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Iwan J Azis[1], Nattapong Putanapong[2]

(1. Johnson Graduate School of Management, Cornell University, NY 14853, USA;

2. Field of Regional Science, Cornell University, NY 14853, USA)

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Revisiting output-price relations in East Asia

Iwan J Azis[1], *Nattapong Putanapong*[2]

(1. Johnson Graduate School of Management, Cornell University, NY 14853, USA;

2. Field of Regional Science, Cornell University, NY 14853, USA)

Abstract: Why slower growth and high inflation can occur concurrently, while in other cases growth can be non-inflationary? Why did aggregate demand policy sometimes fail to work, given an orthogonal shock? This study ponders on these queries by estimating the aggregate supply and aggregate demand curves in four East Asian countries. Applying the Structural Vector Auto-Regression (SVAR) with the restrictions a-la Blanchard and Quah, it is revealed that while the AD and AS curves in most cases follow the textbook definitions, in some countries the AS curve is so flat that demand expansion would have been effective to stimulate growth, and supply-based policies would be more desirable to control prices. We also found that during the crisis the supply shock played a more significant role in the price fluctuations, suggesting that focusing on AD management alone was not the best approach to take.

Key words: decomposition; structural shock; SVAR; crisis; East Asia; aggregate demand management

1. Introduction

Two irregularities prompted our investigations on the slopes of aggregate supply (AS) and aggregate demand (AD) curves: First, a standard AD based policy was not always effective to counter a major shock like a financial crisis; second, AD management policy to control inflation can result in a combination of slow growth and high inflation.

The episode of the Asian Financial Crisis (AFC) in 1997/98 shows that the outcome of policy response has not been the same; it was less effective in some countries than in others: Korea and Malaysia have achieved a non-inflationary high growth pattern while Indonesia is still trapped in a slow-growth high-inflation mode. The current study attempts to explain the diverse results of policy response during the AFC by looking at the dynamics of AS and AD curves. By decomposing the AS and AD components, it is revealed that AS curves are flat in three countries, and AD curves are steep (very steep in one country), suggesting that demand policy is effective to stimulate growth, but not to control inflation. It is also revealed that the sharp increase of prices during the AFC was predominantly a supply shock. Thus, policy response focusing on AD management (contraction) during the time was misplaced.

Studies estimating the slopes of AS and AD that evolved since mid-1960 are largely applied to cases of industrial countries. To our knowledge, the current study is the first to apply the analysis in emerging market of Asia to evaluate the policy response to an orthogonal shock. The goal of the paper is to report the results of the

Iwan J Azis, professor and director of Graduate Study, Regional Science, associate professor of Johnson Graduate School of Management, Cornell University, president of Regional Science and Economic Research Network (RSERN); research fields: macro financial modeling, regional economics, decision making.

Nattapong Putanapong, Ph.D. of Field of Regional Science, Cornell University; research fields: financial economics, regional economics.

study.

2. Methodological approach

Central to the diverging outcomes of policy response are the characteristics of the output-price relations in four countries. Under normal circumstances, a line stretching from northwest (northeast) to southeast (southwest) quadrant is generated under AS (AD) shocks. Plotting the data of GDP growth and inflation will not allow us to conclude whether the locus shifts are due to AD or AS shocks. To the extent that both shocks jointly determine the changes in output and price, a decomposition procedure needs to be applied. One of such procedures is the univariate approach of ARIMA with the assumption that disturbances are orthogonal (Watson, 1986) or serially correlated (Beveridge and Nelson, 1981). In this study, however, we use the Structural Vector Auto-Regression (SVAR) a-la Blanchard & Quah (1989), hereafter B-Q, and a decomposition technique used in Gamber (2001).

Let Δy and π denote output growth and inflation rate, and $\varepsilon^{\Delta y}$ and $\varepsilon^{\Delta\pi}$ are the two innovations. Following B-Q decomposition technique, the moving average (MA) is obtained by inverting the unrestricted vector auto-regression representation:

$$\begin{bmatrix} \Delta y \\ \pi \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon^{\Delta y} \\ \varepsilon^{\pi} \end{bmatrix} \tag{1}$$

