include a larger number of variables so that a larger number of disturbances can be isolated. Clarida and Gali (1994) were the first to do so by presenting a stochastic version of the Mundell-Fleming-Dornbush model in

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years to the lung run effect of any particular shock. For the responses for which the theoretical identifying restrictions impose convergence toward zero, the measure of the speed of adjustment is computed as one minus the impulse-response after three years.

which a third variable was included: real exchange rate. By incorporating monetary neutrality, and thus the assumption that in the long run the real exchange rate (as well as the real GDP) is invariant to monetary shocks, they distinguish between Supply, Demand (or IS) and Monetary (or LM) shocks to output growth level, inflation and real effective exchange rates.

Clarida and Gali (1994)'s methodology can briefly be explained as follows. Let Matrix X (equations 1 and 2 above) now include, besides change in output, Δy and changes in the price level, Δp, a third variable, Δq, changes in the real effective exchange rate (REER[18]). In this case, the reduced form, moving average representation is given by

$$\begin{bmatrix} \Delta y_t \\ \Delta q_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} & a_{13i} \\ a_{21i} & a_{22i} & a_{23i} \\ a_{31i} & a_{32i} & a_{33i} \end{bmatrix} \begin{bmatrix} \varepsilon_{lmt} \\ \varepsilon_{ISt} \\ \varepsilon_{St} \end{bmatrix} \qquad (7)$$

where q_t represents the logarithm of real effective exchange rate, ε_{LMt} and ε_{ISt} independent (LM) monetary disturbances and (IS) demand disturbances, with the remaining variables assuming the same meaning as in the model presented in section 2.

Following the Blanchard and Quah (1989) decomposition method, we assume that the estimated residuals of the VAR e_t are linear representations of the unobservable structural shocks, ε_t, so that $e_t= C\varepsilon_t$, It is now clear that in order to uniquely identifying this model, nine restrictions have to be imposed on Matrix C so that the residuals of the VAR, e_t can be transformed into monetary, demand and supply shocks ε_t. As before, we assume that structural shocks are serially uncorrelated and have a variance-covariance matrix normalized to the identity matrix. In this manner, the orthogonality condition $CC'=\Sigma$

[18] The real effective exchange rates (REER) time series were not available for all countries in the analysis. In fact, and perhaps surprisingly, the IMF's International Financial Statistics do not provide data for Indonesia and Thailand. Therefore, using the method

imposes now six non-linear restrictions on the elements of C. The remaining three (theoretical) necessary restrictions stem from the condition that only supply shocks have permanent effects on output (and therefore the cumulative effect of both ε_{IS} and ε_{LM} shocks on output growth is zero) and that monetary shocks (ε_{LM}) do not have long-run effects on real effective exchange rates. These conditions, given the ordering of the variables, imply the restrictions:

$$\sum_{i=0}^{\infty} a_{11i} = \sum_{i=0}^{\infty} a_{12i} = \sum_{i=0}^{\infty} a_{21i} = 0 \qquad (8)$$

which in terms of the SVAR model implies:

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} & d_{13i} \\ d_{21i} & d_{22i} & d_{23i} \\ d_{31i} & d_{32i} & d_{33i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} = \begin{bmatrix} 0 & 0 & . \\ 0 & . & . \\ . & . & . \end{bmatrix} \qquad (9)$$

Nikolakaki (1997) and more recently Brito (2004) extended Clarida and Gali (1994)'s analysis. The latter, extends the stochastic version of the Mundell-Fleming-Dornbush model to encompass the Balassa-Samuelson-effect[19] that contradicts Clarida and Gali (1994)'s predictions[20] that positive supply shocks induce disinflation and a real depreciation. In fact, Brito (2004) argues that in dynamic developing economies with large external sectors exposed to international competition, a positive productivity shock in the external sector (or a productivity shock that is larger in the external than in the internal sector of the economy) implies that wages in the internal sector (assuming labour mobility across sectors) will grow faster than the respective marginal product of labour. That in turn

employed by the IMF, the REER time series were generated for all five countries under analysis. The source of the data and methodology used in generating the REER time series are presented in Appendix C.

[19] This effect is named after Bela Balassa and Paul Samuelson and states that in countries that experience large productivity gains in the external sector and labour mobility between the internal and external sectors of the economy, this will lead to wage inflation that will ultimately feed into the price level. Therefore, an asymmetric supply shock across sectors will have the net effect of an increase in the price level and, *ceteris paribus,* a real exchange rate appreciation.

