The asymmetric effects of nominal shocks on the Jamaican economy: evidence from a non-linear VAR

INTRODUCTION

It is now generally accepted that monetary innovations can have asymmetric effects on the economy. Such asymmetries have been attributed to real and nominal rigidities, information asymmetries, indexation or changes in the availability of financing over the business cycle (Akerlof and Yellen, 1985). The existence of such asymmetry implies that no single monetary policy rule can be rigidly applied in all circumstances but there is need from some discretion depending on the degree of rigidities and the phase of the business cycle.

Although the evidence is mixed, generally more empirical studies do find evidence of asymmetric effects. Cover (1992), DeLong and Summers (1988), Morgan (1993), Kandil (1995), Karras (1996) and Thoma (1994) do find that the effects of positive and negative monetary shocks on the US...
economy are actually asymmetric. Additionally, Garcia and Schaller (1995) and Thoma (1994) find that the effects of monetary innovations depend on the phase of the business cycle, while Ravn and Sola (1996) find that the impact depends on the size of the shock. In a study of fifteen emerging market countries with varying degrees of dollarization, Biscarri et al. (2004) find asymmetry in response to an exchange rate shock, largely as a result of the degree of dollarization. Bigio and Salas (2006) found a similar result for Peru.

Previous papers on the monetary transmission mechanism in Jamaica, though alluding to this, do not fully account for the possibility that monetary policy has non-linear effects on the economy. Against this background, this paper investigates whether nominal shocks such as monetary or oil price shocks have asymmetric effects on output and prices in the Jamaican economy using a non-linear vector autoregression, namely a logistic smooth transition VAR (LSTVAR). Impulse response functions generated by this model are used to answer three questions: Do positive and negative shocks have different effects? Does the response of macroeconomic variables depend on the state of the economy? Do the effects of the shocks vary disproportionately with their size?

We use a simple aggregate demand-aggregate supply model, as in Weise (1999), with a smooth transition between regimes. This is in contrast to other studies that use discrete regime shifts or other switching variables. The switching variable used is the rate of inflation. Other studies use the money supply, unanticipated money supply growth or the growth rate of output. This paper finds that in the Jamaican case there is evidence to suggest that macroeconomic shocks cause non-linear responses. In particular, positive and negative monetary shocks have different effects, which are amplified depending on the state of the economy.

The next section presents a model with asymmetric rigidity and describes how its reduced form may be represented by an LSTVAR model. Section 2 reports tests for linearity in a standard four variable VAR, where the alternative hypothesis is an

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1 See for example Cover (1992) and DeLong and Summers (1988).
2 See for example Weise (1999), Beaudry and Koop (1993) and Thoma (1994).
LSTVAR model similar to that constructed in section 1. It also describes the estimation strategy and reports on further tests of the validity of the LSTVAR model. The penultimate section presents results from impulse response functions from the LSTVAR model, while section 4 concludes.

1. MODELING ASYMMETRY

In this section we adapt the asymmetric neoclassical models of Cover (1988a, b) and Weise (1999) to the open economy case of Jamaica. In this flexible price model the growth in potential output is given by:

\[ \Delta y_t^p = \Delta y_0^p + \theta, \]

where \( \Delta y_t^p \) is the growth rate of potential output in period \( t \) and \( \Delta y_0^p \) is a constant and \( \theta \) is mean zero shock. Typically this shock is a technology shock but in a small open economy such as Jamaica, it also represents shocks related to the capital stock, such as those arising from natural disasters. Aggregate demand follows the standard form but is augmented with dynamics which capture persistence in the response to shocks, that is:

\[ \Delta y_t = \Delta y_0 + \delta(\Delta m_t - \Delta p_t) + a_1 \Delta e_t + a_2 \delta_t + A(L)\Delta X_t + \eta_t, \]

where \( \Delta m \) is the growth in money supply, \( \Delta p \) is the rate of inflation, \( \Delta y \) the is output growth, \( X = (y, \tilde{p}, m, e, i)^T \) is a vector of variables, which includes the exchange rate, \( e \), and interest rate, \( i \). \( \eta \) is a non-monetary aggregate demand shock. This shock reflects exogenous terms of trade shocks (primarily a result of oil price shocks), which have been an important feature of the Jamaican economy. Equation (2) implies that aggregate demand and potential output grow at the same rate.

The Bank of Jamaica employs a monetary targeting framework\(^5\) in which it sets the money supply equal to the demand for money for a given pre-determined level of interest rate.