Where ε's are mean zero innovations with covariance matrix Ω. B-Q decomposition requires that the variable subject to decomposition, i.e. output growth rate, is I(1). The second (stationary) variable, which undergoes the same orthogonal shocks, is the inflation rate. Given a matrix of coefficients C(L) with lag operator $c_{ij}(L)$, the impulse response function of disturbances shows the effect of shocks (i.e., $\varepsilon^{\Delta y}$ and $\varepsilon^{\Delta\pi}$) in period t on Δy and π in period $t+j$ (j = 0,1,2,....). Note that C(0) is the identity matrix representing contemporaneous responses. It is known that the impulse responses generated by MA form in (1) do not exhibit the responses to the orthogonal innovations because the innovation ε's are generally correlated (Cooley and LeRoy, 1985). Thus, an alternative MA is:

$$\begin{bmatrix} \Delta y \\ \pi \end{bmatrix} = \begin{bmatrix} a_{11}(L) & a_{12}(L) \\ a_{21}(L) & a_{22}(L) \end{bmatrix} \begin{bmatrix} u^{\Delta y} \\ u^{\pi} \end{bmatrix} \tag{2}$$

Where u's are uncorrelated innovations with covariance matrix Σ (a diagonal matrix).

The MA representations in (1) and (2) are linked by:

$$A(j)=C(j)A(0),\ j = 0,1,2,\ldots \tag{3}$$

$$A(0)A(0)'\ \Sigma=\Omega \tag{4}$$

Hence, if one can identity each element of A(0), the MA form in (2) can be obtained. Let ω_{ij} and σ_{ij} denote elements in matrix Ω and Σ so that (4) is

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix} \begin{bmatrix} \sigma_{11} & 0 \\ 0 & \sigma_{22} \end{bmatrix} = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix} \tag{5}$$

From which three elements of A(0) are identified:

$$(a_{11}^2 + a_{12}^2)\sigma_{11} = \omega_{11} \tag{6}$$

$$(a_{21}^2 + a_{22}^2)\sigma_{22} = \omega_{22} \tag{7}$$

$$(a_{11}a_{21} + a_{12}a_{22})\sigma_{22} = \omega_{12} \tag{8}$$

Following B-Q, σ_{11} and σ_{22} are set to equal unity. That is, AS and AD shocks are normalized with standard deviation equals to 1. Considering the neutrality of long run effect of AD shock on output, the following applies:

$$\Sigma c_{11}(L)a_{11}(0)+\Sigma c_{12}(L)a_{12}(0)=0 \tag{9}$$

Solving (6) to (9) gives the four elements in A(0), based upon which the impulse responses of the orthogonal shocks can be generated by (3). Thus, the unrestricted VAR with n lags is:

$$\Delta^2 y = b_0 + \sum_{i=1}^{n} b_{1i}\Delta^2 y_{i-1} + \sum_{i=1}^{n} b_{2i}\Delta^2 p_{i-1} + \varepsilon_t^{\Delta y} \tag{10}$$

$$\Delta^2 p_t = d_0 + \sum_{i=1}^{n} d_{1i}\Delta^2 y_{i-1} + \sum_{i=1}^{n} d_{2i}\Delta^2 p_{i-1} + \varepsilon_t^{\Delta p} \tag{11}$$

Where $\Delta^2 y_t$ and $\Delta^2 p_t$ are the second-difference log of real output and CPI, respectively.

The Moving Average (MA) form shown in (1) is generated by inverting the above VAR representation. To insure that the residuals $\varepsilon_t^{\Delta y}$ and $\varepsilon_t^{\Delta p}$ in (1) are orthogonal, not correlated, we use (6)-(9) and multiply A(0) with C(j)–as shown in (3). This gives a new MA representation of (2), which has orthogonal residuals ($u_t^{\Delta y}$ and $u_t^{\Delta p}$):

$$\Delta^2 y_t = \sum_{s=0}^{j-1} a_{11}(s)u_{T+j-s}^{\Delta y} + \sum_{s=0}^{j-1} a_{12}(s)u_{T+j-s}^{\Delta p} \tag{12}$$

$$\Delta^2 p_t = \sum_{s=0}^{j-1} a_{21}(s)u_{T+j-s}^{\Delta y} + \sum_{s=0}^{j-1} a_{22}(s)u_{T+j-s}^{\Delta p} \tag{13}$$

Where $u_t^{\Delta y}$ and $u_t^{\Delta p}$ are the orthogonal residuals.