[20] Nikolakaki (1997) also predicts a positive cumulative effect of a supply shock to both the price level and real effective exchange rates.

leads to wage inflation in excess of productivity growth, which will ultimately feed into the price level and cause an appreciation of the real exchange rate[21].

3.2. Data and Results

To identify supply, monetary (or LM) and demand (or IS) disturbances with the model described above, trivariate VARs were estimated for each of the five countries under analysis for the period 1968-2001. The results for both the Augmented Dickey-Fuller test and the Phillips-Peron test on the first difference of the log of all three variables are presented in Table A-2 of appendix A and shows all time series to be stationary in at least one of the tests at the 5% level of confidence. As all individual VARs proved to be stable[22] we can reasonably assume all time series to be stationary. Data on the REER had to be generated, as the IFS database (or any other) did not provide data for all countries under analysis[23]. The source of the data and methodology used in generating the REER time series are presented in Appendix B. Also in this case, one lag was chosen for all VARs as the Likelihood Ratio test clearly indicated that one was the ideal lag length in all of the five models.

3.2.1. The Long-Run Pattern

As predicted by the aggregate demand and supply model (see section 2) as well as in the Mundell-Fleming-Dornbush setting, it is expected that in the long run, aggregate demand shocks (and thus both IS and LM shocks) have no effect on the output while having a positive permanent effect on the price level (and therefore positive IS and LM shocks on prices) while supply shocks are expected to have a positive, permanent effect on

[21] Brito (2004) found strong evidence of the presence of the Balassa-Samuelson effect in the case of five of the six East Asian economies in his study (Hong Kong, Japan, Malaysia, Philippines and Singapore, and not in Korea) but not in the case of the Euro-Zone.
[22] The VAR proved to be stable as the inverse roots of the characteristic AR polynomial test showed that all roots had modulus less than one and thus lie inside the unit circle.
[23] The Real Effective Exchange Rates (REER) time series were not available for all countries in the analysis. In fact, and perhaps surprisingly, the IMF's International Financial Statistics do not provide data for Indonesia and Thailand. Therefore, using the method employed by the IMF, the REER time series were generated for all five countries under analysis.

the output level. On the other hand, monetary shocks are expected to have no long run effect on real effective exchange rates as implied by monetary neutrality. Finally, the cumulative long run effect of a supply shock on both on the price level and REER is ambiguous and depends on whether or not we are in presence of the Balassa-Samuelson effect. The long-run response pattern to structural innovations for the ASEAN countries under analysis is shown in Table 6.

Table 6: Long Run Pattern of LM, IS and Supply shocks – Data Range: 1968-2001

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Exp. Sign
LM shock to output§	0	0	0	0	0	0
LM shock to REER§	0	0	0	0	0	0
LM shock to prices	0.143505*	0.043975*	0.068905*	0.059496*	0.066498*	+
IS shock to output§	0	0	0	0	0	0
IS shock to REER	0.140075*	0.059413*	0.074164*	0.066473*	0.075634*	+
IS shock to prices	0.104678*	0.014433*	0.016209	0.041756*	0.050022*	+
Supply shock to output	0.054843*	0.042104*	0.064000*	0.048760*	0.077153*	+
Supply shock to REER	0.074194*	0.059530*	0.051307*	0.040748*	0.035434*	?
Supply shock to prices	-0.053837***	0.029220*	-0.032578**	0.033900*	0.021354	?

Notes: § = the long run effect of these shocks is zero by imposition of the model.
*, ** and *** = significant at the 1%, 5% and 10% level, respectively.
Exp. sign = Expected sign of the variable from the theory

From Table 6 it is clear that all variables yielded the expected positive signs and were all found to be significant at the 1% level with the exception of demand shocks to prices in the case of the Philippines. Also, supply shocks were found to lead to an appreciation of the real exchange rates in the long run in all cases. However, the Balassa-Samuelson prediction that a supply shock leads to inflation was only found to be present in the cases of Malaysia, Singapore and Thailand (but not significant in the latter). Conversely, for both Indonesia and the Philippines a supply shock to prices leads to deflation (even though a supply shock to their real exchange rates was found to be positive). This seems to indicate that, the Balassa-Samuelson effect is more preponderant in the output than in the money market.

The magnitude of the long-run pattern of supply shocks to output (but also to real effective exchange rates) were found to be, once again, quite similar across ASEAN's big5 economies. Also, the long-run pattern of monetary shocks are larger than those of demand shocks to prices in all cases, suggesting that a common currency could stabilise the economy better than floating exchange rates.

