Monetary policy and macroeconomic shocks in Malaysia: Evidence from aggregate demand-aggregate supply model

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ABSTRACT Using the Blanchard-Quah (1989) aggregate demand/aggregate supply model, the study examines the effects of macroeconomic shocks on monetary policy decisions for the Malaysian economy. The long-run neutrality is imposed so that temporary (aggregate demand) shocks have no effect on output growth. But permanent (aggregate supply) shocks would affect output growth. Empirically, the economy does subscribe to the textbook aggregate demand/aggregate supply model. Using a reaction function, it finds that monetary policy tends to respond more vigorously to aggregate demand shocks than to aggregate supply shocks. Monetary policy responds positively to aggregate demand shocks; while negatively to aggregate supply shocks.

THE SOURCES OF business cyclical fluctuations have been a major macroeconomic concern for developing economies including Malaysia. The effects of permanent and temporary shocks on output growth and price level have been the subject of much discussion since the Asian financial crisis in 1997/98. Malaysia with its small-sized economy was not spared during the financial crisis period as real output fell.

The purpose of this study is to examine the interaction between macroeconomic shocks to aggregate output growth and price level from an empirical perspective. In this sense, it investigates whether the neoclassical view that transitory (aggregate demand) shocks have no effect on the aggregate output growth in the long-run period does hold empirically for the Malaysian economy. In short, the study determines whether the textbook AD/AS framework applies to the Malaysian economy from the historical perspective. Secondly, the study aims to employ a monetary reaction function so as to provide information on the Bank Negara Malaysia (BNM) monetary policies and priorities on these structural shocks. Suppose that there is a decline in the output level due to a negative demand shock, it follows that the decline in the price level would easily allow BNM to initiate expansionary monetary policy tools to boost output growth. On this premise, the outcome on the monetary policy is clearly predictable. However, if the decline in output is due to a negative supply shock (for example, an oil price shock), then the immediate economic consequence would be an increase in inflation. BNM would face a dilemma in the this case, namely (a) to ease its monetary policy with a further pressure on the price level or (b) to contract money supply so as to subdue inflation but with a further adverse effect on output growth. In the latter scenario, monetary policy would be ambiguous.

Following Blanchard-Quah (1989), the paper uses the multivariate approach to decompose the transitory (aggregate demand) and permanent (aggregate supply) shocks from the economic time series. Many studies have used the Blanchard-Quah VAR-based decomposition methodology to identify the permanent and temporary effects. These studies include Hoffmaister and Roldos (2001) on the sources of macroeconomic fluctuations in Brazil and Korea; Gavosto and Pellegrini (1999) on demand and supply shocks in Italy using industrial output; Roberts (1993) on the sources of business cycles from a monetarist interpretation; as well as Christou, et al (1993) on optimal monetary policy. Similarly, Gamber and Hakes (1997) employ the Blanchard-Quah decomposition to study the Fed's monetary responses to aggregate demand and aggregate supply shocks within a partisan political cycle.

The paper is structured hereafter as follows: Section 2 describes the VAR decomposition by using the Blanchard-Quah decomposition technique, while Section 3 describes data sources and variable definition. Empirical methodology is discussed in Section 4, while Section 5 provides the estimation results. Section 6 contains the summary and conclusion.

VAR DECOMPOSITION

The multivariate model developed by Blanchard-Quah (1989) consists of output growth and unemployment rate. The Blanchard-Quah (B-Q) decomposition subscribes to the conventional AD/AS framework with a long-run restriction on the VAR approach. The structural restriction as imposed is that the economy has a long-run vertical supply curve. Hence, aggregate demand (transitory) shocks do not affect real output level. Only permanent disturbances (aggregate supply shocks) would result in permanent movements of real output.

Other variables have been used in place of the unemployment rate. For instance, the use of price level or inflation that has been deemed to be more appropriate (Keating and Nye, 1998) as aggregate demand-aggregate supply deals with the relationship of output and price. As in price theory, an aggregate demand shock would affect real output and price in the same direction. An aggregate supply shock would cause real output to rise and price to fall as in the opposite direction.

The plausibility of B-Q decomposition holds that, if the aggregate supply curve is vertical in the long-run, aggregate demand shocks do not affect real output and shocks to aggregate demand and aggregate supply are uncorrelated. Henceforth, the long-run restrictions are the premise of B-Q methodology.