To generate the decomposed series of output growth as a result of AD shocks, we assign zero to $u_t^{\Delta p}$ in (12). This results in second-difference log of real GDP $\Delta^2 y_t^{AD}$ due to AD shocks. Similarly, to obtain second-difference log of CPI ($\Delta^2 p_t^{AD}$), the value of $u_t^{\Delta p}$ in (13) is set to zero. Converting the second-difference log data into the first second-difference is similar to integrating the second derivative to obtain the first derivative in continuous domain (obtained by cumulatively summing the values of second-difference log data):

$$\Delta y_t^{AD} = \sum_{i=0}^{t} \Delta^2 y_{t-i}^{AD} \tag{14}$$

$$\Delta p_t^{AD} = \sum_{i=0}^{t} \Delta^2 p_{t-i}^{AD} \tag{15}$$

Using the above procedure, we generate the scatter plot of Δy_t^{AD}, Δp_t^{AD}, and the corresponding slope of the linearized trend:

$$\Delta p_t^{AD} = g + h\,\Delta y_t^{AD} + v \tag{16}$$

Where *g*, *h* and *v* are the intercept, slope and residual, respectively. This captures the responses of real GDP growth and inflation to the AD shocks. Since theoretically the short-run response of $\Delta y_{t,}$ and Δp_t to the AD shock is in the same direction, the slope (*h*) of the AS curve should be positive.

A similar approach is applied to generate the decomposed series of output growth and inflation due to AS shocks, i.e., setting the value of $u_t^{\Delta y}$ in (12) and (13) to zero, and compute the series of $\Delta^2 y_t^{AS}$ and $\Delta^2 p_t^{AS}$.

3. Analysis

We use data of real GDP and CPI (2000 base year) of Thailand, Indonesia, Malaysia, and Korea for 1993: Q1 – 2007: Q2. Testing the unit root of the time series (using ADF) suggests that when the second-difference log is used the null hypothesis of unit-root is rejected at 1 percent level (see Appendix 1). Next is to determine the appropriate time lag. Following the selection process as in Gamber (2001), the Ljung-Box test shows that by using the lag length of 4, all residual series are no longer serially correlated (Appendix 2). Thus, we use the following unrestricted VAR:

$$\Delta^2 y = b_0 + \sum_{i=1}^{4} b_{1i} \Delta^2 y_{i-1} + \sum_{i=1}^{4} b_{2i} \Delta^2 p_{i-1} + \varepsilon_t^{\Delta y}$$

$$\Delta^2 p_t = d_0 + \sum_{i=1}^{4} d_{1i} \Delta^2 y_{i-1} + \sum_{i=1}^{4} d_{2i} \Delta^2 p_{i-1} + \varepsilon_t^{\Delta p}$$

The results, depicted in Fig. 1 to Fig. 4, show that in all countries the slopes of AS and AD are according to what the theory predicts, i.e., positive for AS and negative for AD. However, the slope size differs markedly; the AS curves in Thailand, Indonesia, and to some extent also Malaysia, are far flatter than In Korea, suggesting that in those three countries AD expansion would have been effective to stimulate the economic growth; it would generate greater increase of output than prices. With the known slopes, it can be deduced that along the AS curve a positive output growth innovation of 1 percent corresponds to a positive inflation innovation of 0.01, 0.02, 0.06 and 0.41 percent in Thailand, Indonesia, Malaysia, and Korea, respectively.[1]