It is also clear that with one exception, in terms of the long-run pattern of supply shocks to real effective exchange rates, Singapore and Malaysia have the lowest effect of all the disturbances to the three variables and that Indonesia experiences the largest cumulative long run monetary and demand shocks to output, prices and real exchange rates.

3.2.2. Correlation and Size of Shocks

This trivariate Structural VAR allows for the determination of the correlation of three separate types of shocks. The correlation coefficients of Monetary (or LM) shocks, Demand (or IS) shocks and Supply shocks are presented in Tables 7, 8 and 9, respectively.

Table 7: Correlation of Monetary Shocks in ASEAN. Data Range: 1968-2001

	Indonesia	Malaysia	Philippines	Singapore
Indonesia				
Malaysia	0.443			
Philippines	0.082	0.369		
Singapore	0.333	0.690	0.330	
Thailand	0.365	0.585	0.175	0.546

Table 8: Correlation of Demand Shocks in ASEAN. Data Range: 1968-2001

	Indonesia	Malaysia	Philippines	Singapore
Indonesia				
Malaysia	0.130			
Philippines	0.514	0.104		
Singapore	0.285	0.327	0.360	
Thailand	-0.323	0.261	0.586	0.308

Table 9: Correlation of Supply Shocks in ASEAN. Data Range: 1968-2001

	Indonesia	Malaysia	Philippines	Singapore
Indonesia				
Malaysia	0.768			
Philippines	0.522	0.318		
Singapore	0.522	0.681	0.217	
Thailand	0.718	0.515	0.344	0.473

An analysis of Tables 7-9 allows for several conclusions. First, with one exception (Correlation of Demand shocks between Indonesia and Thailand) all coefficients yield a positive sign which can be seen as an encouraging sign for the existence of preconditions for a common currency area in the region. Second, the correlations of supply shocks in the trivariate model (Table 9) present the same pattern found in the bivariate version (Table 3). In terms of the correlation of Monetary shocks, the highest values (at 55% or more) are those of the pairs Malaysia-Singapore, Malaysia-Thailand and Singapore-Thailand. The two highest correlations of output shocks are for the pair Indonesia-Philippines and Philippines-Thailand which in turn are also the pairs that yielded the lowest coefficients of the correlation of Demand Shocks.

Next, the average size of Monetary, Demand and Supply disturbances to the three endogenous variables are presented in Table 10.

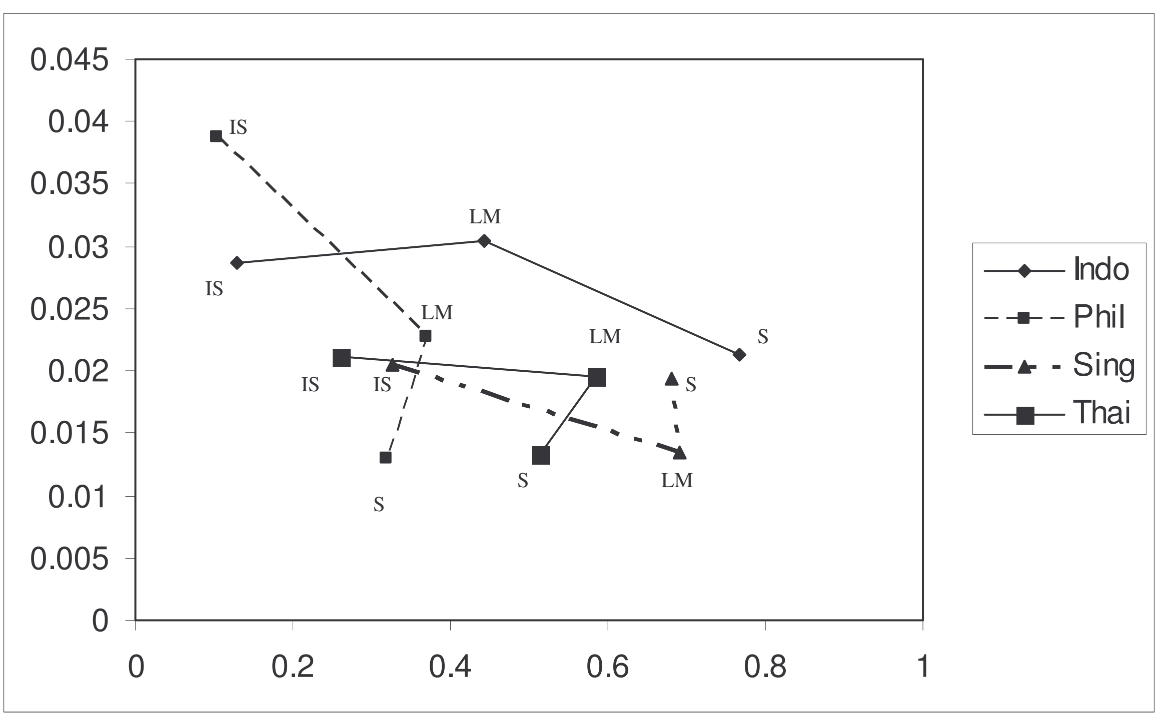
Table 10: Size of Monetary, Demand and Supply Shocks in ASEAN (1968-2001)