Following the B-Q decomposition, this study uses output growth and prices to estimate the aggregate demand and aggregate supply innovations. Similarly, I assume that aggregate demand shocks have no long run impact on output growth as postulated by the neoclassical AD/AS theory.

DATA SOURCES AND VARIABLES

The study uses monthly data covering the period from 1990: January till 2005: December, with a total of 192 observations. The seasonally adjusted consumer price index (CPI) is used as a measure for the inflation rate (denoted by p_t). Since monthly data on the Gross Domestic Product (GDP) is not easily available, the industrial index (IPI) is used as a proxy for measuring output/growth rate. The IPI (seasonally adjusted) is used as the measure for output growth (denoted by y_t). Since these time series data (p_t and y_t) are seasonally adjusted, there is no statistical concern for seasonality effect in this study. These time series data are obtained from the Asian Development Center, the Asian Development Bank's website. For the purpose of the study, all these variables of interest (as expressed by the lowercase letters) are transformed into natural logarithms. For the reaction function, the monthly 3-month discount rate for Treasury Bills (denoted by $r3_t$) covering the same duration of the study is compiled from the various issues of the Monthly Statistical Bulletin, Bank Negara Malaysia (BNM). The changes in the 3-month discount rate serve as a measure of BNM's monetary policy instruments.

Empirical Methodology

Using the B-Q decomposition, the economic structure can be expressed in a compact notation of vector X_t as follows:

$$X_t = \begin{bmatrix} \Delta y_t \\ p_t \end{bmatrix} \qquad (1)$$

where output growth is denoted by Δy_t and the second variable, price level, is denoted by p_t.

The vector of zero mean and orthogonal innovations (ε_t) with its diagonal covariance matrix Σ (denoted by their σ^2's) and given as:

$$\varepsilon_t = \begin{bmatrix} \varepsilon_{s,t} \\ \varepsilon_{d,t} \end{bmatrix} \qquad (2)$$

Equation (2) contains the two structural shocks, where $\varepsilon_{s,t}$ denotes the aggregate supply (permanent) shocks and $\varepsilon_{d,t}$ denotes the aggregate demand (transitory) shocks.

The empirical model can be expressed in a vector moving average representation given as follows:

$$\begin{bmatrix} \Delta y_t \\ p_t \end{bmatrix} = \begin{bmatrix} a_{11}(L) & a_{12}(L) \\ a_{21}(L) & a_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{s,t} \\ \varepsilon_{d,t} \end{bmatrix} \qquad (3)$$

where $\varepsilon_{s,t}$ are permanent shocks to output, $\varepsilon_{d,t}$ are transitory shocks to output and L is the lag operator, given that a_{ij}, i and j = 1, 2 are coefficients to be estimated. Given that aggregate demand shocks have no long run effect on real output, the coefficients, then are:

$$a_{12}(L) = 0 \qquad (4)$$

The structural equation (3) can be re-written in a compact form as:

$$X_t = A(L)\varepsilon_t \quad (5)$$

$$X_t = A(0)\varepsilon_t + A(1)\varepsilon_{t-1} + A(2)\varepsilon_{t-2} + ... \quad (6)$$

The impulse responses can then be estimated from equation (6). However, estimating equation (5) or equation (6) would require another VAR representation.

Firstly, I use a bivariate unconstrained VAR. Then, by inverting the representation and comparing the effects of a one-unit shock from both equations, their impulses can easily be traced.

This alternative unconstrained VAR representation where *B(L)* are the coefficients in VAR and their respective innovations, given as $\mu_t (= \mu_{s,t}\, \mu_{d,t})'$ with diagonal covariance Ω can be written as:

$$\begin{aligned} X_t &= B(L)X_{t-1} + \mu_t \\ X_t &= (1 - B(L))^{-1}\mu_t \\ &= (1 + B(L) + B(L)^2 + ...)\mu_t \\ &= B(0)\mu_t + B(1)\mu_{t-1} + B(2)\mu_{t-2} + ... \quad (7) \end{aligned}$$

The identification of the structural equations from equation (3) requires these restrictions: The assumptions that: (i) the normalisation of the variance of structural supply shocks, $\sigma^2_{s,t} = 1$, (ii) the normalisation of the variance of structural demand shocks, $\sigma^2_{d,t} = 1$, (iii) the permanent shocks and transitory shocks are orthogonal, that is $E\sigma_{s,t}\sigma_{d,t} = 0$, and (iv) the transitory shocks $(\varepsilon_{d,t})$ have no long-run effect on output growth, that is: $a_{12}(L) = 0$.