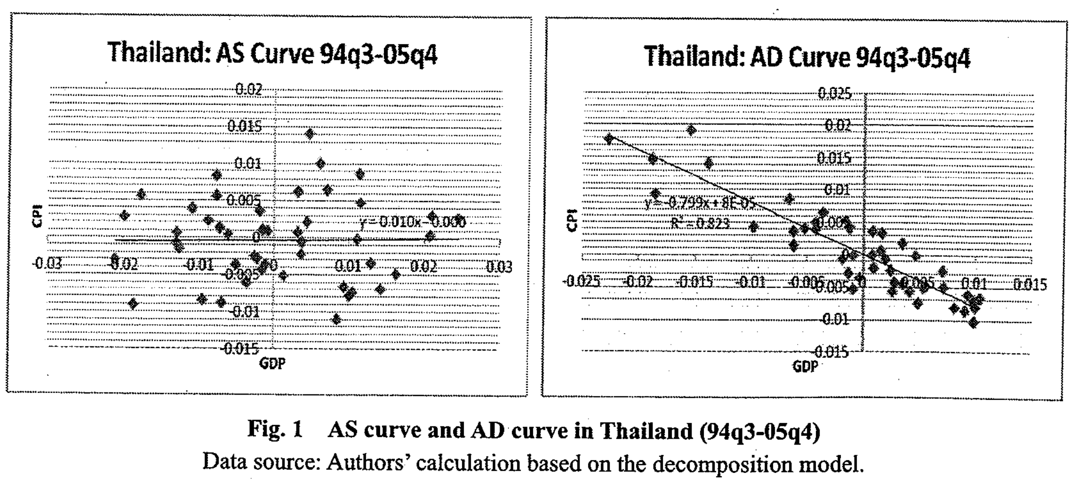

Fig. 1 AS curve and AD curve in Thailand (94q3-05q4)
Data source: Authors' calculation based on the decomposition model.

[1] Note that Fig. 1 to Fig. 4 shows the relationship between price and output generated by the decomposition technique elaborated in the preceding section. This approach is similar to the decomposition technique used in Fig. 6 and Fig. 7 of Gamber (1996).

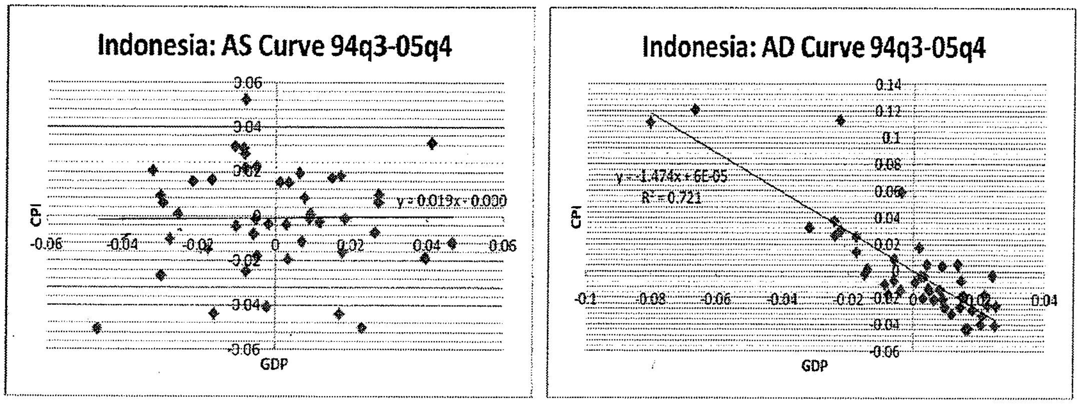

Fig. 2 AS curve and AD curve in Indonesia (94q3-05q4)

Data source: Authors' calculation based on the decomposition model.

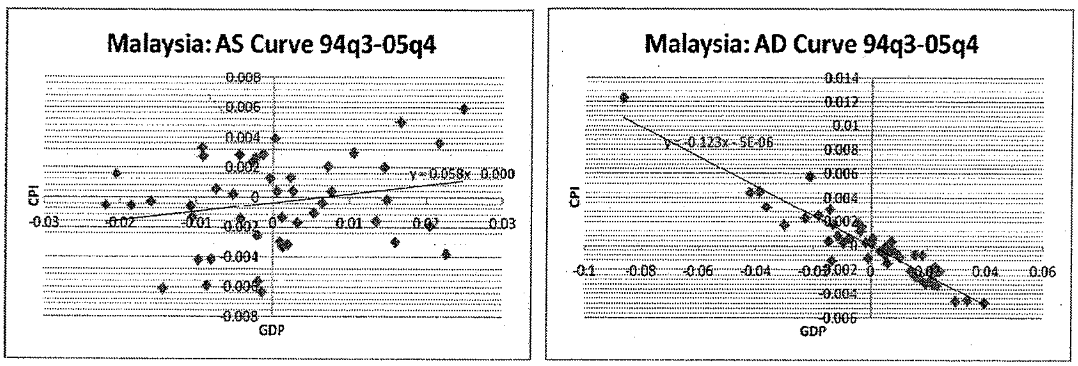

Fig. 3 AS curve and AD curve in Malaysia (94q3-05q4)

Data source: Authors' calculation based on the decomposition model.