	Monetary Shocks	Demand Shocks	Supply Shocks
Indonesia	0.030473	0.028715	0.021249
Malaysia	0.020367	0.025294	0.026934
Philippines	0.022772	0.038804	0.013033
Singapore	0.013505	0.020453	0.019348
Thailand	0.019463	0.021124	0.013225

Table 10 shows a remarkable similarity of shocks across ASEAN with all coefficients being in the 1-2 percent range with the exception of the size of Indonesia's Monetary Shocks (3%) and Philippines's Demand Shocks (3,9%). Also, it is apparent that with the exception of Indonesia, Monetary shocks are smaller than Demand Shocks in all countries of ASEAN5. Moreover, contrary to what was found in the bivariate model, Demand shocks are larger than Supply shocks (with the exception of Malaysia), which is not surprising seen that in the bivariate model demand shocks encompass both monetary (or LM) and real (or IS) shocks.

Finally, the size and the correlation of shocks between ASEAN countries and an anchor country (Malaysia), is presented in graphic form in Figure 2, where the size of disturbances is presented in the left axis and the correlation coefficients in the horizontal axis.

Figure 2: Correlation and Size of Monetary, Demand and Supply Shocks with Malaysia. Data Range: (1968-2001)



Due of the construction of the figure, the more to the right and the lower the coefficients are in the figure, the better prepared are the countries to form a currency union as they experience smaller and more correlated disturbances. Figure 2 allows for the clear distinction between a core (formed by Malaysia, Singapore and Thailand) and a periphery (formed by Indonesia and Thailand). The pattern found here is consistent with the one found in Figure 1 above which juxtaposed the correlations of supply and demand shocks found in the bivariate model.

3.2.3. Impulse-Response Functions

Figure A-2 of Appendix A presents the impulse-response functions of the trivarite SVAR model described above for ASEAN's 'Big5' economies[24]. Not surprisingly, supply shocks to output are once again larger than monetary and demand shocks in all cases and once again, the pattern of supply shocks to output is remarkably similar across the five countries. In terms of shocks to real effective exchange rates and inflation the situation is quite different. Firstly, Indonesia experiences by far the largest responses to all three types of shocks to both real effective exchange rates and the price level. Secondly, the responses of real effective exchange rates to a monetary shock follow the classical (Dornbush) overshooting result in all countries except for Indonesia, which presents a pattern of undershooting in its real effective exchange rate. Finally, the pattern of the responses of all three endogenous variables to the demand shocks is quite similar across the countries under analysis.

Next, the average speed of adjustment of the endogeneous variables to the three types of shocks is presented in Table 10.

[24] In order to facilitate the comparison, the left axis of all the graphs were normalised so that the scale is the same in all of them. Therefore, the graphs of the countries with larger disturbances (namely, Indonesia and Philippines) do not show the complete picture.

Table 10: Speed of Adjustment to Shocks (1968-2001)

Country	Monetary Shocks	Demand Shocks	Supply Shocks
Indonesia	0.981	0.954	0.855
Malaysia	0.979	0.973	0.919
Philippines	0.973	0.940	0.717
Singapore	0.950	0.896	0.746
Thailand	0.934	0.989	0.528

Once again, full-adjustment to Supply shocks takes longer than adjustment to the other two types of disturbances in all 5 countries with Thailand and the Philippines experiencing the slowest adjustment to supply shocks which might be seen as a strong reason against the formation of a currency area for those two countries. However, Table 9 showed that those two countries also experienced the smallest supply disturbances of the countries under analysis so that the costs arising from the loss of monetary independence might be somehow mitigated. The speed of full-adjustment to both Monetary and Demand Shocks are very similar amongst the 5 countries with at least 95% and 90% of full-adjustment to Monetary and Demand shocks accomplished after three years following the occurrence a shock.

3.2.4. Variance Decomposition

In terms of the variance decomposition of output (see Table B-2 of Appendix B), the results of the trivariate model are very similar to those of the bivariate model in terms of supply shocks to output. In fact, supply shocks are responsible for most of the variability of output levels in all countries.