Comparing equations (6) and (7), the structural shocks are related as follows:

$$A(0)\varepsilon_t = \mu_t \quad (8)$$

where *A(0)* is the 2 x 2 matrix of contemporaneous responses.

This also implies that:

$$A(j) = B(j)A(0) \text{ for all } j = 1, 2, ... \quad (9)$$

and that: $$A(0)A(0)'\sum = \Omega \quad (10)$$

Thus, the structural shocks (ε_t) can be estimated from the reduced form disturbances (μ_t) as in equation (8); while the impulse responses (A_j) can be estimated from the reduced form VMA coefficients (B_j) as in equation (9). By definition, *B(0)* is an identity matrix. The 4 elements of the *A(0)* matrix can be estimated from equation (10).

ESTIMATION RESULTS

(a) Descriptive Statistics

Descriptive statistics of the data series at the level and first difference are summarised in Table 1. The simple means of price level, output growth and discount rate at the level series range 4.660, 4.958 and 4.749, respectively. Comparing price level and output growth, the standard deviation indicates a greater variance for the latter series, while a much higher variation comes from the 3-month discount rate. The level series for price level and output growth are negatively skewed, but with relatively low kurtosis. The level series for the 3-month discount rate has a positively skewed characteristic, with relatively low kurtosis. The first difference series for output growth is positively skewed, with excess kurtosis. The first difference for

Table 1: Summary of Descriptive Statistics

Variables	p_t	y_t	$r3_t$	$d(y_t)$	$d(r3_t)$
Mean	4.660	4.958	4.749	0.0058	-0.0098
Median	4.684	4.999	4.965	0.0056	-0.0040
Max.	4.865	5.527	9.982	0.1157	1.6270
Min.	4.378	4.364	1.837	-0.0985	-1.9260
Std. Dev.	0.114	0.352	2.009	0.0296	0.3895
Skewness	-0.472	-0.251	0.218	0.0993	-1.1980
Kurtosis	1.927	1.798	1.590	3.9293	11.6124
Jarque-Bera	16.328***	13.586***	17.421***	7.187**	635.9784***
Observations	192	192	192	191	191

*** denotes rejection of null hypothesis of normality at the 1% level
d(.) denotes first difference time series data

the 3-month discount rate series shows a negatively skewed distribution, with excess kurtosis. The Jarque-Bera statistics reject the null hypothesis of normality for all series.

(b) Unit Root and Stationarity Tests

Table 2 shows the summary of unit root and stationarity tests from the Augmented Dickey-Fuller (ADF) and Phillip-Peron (PP) statistics. Notably the level series for output growth (y_t) and 3-month discount rate ($r3_t$) exhibit the characteristic of nonstationarity with unit root. For the first difference series of these 2 variables, both the ADF and PP statistics reject the null hypothesis of unit root, thus ensuring stationarity. This implies that both the series in question are integrated of order 1, namely *I(1)*. For price level, the ADF and PP statistics (with a constant) fail to reject the null hypothesis of unit root.

Since the output growth series (y_t) is non-stationary in its level but stationary in its first difference, the study uses the first-difference time series (y_t) in the analysis. On the other hand, the level series for the price level variable (p_t) is stationary. Henceforth, for the purpose of AD/AS decomposition, the first difference output growth (y_t) and the level price series (p_t) will be used in the analysis. For the reaction function, the first difference 3-month discount rate ($r3_t$) will be used in the regression.

(c) Permanent-Transitory Decomposition

The estimated VAR results using 5 lags (with a constant) are not tabulated here because the main concern of this study is the permanent-transitory decomposition of the time series. The optimal lag is determined by minimising the Akaike final prediction error. The residuals from the VAR estimation are tested for 'whiteness" and corrected for serial correlation. Figure 1 plots the impulse responses for output growth and price level to structural aggregate supply (permanent) and aggregate demand (transitory) shocks.