\(^5\) The BOJ uses a financial programming framework which is based on the quantity theory.
which for simplicity we assume is set in the previous period, and inflation. As such the money supply evolves according to:

\[ \Delta m_t = \Delta m_{t_0} + \phi \Delta y_t + \pi \Delta p_t + B(L) \Delta X_{t-1} + \mu_t, \]

where \( \mu \) is a monetary shock with expected value zero. The model is completed by the uncovered interest rate parity condition.

Prices adjust so that output demanded is equal to potential output, such that the inflation rate is:

\[ \Delta p_t^* = \Delta m_t + \frac{1}{\delta} ((a_1 - a_2) \Delta e_t + A(L) \Delta X_{t-1} + \eta_t - \theta_t). \]

Owing to rigidities, as emphasized in the New Keynesian literature, prices do not immediately adjust to the equilibrium. To motivate this idea we assume state dependent pricing, whereby a fraction \( (1 - \alpha(z_t)) \) of firms choose the optimal price and the remainder follows a rule of thumb that is based on the recent past inflation. Given this inflation in any given period is:

\[ \Delta p_t = \alpha(z_t) \Delta p_{t-1} + (1 - \alpha(z_t)) \Delta p_t^*, \]

where \( z_t \) is a switching variable that represent the state of the economy at time \( t \). Using the above pricing rule and equation (4) we obtain:

\[ \Delta p_t^* = \frac{(1 - \alpha(z_t))}{(1 - \alpha(z_t))L} \left\{ \Delta m_t + (a_1 - a_2) \Delta e_t + \frac{1}{\delta} (A(L) \Delta X_{t-1} + \eta_t - \theta_t) \right\}. \]

Weise (1999) shows that the structural form represented by (2), (3) and (5) can be expressed in matrix form as:

\[ X_t = X_0 + C_0 X_t + C(L) X_{t-1} + D(L) \varepsilon_t, \]

and the corresponding reduced form:

\[ X_t = X + G(L) X_{t-1} + u_t, \]

\[ \text{4 The BOJ pre-announces an interest rate for its open market instrument at which it takes all subscriptions.} \]

\[ \text{5 For simplicity and in order to focus on the dynamics of domestic variables we assume that the foreign interest rate is at its equilibrium level and is therefore suppressed in the analysis.} \]
where $X_0 = (y_0, 0, m_0, e_0, i_0)'$, $e_i = (\theta, \eta, \mu, \varepsilon, e_i)'$, $X = (I - C_0)^{-1} X_0$, $G(L) = (I - C_0)^{-1} C(L)$, $u_t = (I - C_0)^{-1} D(L)$, $e_i = (I - C_0)^{-1} D e_i$ and $C_0 =$

$$
\begin{bmatrix}
0 & -\delta & \delta & a_1 - a_2 & 0 \\
0 & 0 & 1 - \alpha(z) & (a_1 - a_2)(l - \alpha(z)) & 0 \\
\varphi & \pi & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -1 \\
0 & 0 & 0 & 0 & 0
\end{bmatrix}.
$$

Equation (6) is a time varying VAR, where the estimated reduced-form coefficients will vary to the state of the economy. In this model the source of asymmetry is $\alpha(z)$. While this is ad hoc, Weise (1999) presents a number of cases where such asymmetry may arise and discusses the corresponding appropriate switching or transition variable. One such case is where workers and firms resist downward changes in nominal variables, in which case the appropriate switching variable is the rate of price or wage inflation. Asymmetry can also be generated if the aggregate supply curve is convex such that wages and price are less flexible when real output is low. A measure of the output gap or the growth rate of real output is therefore recommended as the switching variable. These two cases are more likely when there are strong labour unions or monopolistic/oligopolistic industries as in Jamaica.

As in Weise (1999), we rewrite equation (6a) by expanding the $G(L)X_1$ matrix to obtain the smooth transition vector autoregression model:

$$
X_t = X + G(L)X_1 + (\theta + \theta(L)X_1) F(z) + u_t,
$$

where $F(z)$ is assumed to be a logistic function:

$$
F(z) = (1 + \exp(-\gamma(z - c)))^{1/2}, \gamma > 0.
$$

This gives the multi-equation version of the single equation STAR model of Teräsvirta and Anderson (1992) –the logistic smooth transition VAR (LSTVAR). The parameter $c$ represents the threshold around which the dynamics transition. The rate of this transition depends on $\gamma$, the smoothness parameter. As $\gamma$ approaches zero, $F$ converges to a constant and the model becomes a standard linear VAR. Alternatively, as $\gamma$ approaches infinity the model becomes a threshold autoregression model with the dynamics changing abruptly,
2. LINEARITY TESTS AND THE LSTVAR MODEL

Before estimating the LSTVAR we test for linearity in a benchmark VAR in the first difference of the logs of real GDP, the CPI, exchange rate, money supply (M1) and interest rates, estimated over the period 1990:Q1 to 2006:Q2. We estimate a VAR of order one because of the loss of degrees of freedom as the number of coefficients estimated in the linearity tests and the LSTVAR model rises in proportion to the number of coefficients in the standard linear model. Hence, there is virtue to parsimony and working with a smaller baseline model.