In terms of inflation, monetary shocks account for most of the variability of inflation in Indonesia, Singapore, Malaysia and the Philippines. For Thailand demand shocks are the major source of variance of inflation.

Finally, in terms of the variance decomposition of real effective exchange rates, demand shocks contribute the most to the variance of exchange rates in all countries except for Indonesia in which case supply shocks were found to be the major source of the variance to exchange rates.

4. Concluding Remarks

Even if definite evidence could not be found on whether ASEAN is an optimum or a '*pessimum*' currency area, several conclusions concerning the asymmetry of disturbances across the five largest economies of ASEAN can be presented.

The five countries of ASEAN under analysis seem to be in general as prepared to form a currency union (or other form of rigid or semi-rigid currency arrangement) as the evidence found by Bayoumi and Eichengreen (1993) on the EU before the lunch of the Euro. Nevertheless, the potential losses from the creation of a common currency are not spread evenly in ASEAN. The strongest common message from both the bivariate and trivariate structural autoregressive (SVAR) models presented here, is that Singapore and Malaysia, with Thailand close behind, are the countries that consistently have the most similar pattern shocks to output growth, inflation and real effective exchange rates. The simultaneous analysis of the size and correlation of disturbances reinforced that Malaysia, Singapore and Thailand constitute the core of ASEAN's big5 economies under analysis. Also, Indonesia stands out as having a more asymmetric behaviour than its counterparts suggesting it is the country which would have more to lose in creating a currency union with the others. Moreover, the Philippines is clearly better prepared for a currency union than Indonesia but both can be seen as constituting the periphery of ASEAN. Finally, these results (partially) validate Brito (2004)'s claim that in economies with a competitive external sectors, such as in the case of countries from the ASEAN grouping, positive supply disturbances can lead to real exchange rate appreciation and inflation - the Balassa-Samuelson effect - and not the opposite as predicted in both Eichengreen and Bayoumi (1993) and Clarida and Gali (1994)'s models.

In this way, several areas of further research can be identified. First, the structural VAR method presents serious limitations; the imposition that demand shocks only have transitory effects on output is very questionable. A non-monetary demand shock (as a fiscal or consumer preference shock) can have very persistent if not permanent effects on output. The orthogonality of shocks is also at best, very questionable. Therefore, a new econometric method that deals with those problems would be preferable. Second, the inclusion of a benchmark area (like the US or the EU) would allow the comparison of the results with an existing (and in the case of the US a supposedly efficient) currency union. Third, the inclusion of a larger number of ASEAN economies in the analysis would certainly allow us to refine our conclusions on the desirability (and extent) of ASEAN becoming a currency union. Finally, the study of the degree of factor mobility across countries, especially in terms of labour movements, would almost certainly help explain the reasons behind the fact that some countries appear to have more synchronised business cycles than the rest and thus complement the results presented in this study.

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APPENDIX A:

Table A-1: Unit Root Test Results for the first difference of the log of real GDP and CPI time series.
Data Range: 1962-2001

	ADF Test Statistic		PP Test Statistic	
Country	CPI	Real GDP	CPI	Real GDP
Indonesia	-4.0865*	-4.1736*	-5.7265*	-6.1162*
Malaysia	-6.6301*	-4.2810*	-7.4614*	-9.2783*
Philippines	-4.4877*	-3.4066**	-5.9164*	-5.2711*
Singapore	-4.3847*	-1.8480	-3.8313*	-4.5677*
Thailand	-4.7775*	-4.1486*	-6.8020*	-7.6160*

Where: * and ** = significant at the 1% and 5% level, respectively.
ADF= Augmented Dickey-Fuller
PP = Phillips-Peron

Table A-2: Unit Root Test Results for the first difference of the log of real GDP, CPI and REER time series. Data Range: 1962-2001

	ADF Test Statistic			PP Test Statistic		
Country	CPI	Real GDP	REER	CPI	Real GDP	REER
Indonesia	-4.0246*	-3.5754**	-2.8257***	-4.1390*	-5.3867*	-4.1924*
Malaysia	-3.7022*	-3.9476*	-2.5345	-3.8853*	-6.5040*	-6.7646*
Philippines	-4.4456*	-5.3760*	-2.5859	-6.9372*	-6.1911*	-3.2183**
Singapore	-4.0535*	-4.6850*	-2.6269	-7.4165*	-6.5141*	-4.2795*
Thailand	-5.4131*	-3.7102*	-3.3226**	-7.6884*	-6.0761*	-4.7370*