From Figure 1(a), a permanent (aggregate supply) shock causes output level to increase rapidly and positively. The effect of the permanent shock on output growth becomes negative in the second month, representing an undershooting, then declines rapidly

Table 2: Summary of Unit Root and Stationarity Tests

Restriction	ADF Statistic [1/] p_t	y_t	$r3_t$
Level			
With intercept	-3.577***(0)	-0.613 (14)	-2.171 (9)
With intercept and trend	-1.114 (0)	-2.897 (12)	-3.363 (9)
First Difference			
With intercept	-11.940***(0)	-4.093***(14)	-3.895***(10)
With intercept and trend	-12.544***(0)	-4.092***(14)	-3.851**(10)

Restriction	PP Statistic [2/] p_t	y_t	$r3_t$
Level			
With intercept	-3.291**(5)	-0.510 (5)	-1.457 (9)
With intercept and trend	-1.146 (5)	-2.513 (4)	-2.923 (7)
First Difference			
With intercept	-12.158***(6)	-19.824***(5)	-9.484***(24)
With intercept and trend	-12.558***(4)	-19.772***(5)	-9.459***(24)

[1/] Optimal lag is based on the Akaike Information Criterion (AIC)
[2/] Optimal lag is based on the Newey-West truncation approach
*** denotes rejection of null hypothesis of unit root at the 1% significance level
** denotes rejection of null hypothesis of unit root at the 5% significance level
Figures in parentheses denote lags

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after the third month and subsequently falls rapidly to zero. In this sense, a permanent shock does affect output growth on a short-term basis. It does not exert a permanent effect in the longer term as shocks fizzle out to zero. On the other hand (as shown in Figure 1(c), a permanent (aggregate supply) shock causes the price level to fall (negatively), and thereafter remains relatively stable with a negative trend. Note that permanent shocks (aggregate supply) have a positive impact on output growth and a negative impact on price level.

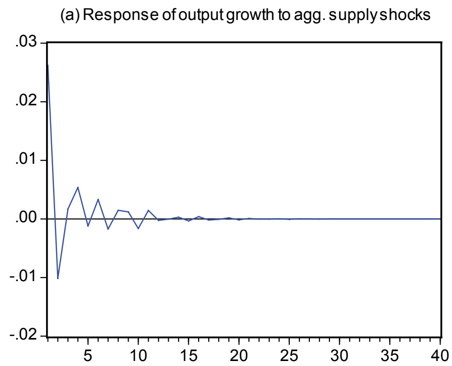
From Figure 1(b), a transitory (aggregate demand) shock causes output growth to respond positively and negatively in an oscillatory manner in the short-run period and then to decline rapidly after the sixth month as it moves to the long-run period. Negative spikes are found in the second and fifth months, but with negligible effects. In Figure 1(d), a transitory (aggregate demand) shock causes price level to first increase and then fall gradually after the second month, yet with a positive impact throughout the duration. For the longer horizon, the impulse responses show that permanent and transitory shocks have negligible effects on output growth and price level.

Henceforth, the empirical evidence of the impulse responses of these variables to permanent-transitory shocks underscore the argument that output growth and price level do not follow and conform to standard textbook behaviour in explaining business cycle fluctuations for the Malaysian economy.

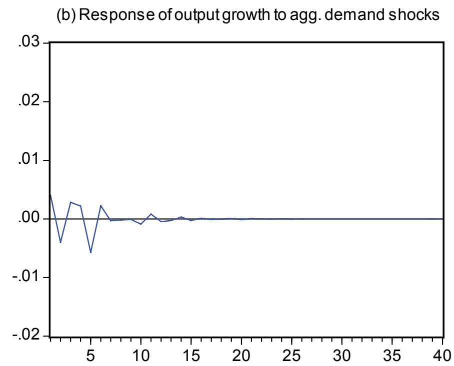
Table 3 shows the variance decompositions from the permanent and transitory shocks on output growth and price level.

Figure1: Response to Structural One S.D. Innovations

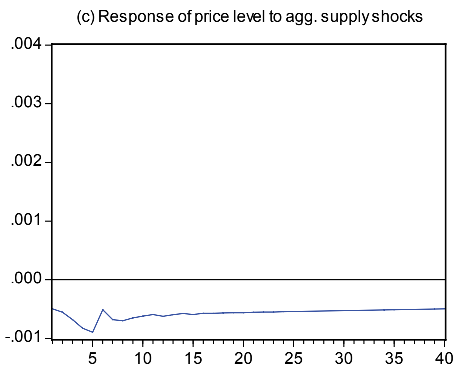
(a) Response of output growth to agg. supply shocks