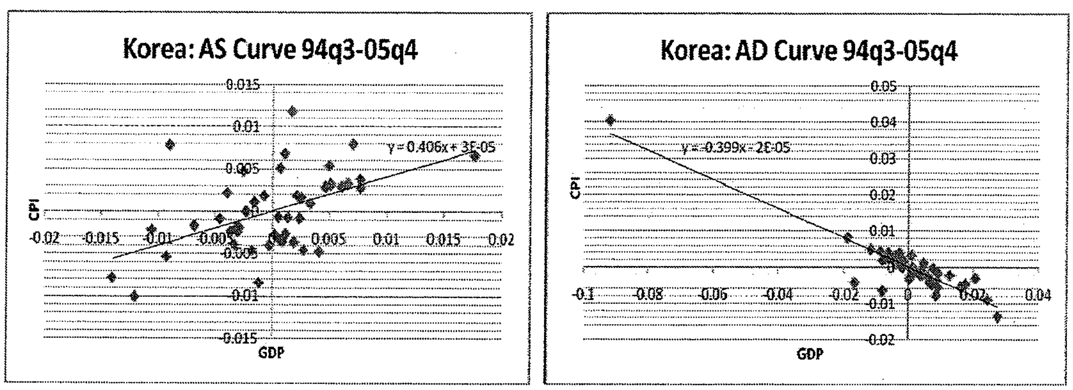

Fig. 4 AS curve and AD curve in Korea (94q3-05q4)

Data source: Authors' calculation based on the decomposition model.

The decomposition results also show that Indonesia has the steepest AD curve (with the slope of -1.474). That is, along the AD curve a positive inflation innovation of 1 percent corresponds to a negative output growth innovation of -0.68 percent. The corresponding Figs. for Thailand, Malaysia and Korea are -1.25, -8.13 and -2.51, respectively. To the extent that the monetary authority in most countries focuses its policy on inflation control, a steep AD curve suggests that using AS shock rather than AD policy to lower the price level would have been more effective.

Broken down the period into pre-crisis and post-crisis, Table 1 shows that in all countries the AS curve has become flatter after the crisis; the slope of the curve even reached small negative in Indonesia. While such a trend is generally expected, the variations between countries warrant explanations. In terms of AD curve, Indonesia is also unique as it is the only case where the AD curve became steeper after the crisis. Thus, while an AD expansion would have been more effective to stimulate growth for a more speedy recovery, efforts to control inflation should have focused more on the AS side. That is, the authority should not rely too heavily on monetary and fiscal contraction to control inflation. Supply-side policies that include infrastructure provision, labor market reform, and other structural reforms would have been more effective. The demand side should instead be expanded (lower interest rates, larger fiscal spending or lower taxes) to insure that the post-crisis growth recovery is faster and steadier.

Table 1 Slopes of AS and AD curves

	Thailand	Indonesia	Malaysia	Korea
AS curve slopes				
Pre-crisis	0.59	0.316	0.099	0.794
Post-crisis	0.008	-0.133	0.094	0.393
AD curve slopes				
Pre-crisis	-0.919	-0.819	-0.161	-0.545
Post-crisis	-0.686	-1.008	-0.105	-0.353

Data source: Calculated from the decomposition model.

Following the crisis, Thailand adopted fiscal deficits. The policy continued to support the country's recovery as shown by the growth path in Fig. 5. Even when the external assistance provided under the *Miyazawa Fund* and other sources ended in 2000, the Thai government continued to adopt fiscal deficit in 2001 and 2002, i.e., between 2 and 3 percent of GDP. As the economy recovered, fiscal surplus began in 2003. On the contrary, until few years after the crisis Indonesia's fiscal deficit has been the lowest among all countries. This is quite puzzling given the fact that the country has suffered the most from the shock, i.e., a sharpest fall in output.

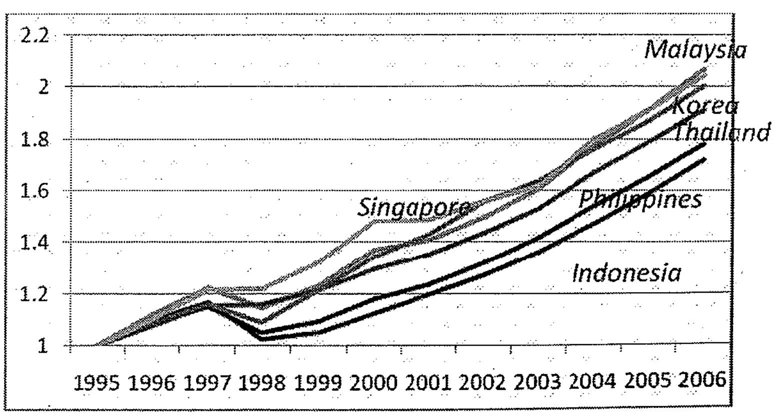

Fig. 5 PPP-based GDP index (1995=1)
Data source: Processed from IMF calculations of PPP-based GDP.