Where: *, ** and *** = significant at the 1%, 5% and 10% level, respectively.
ADF= Augmented Dickey-Fuller
PP = Phillips-Peron

<u>Figure A-1</u>: Impulse- Response Functions of ASEAN's BIG5: Demand and Supply Shocks

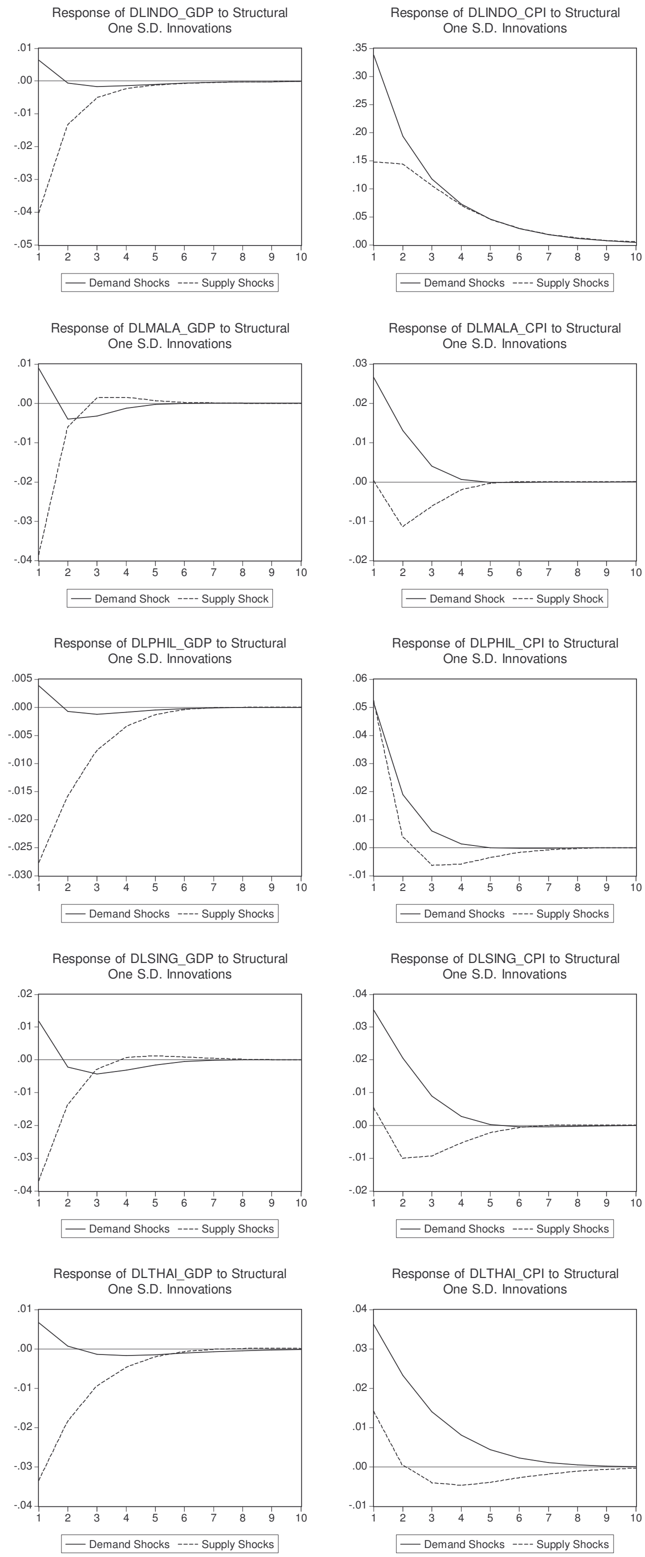

Figure A-2: Impulse- Response Functions of ASEAN's BIG5: Supply, Demand and Monetary Shocks

Normalized Left Axis (minimum = -0.05, maximum = +0.05)