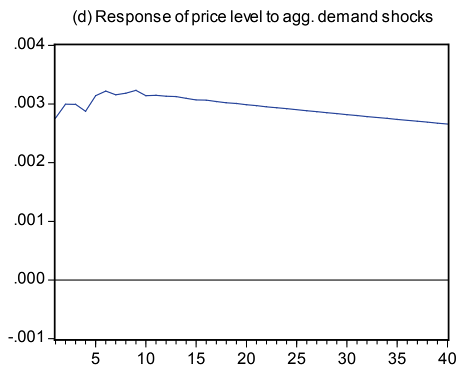
(a) Response of output growth to agg. demand shocks



(a) Response of price level to agg. supply shocks



(a) Response of price level to agg. demand shocks



Y-axis = Percent deviation
X-axis = Time duration (months)

Table 3: Variance Decomposition of AD/AS Model

Period (Monthly)	Variation in output growth		Variation of price level	
	Supply shock	Demand shock	Supply shock	Demand shock
1	97.713	2.287	3.105	96.895
2	96.126	3.873	3.198	96.802
3	95.204	4.796	3.799	96.201
4	94.829	5.171	4.750	95.250
5	91.405	8.595	5.377	94.623
6	91.006	8.994	4.830	95.170
7	91.026	8.974	4.763	95.237
8	91.045	8.955	4.737	95.263
9	91.058	8.942	4.632	95.368
10	91.011	8.989	4.538	96.462
20	90.922	9.078	3.991	96.009
30	90.921	9.079	3.793	96.207
40	90.921	9.079	3.696	96.304

As shown in Table 3, structural aggregate supply shocks (permanent) account for 90% - 98% of output growth variation; while structural aggregate demand shocks (transitory) contribute to 3% - 9% of output growth variation. For price level, structural aggregate supply shocks (permanent) account for about 3% - 5% of price level variation while structural aggregate demand shocks (transitory) contribute to about 95% - 97% of the variation. The results imply that these variations tend to be persistent. Based on the assumption of the B-Q decomposition approach, as expected, an aggregate demand shock will have a lesser impact on output growth and a greater impact on price level. Alternatively, an aggregate supply shock will have a lesser impact on price level and a greater impact on output growth

(d) Reaction Function

The next task is to generate the reaction function of monetary policy ($\Delta r3_t$) by regressing the permanent ($\mu_{s,t}$) and transitory ($\mu_{d,t}$) shocks given as follows:

$$\Delta r3_t = \alpha_0 + \sum_{j=1}^{m} \beta_j^d \mu_{d,t-j} + \sum_{j=1}^{m} \beta_j^s \mu_{s,t-j} + \eta_t \qquad (11)$$

where α_0, β_j^d, and β_j^s are the coefficients to be estimated, Δ is the first difference, m is the lag operator and η_t is the error term.

The series of aggregate demand shocks ($\mu_{d,t}$) and aggregate supply shocks ($\mu_{s,t}$) are obtained from equation (8). That is, the resulting series are obtained by multiplying the residuals from the unconstrained VAR ($\square_t$) and multiplied by the inverse of $A(0)$ matrix: namely, $\mu_{st} = A(0)^{-1}.\square_t$.

From the reaction function (11), the sum of the estimated coefficients from the aggregate demand shocks $(\sum_{j=1}^{m} \beta_j^d)$ and aggregate supply shocks $(\sum_{j=1}^{m} \beta_j^s)$ will measure the response of BNM's monetary policy to these innovations. The lag length of m in the regression equation (11) would be determined by the Akaike information criterion and the highest significant lagged innovations.

Meanwhile, the aggregate supply (permanent) and aggregate demand (transitory) shocks as generated from equation (8) are shown in Figure 2 and Figure 3, respectively. The vertical y-axis represents percent deviation; while the horizontal x-axis represents time duration (months).

Figure 2: Aggrgate Supply Shocks (1990:01 - 2005:12)

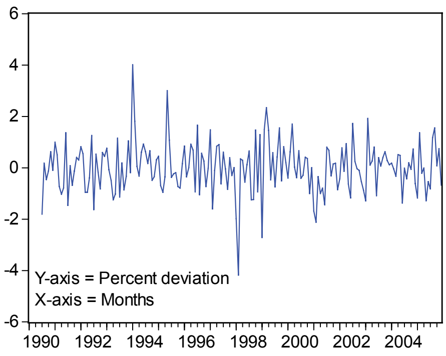
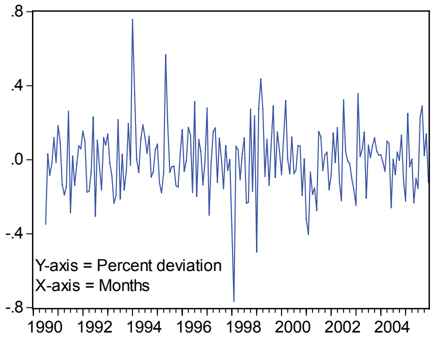


Figure 3: Aggrgate Demand Shocks (1990:01 - 2005:12)



The estimated statistical results for the reaction function are displayed in Table 4.