Not constrained by the IMF agreements, Malaysia's fiscal deficit was fairly large, reaching close to 6 percent of GDP during 2000-2003. The deficit remained larger than 2 percent in 2006, validating the country's stand in adopting the necessary counter-cyclical fiscal policy. Even Korea's fiscal deficit during and immediately after the crisis was larger than in Indonesia. However, the country's V-shape recovery had subsequently allowed the Korean government to reverse the trend by recording fiscal surplus in 2000-2002.

On the monetary front, Indonesia's position stands out as having the highest interest rate among all countries (Fig. 6). Yet, the country's inflation rate is also the highest (Fig. 7), implying that the AD contraction has not been effective. Indeed, while the decomposition analysis shows that the country's AS curve is flat and AD curve is very steep, every indication points to a strong tendency that the authority continues to use AD-based policy to curb inflation (e.g., cutting money supply, fiscal tightening).

Given the fact that Indonesia's fiscal deficit after the crisis has been lower than in other countries (lower than 2 percent of GDP since 2000), and interest rates higher (typically double-digit rates), it is not surprising that the country's GDP growth performance based on PPP has been most disappointing among all countries (Fig. 5).

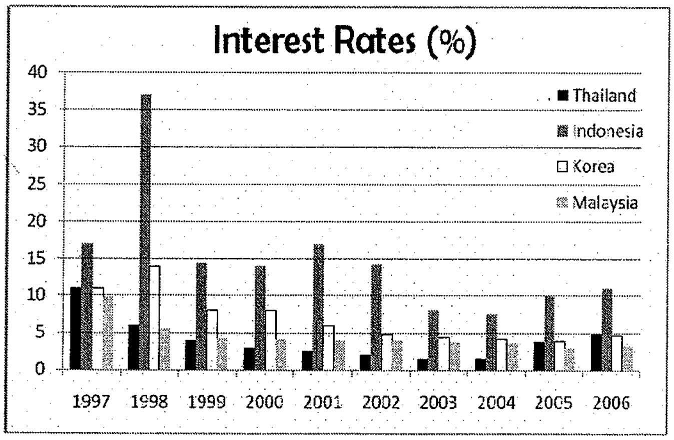

Fig. 6 Interest rates in four countries (1997-2006)
Data source: International financial statistics, and country's statistical office.

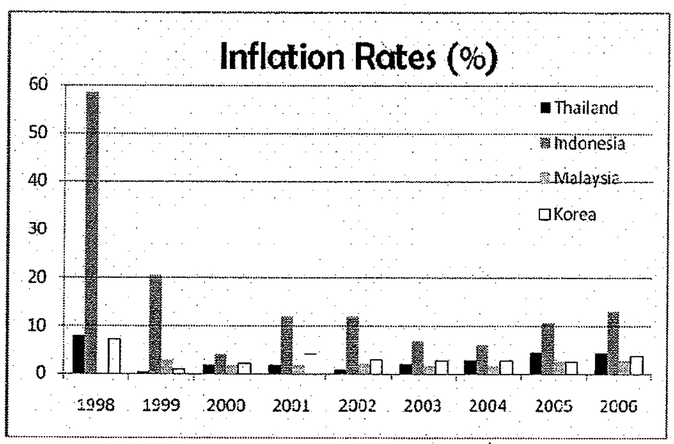

Fig. 7 Inflation rates in four countries (1998-2006)
Data source: International financial statistics, and country's statistical office.

The role of the supply and demand shocks as the source of the inflationary pressure during the crisis can be analyzed further by generating the time series of inflation due to each shock. The results that exclude the drift term or the persistent impacts of supply shocks are shown in Fig. 8 to Fig. 11 (the vertical lines indicate the beginning of AFC, i.e., second quarter of 1997 in Thailand, Indonesia, and Malaysia, and fourth quarter of 1997 in

Korea).