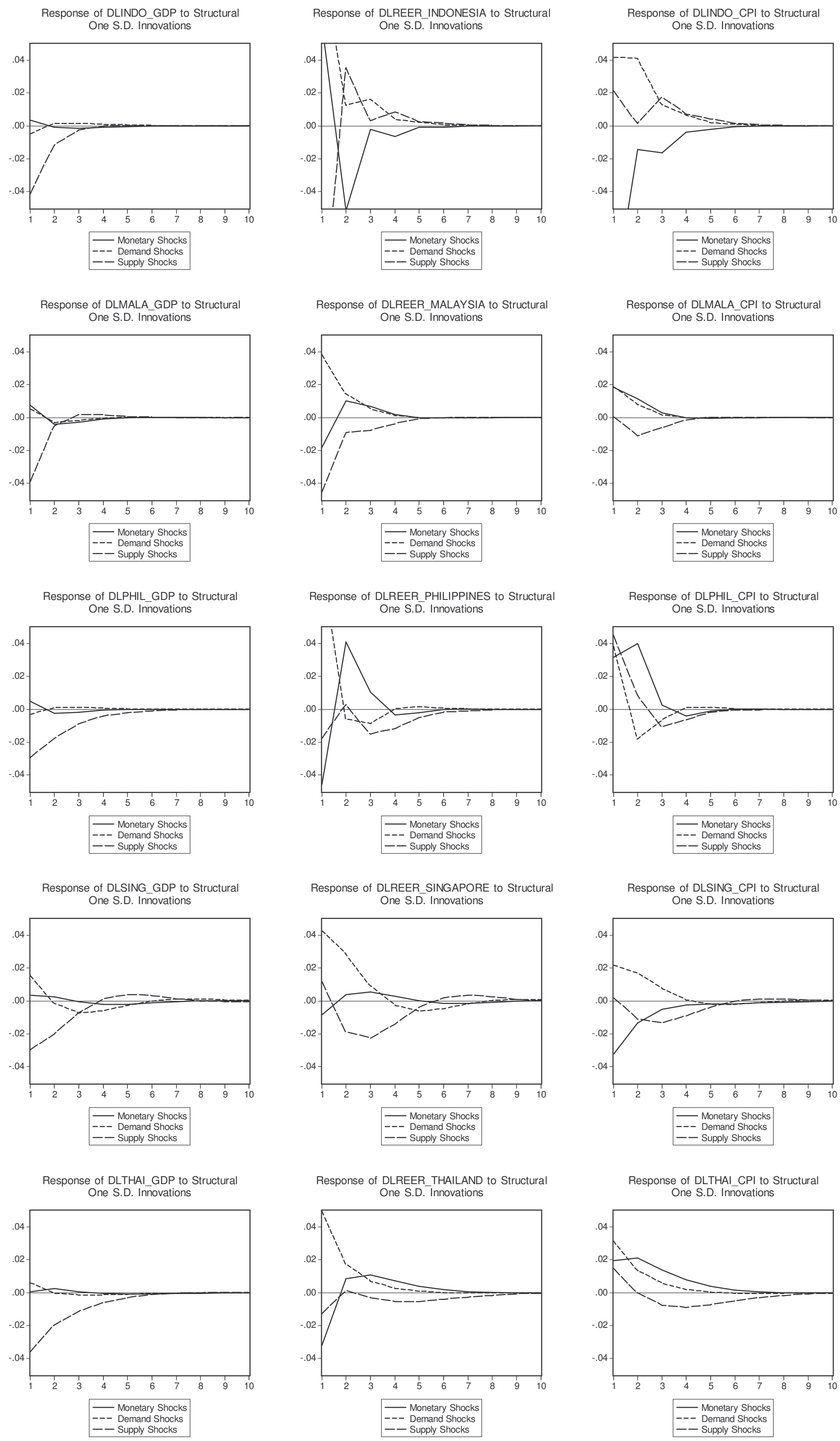

Table A-3: Variance Decomposition of Output Growth and Inflation (percent)

Variance Decomposition of:	Variance Period	Indonesia Demand Shock	Indonesia Supply Shock	Malaysia Demand Shock	Malaysia Supply Shock	Philippines Demand Shock	Philippines Supply Shock	Singapore Demand Shock	Singapore Supply Shock	Thailand Demand Shock	Thailand Supply Shock
Output Growth	1	2.48	97.52	0.37	99.63	1.85	98.15	9.20	90.80	3.82	96.18
	2	2.26	97.74	0.44	99.56	1.45	98.55	8.44	91.56	3.00	97.00
	5	2.51	97.49	0.48	99.52	1.59	98.41	10.03	89.97	3.20	96.80
	10	2.55	97.45	0.48	99.52	1.60	98.40	10.04	89.96	3.32	96.68
Inflation	1	84.08	15.92	97.95	2.05	49.04	50.96	97.67	2.33	86.77	13.23
	2	78.20	21.80	82.42	17.58	52.06	47.94	92.71	7.29	90.24	9.76
	5	74.16	25.84	78.77	21.23	51.56	48.44	87.32	12.68	89.27	10.73
	10	73.88	26.12	78.74	21.26	51.52	48.48	87.30	12.70	88.79	11.21