As in Table 4, the statistical results show that both the estimated coefficients for aggregate demand and aggregate supply shocks are statistically significant at the 5% level.

As postulated in economic theory, aggregate demand shocks will have a positive effect on the 3-month discount rate. This implies that the central bank's monetary policy tends to be countercyclical. An increase in inflation, due to an increase in aggregate demand, causes a response of a raised interest rate. The coefficient as estimated is 0.27; cautiously implying that a 1 unit (standard deviation) in aggregate demand shock would allow the central bank to raise the interest rate by an average of 27 basis points over a 3-month period.

On the other hand, how does the central bank respond to an aggregate supply shock? This has been an ambiguous question in the earlier discussion. From the statistical results in Table 4, the sum-coefficient for the aggregate supply shocks variable shows an estimated negative value of -0.05. This implies that aggregate supply shocks exert a negative impact on monetary policy. Hence, monetary policy tends to be accommodative to aggregate supply shocks. For a 1 unit (standard deviation) increase in aggregate supply shocks, the central bank would tend to lower the interest rate by an average of 5 basis points.

Comparing aggregate demand and aggregate supply shocks, the central bank tends to respond more vigorously to an aggregate demand shock than to an aggregate supply shock, with a vast difference averaging 22 basis points.

In short, the empirical results underscore the conclusion that the central bank responds more readily and vigorously to an aggregate demand than an aggregate supply shock. Monetary policy tends to be counter cyclical to an aggregate demand shock, while being accommodative of an aggregate supply shock.

SUMMARY AND CONCLUSIONS

The paper addresses the important question of whether the Malaysian economy does abide by the conventional textbook AD/AS model. In the AD/AS model, aggregate demand will be neutral in the long-run period. This implies that a transitory (aggregate demand) shock will have no impact on output growth; while a permanent (aggregate supply) shock will affect both output growth and price level. Empirically, the results show that aggregate supply shocks have a positive effect (with undershooting) on output growth and a negative effect on price level. Thereafter, the response of the output growth converges to the long-run mean level; while the response of price level to aggregate supply innovations remain negative as it moves to the longer horizon.

On the other hand, aggregate demand shocks have an oscillating effect on output growth in the shorter-run period which converge to

Table 4: Coefficient Estimates of the Reaction Function (1990:01 – 2005:12)

Model estimated	Aggregate demand shocks	Aggregate supply shocks
Equation (11)	. $(\sum_{j=1}^{m} \beta_{yj}^{d}) = 0\ 2746^{**}$	. $(\sum_{j=1}^{m} \beta_{yj}^{s}) = -0\ 0527^{**}$
Wald coefficient test	F = 5.1502 (p = 0.0245)	F = 5.0908 (p = 0.0253)
m = 3 lags (based on AIC) R^2 = 0.0912 *F-statistic* = 2.9450 (p = 0.0092)		

** denotes significance at the 5% level

the mean in the longer horizon, while price level responds positively to aggregate demand innovations. These investigations show that, in the Malaysian case, the responses of output growth and price level to aggregate demand and aggregate supply shocks are inconsistent with the economic theory of the AD/AS model.

Finally, the reaction function is used to estimate the response of monetary policy to the structural decomposed aggregate demand and aggregate supply shocks in the short-run period. The empirical results show that aggregate demand shocks tend to exert a positive influence on the change in monetary policy while aggregate supply shocks tend to exert a negative impact on monetary policy. Monetary policy decisions tend to be more vigorous and aggressive towards aggregate demand shocks than aggregate supply shocks. Monetary policy's positive response towards aggregate demand shocks is countercyclical perhaps, with a view to controlling the spiraling inflationary rate. Monetary policy's negative response towards aggregate supply shocks is procyclical, implying that the central bank is more accommodating in one sense. For instance, an aggregate supply shock, say, due to a world oil price hike, would see expansionary yet inflationary monetary policy to sustain output growth BJM

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