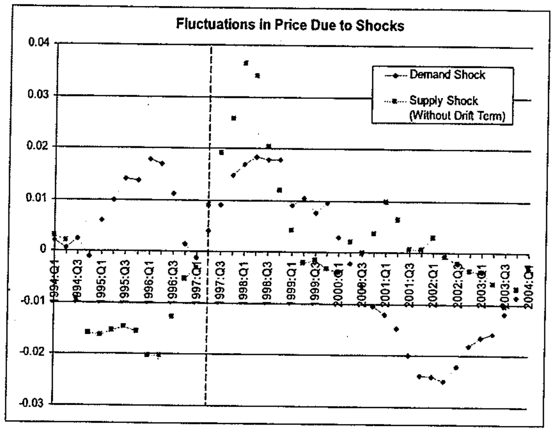

Fig. 8 Thailand: Inflation dynamics

Data source: Authors' calculation based on the decomposition model.

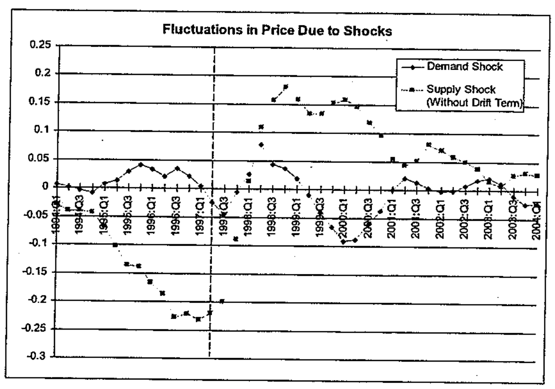

Fig. 9 Indonesia: Inflation dynamics

Data source: Authors' calculation based on the decomposition model.

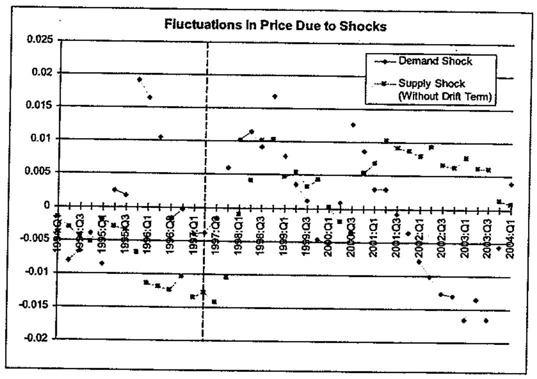

Fig. 10 Malaysia: Inflation dynamics

Data source: Authors' calculation based on the decomposition model.

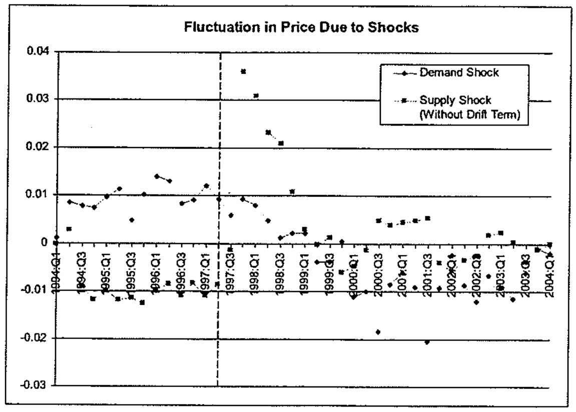

Fig. 11 South Korea: Inflation dynamics

Data source: Authors' calculation based on the decomposition model.

The reconstructed time series components clearly show that in virtually all economies the supply shock dominates the source of the sharp price fluctuation in 1997. The most dramatic price increase was in Indonesia. In Korea, the domination occurred immediately after December 1997, the starting date of the country's crisis, and it lasted until 1991:Q1. In Thailand it occurred from 1997:Q2 to 1998:Q3. The dominance of AS shock during the post-crisis inflation lasted longest in Indonesia, i.e., from 1998:Q2 to 2002:Q4. The country's socio-political crisis that led to political liberalization and significant institutional changes prompted a major cost-push pressure. The severe drought season related to the El-Nino exacerbated the inflationary pressure. At any rate, controlling AD to curb inflation in such circumstances is clearly not effective.

4. Conclusion

Revealing the shape of AS and AD curves in four East Asian countries allows us to evaluate the policy response during and after the crisis. Since AS and AD shocks jointly determine changes in the output and prices, a decomposition procedure is applied to separate the effects of the two shocks.