Table A-4: Variance Decomposition of Output Growth, Inflation and Real Effective Exchange Rate (REER) Movements (percent)

Variance Decomp. of:	Variance Period	Indonesia Monetary Shock	Indonesia Demand Shock	Indonesia Supply Shock	Malaysia Monetary Shock	Malaysia Demand Shock	Malaysia Supply Shock	Philippines Monetary Shock	Philippines Demand Shock	Philippines Supply Shock	Singapore Monetary Shock	Singapore Demand Shock	Singapore Supply Shock	Thailand Monetary Shock	Thailand Demand Shock	Thailand Supply Shock
Output Growth	1	0.71	1.33	97.96	0.15	0.25	99.60	2.69	1.05	96.26	1.16	20.77	78.07	0.03	2.43	97.54
	2	0.69	1.34	97.97	0.15	0.37	99.48	2.51	0.83	96.66	1.23	15.37	83.40	0.35	1.89	97.76
	5	0.82	1.52	97.66	0.19	0.39	98.42	2.55	0.92	96.53	1.61	19.65	78.74	0.38	2.00	97.62
	10	0.83	1.53	97.64	0.19	0.39	98.42	2.55	0.92	96.53	1.71	19.62	78.67	0.44	2.02	97.54
Reer	1	12.51	35.88	51.61	10.93	58.45	30.62	20.72	76.16	3.12	3.64	89.72	6.64	27.93	67.70	4.37
	2	18.70	32.13	49.17	11.48	56.94	31.58	31.96	65.32	2.72	2.74	82.01	15.25	27.14	68.85	4.01
	5	18.61	32.5	48.84	12.56	54.85	32.59	31.40	62.78	5.82	3.08	67.11	29.81	29.37	65.30	5.33
	10	18.61	32.5	48.84	12.56	54.85	32.59	31.39	62.76	5.85	3.16	66.91	29.93	29.23	64.81	5.96
Inflation	1	83.73	12.89	3.38	73.15	24.17	2.68	22.20	32.62	45.18	68.71	31.10	0.19	24.19	62.21	13.60
	2	74.78	22.24	2.98	62.88	15.99	21.13	40.05	27.59	32.36	58.38	35.76	5.86	37.48	52.76	9.76
	5	72.53	22.35	5.13	60.88	14.68	24.43	39.05	27.30	33.65	51.00	32.83	16.17	40.41	44.29	15.29
	10	72.51	22.35	5.14	60.88	14.68	24.43	39.04	27.30	33.66	50.92	32.90	16.18	39.84	43.59	16.57

APPENDIX B: Description of the Real Effective Exchange Rate Methodology

The real effective exchange rate (REER) time series were calculated for the five countries under analysis for the period 1968-2001. According to IMF's definition, the REER is computed as the weighted geometric average of the price of the domestic country relative to the prices of its trade partners. Following Zanello and Desruelle (1997), the Real Effective Exchange Rate (based on consumer price indices) can be expressed[25] as:

$$REER = \prod_{j \neq i} \left[\frac{P_i R_i}{P_j R_j} \right]^{Wij}$$

where *j* is an index that runs over country *i*'s partners, W_{ij} is the competitiveness weight put by country *i* on country *j*, P_i and P_j are consumer price indices in countries *i* and *j*, and R_i and R_j represent the nominal exchange rates of countries *i* and *j*'s currencies in US dollars. An increase in the index denotes an appreciation of country *i*'s currency.

In this computation, IMF weights were calculated by using trade flows from 1988-1990 and were based on (a weighted average of) trade in manufactures, primary commodities and tourism services. The CPI based REER index uses the IMF weights for 23 countries including Australia, Belgium, Brazil, Canada, China, Hong Kong, Germany, Indonesia, Italy, Japan, Korea, Malaysia, Netherlands, Philippines, Singapore, Spain, Sweden, Switzerland, Thailand, United Kingdom, United States and Taiwan.

Data for the competitiveness weights, W_{ij} was kindly provided by IMF's Dominique Desruelle. Both price index and nominal exchange rates source of data was mostly IMF's International Financial Statistics. Exceptions are the CPI data for China and Taiwan with the first taken from the World Bank's World Development Indicators while the later provided by the Directorate -General of Budget, Accounting and Statistics of the Republic of China.

The indices were calculated at yearly frequency and have 1995 as the base year.

[25] They also present a method of computation of REER based on unit labour costs. However, in this paper the CPI based REER was chosen since as a rule it should provide the same information and its data is more readily available.