By using SVAR and a decomposition approach it is revealed that the AS curves in Thailand and Indonesia have been flat, slightly steeper in Malaysia, and steepest in Korea. In the case of AD curve, it is flattest in Korea, and steepest in Indonesia. While these results suggest that these countries should have used AD expansion to stimulate growth and AS-based policy to curb inflation, it appears only in Malaysia, Korea, and Thailand the actual policy at the time was in line with the conjecture. The policy in Indonesia contradicted with the proposition. While fiscal deficits in Thailand, Malaysia and to some extent Korea are larger than in Indonesia, their interest rates are lower, such that the growth and the inflation performance in the three countries has been more favorable than in Indonesia.

The analysis of the price dynamics also reveals that during the crisis the source of the inflationary pressure originates mostly in the supply-side, implying that the policy response that focuses on the aggregate demand management is misplaced.

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(Edited by Emily)

Appendix 1

Results of Augmented Dickey-Fuller (ADF) test

Null hypothesis: Δ^2ln (RGDP) has a unit root

Country	Lag (Selected by SIC)	T-statistic	P-value
Thailand	3	-5.1517	0.0001
Indonesia	2	-11.5323	0.0000
Malaysia	3	-4.4044	0.0009
Korea	0	-11.0988	0.0000

Null hypothesis: Δ^2ln (CPI) has a unit root

Country	Lag (Selected by SIC)	T-statistic	P-value
Thailand	1	-7.5725	0.0000
Indonesia	0	-8.3888	0.0000
Malaysia	2	-9.3804	0.0000
Korea	2	-8.5245	0.0000

Appendix 2

Results of Ljung-Box test

The Q-statistic at lag *k* is a statistical test for the null hypothesis that there is no autocorrelation up to lag *k*.

Thailand

Lag	$\varepsilon_t^{\Delta y}$		$\varepsilon_t^{\Delta p}$	
	Q-statistic	P-value	Q-statistic	P-value
1	0.033	0.856	0.000	0.998
2	0.226	0.893	0.056	0.972
3	2.512	0.473	0.433	0.933
4	2.561	0.634	1.139	0.888
5	3.127	0.680	4.079	0.538
6	3.596	0.731	4.943	0.551
7	7.643	0.365	5.747	0.570
8	13.268	0.103	5.749	0.675
9	13.735	0.132	9.518	0.391
10	13.879	0.179	9.681	0.469

Indonesia

Lag	$\varepsilon_t^{\Delta y}$		$\varepsilon_t^{\Delta p}$	
	Q-statistic	P-value	Q-statistic	P-value
1	0.123	0.725	0.251	0.616
2	0.278	0.870	0.256	0.880
3	1.091	0.779	0.262	0.967
4	1.191	0.880	1.645	0.801
5	1.258	0.939	4.994	0.417
6	1.284	0.973	5.464	0.486
7	1.341	0.987	9.567	0.214
8	1.493	0.993	9.567	0.297
9	2.987	0.965	9.568	0.387
10	3.959	0.949	9.585	0.478

Malaysia

Lag	$\varepsilon_t^{\Delta y}$		$\varepsilon_t^{\Delta p}$	
	Q-statistic	P-value	Q-statistic	P-value
1	0.198	0.656	0.359	0.549
2	0.366	0.833	1.669	0.434
3	0.654	0.884	1.693	0.638
4	7.298	0.121	2.033	0.730
5	10.402	0.065	4.019	0.547
6	11.372	0.078	5.309	0.505
7	11.662	0.112	5.577	0.590
8	14.346	0.073	5.586	0.693
9	14.434	0.108	6.045	0.735
10	15.169	0.126	6.064	0.810

Korea

Lag	$\varepsilon_t^{\Delta y}$		$\varepsilon_t^{\Delta p}$	
	Q-statistic	P-value	Q-statistic	P-value
1	0.0937	0.760	0.031	0.861
2	0.1195	0.942	0.739	0.691
3	0.1695	0.982	1.180	0.758
4	1.1588	0.885	2.779	0.595
5	3.5112	0.622	3.919	0.561
6	4.0071	0.676	3.973	0.680
7	4.1567	0.762	4.598	0.709
8	5.2482	0.731	4.699	0.789
9	7.1872	0.618	7.229	0.613
10	7.2527	0.701	7.236	0.703