The linearity tests are F versions of the Lagrange multiplier tests described in Granger and Teräsvirta (1993) and assume that the switching variable is known. The null hypothesis is \( H_0: \gamma = 0 \) against the alternative \( H_1: \gamma > 0 \) in equation (10) and is a three step procedure based on an approximation to equation (10). The steps in the procedure are:

i) Run the regression \( X_t = \beta_0 + \sum_{j=1}^{pk} \beta_j W_j + u_t \) and collect the residuals \( \hat{u}_t \).

Define \( SSR_0 = \sum \hat{u}_t^2 \).

ii) Run the regression \( u_t = \alpha_0 + \sum_{j=1}^{pk} \alpha_j W_j + \sum_{j=1}^{pk} \delta_j z_j W_j + v_t \) and collect residuals \( \hat{v}_t \).

Define \( SSR_1 = \sum \hat{v}_t^2 \).

iii) Compute the test statistic \( LM = T(\text{SSR}_0, \text{SSR}_1) / \text{SSR}_0 \), where \( T \) is the number of observations and \( W_t = (X_{t-1}, ..., X_{t-p}, X_{2t-1}, ..., X_{2t-p}) \). Under the null hypothesis, \( LM \) is distributed \( \chi^2(pk) \). Our sample size is relatively small (\( n \leq 60 \)) and as such we use the equivalent \( F \) statistic,

\[
F = \frac{(\text{SSR}_0 - \text{SSR}_1) / pk}{\text{SSR}_0 / (t - (2pk + 1))}.
\]

The power of this test is weak in the presence of structural breaks in the data. Consequently,
following Weise (1999), each series is pre-filtered by regressing on a constant, dummies for liberalisation of Jamaica’s financial system and the regime shift in 1995 and a time trend. The results, shown in the table below, suggest that linearity is rejected for inflation and exchange rate changes, and depending on the switching variable, output growth.

**TABLE 1. LINEARITY TESTS**

<table>
<thead>
<tr>
<th>Switching variable</th>
<th>F statistic: Dependent Variable</th>
<th>Likelihood Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y</td>
<td>m</td>
</tr>
<tr>
<td>p</td>
<td>2.7832 (0.0931)</td>
<td>2.1849 (0.1518)</td>
</tr>
<tr>
<td>m</td>
<td>2.5560 (0.1115)</td>
<td>2.3773 (0.1291)</td>
</tr>
<tr>
<td>y</td>
<td>3.8778 (0.0423)</td>
<td>1.8303 (0.2072)</td>
</tr>
<tr>
<td>e</td>
<td>3.2453 (0.0658)</td>
<td>2.1972 (0.1502)</td>
</tr>
</tbody>
</table>

**NOTES**: Variables are quarterly change in the logs of CPI (p), real GDP (y), M1 (m) and exchange rates (e). The interest rate is taken as is. p values are in parentheses. Data are pre-filtered to remove structural breaks and trends. Null hypothesis is linearity; alternative hypothesis is LSTVAR model.

We estimate the LSTVAR model where $X = (y, p, m, e, i)'$, $A(L)$ and $\Theta(L)$ are first order polynomials in the lag operator and $F(z_t) = 1/(1 + \exp{-γ(z_t - c)/σ_z})^{-1/2}$. The parameter $σ_z$ is the standard deviation of the switching variable. Its inclusion normalizes the deviations of $z$ from the threshold value and facilitates the interpretation of the smoothness parameter. On the basis of the likelihood ratio statistics, the inflation rate and the change in the exchange rate are selected as the switching variables. We report the more robust results when inflation is used as the switching variable.

The main challenge in estimating the LSTVAR model arises from the fact that the model is unidentified because of the additional parameters in the non-linear component, in particular $c$ and $γ$. One can impose restrictions as in Teräsvirta and Anderson (1992), however, the results would be a function of
these restrictions. The procedure chosen follows Wiese (1999) who sets the threshold parameter to zero for the switching variables $y_{t1}$ and $p_{t1}$, and equal to the average inflation over the full sample for $p_{t2}$. The LSTVAR model is then estimated using these values for $c$, while allowing $\gamma$ to vary. The value of $\gamma$ that minimizes the log of the determinant of the variance-covariance matrix of residuals from these regressions is used in the final regressions. The estimates of $c$ and $\gamma$ produced by this procedure are given in the table below. When the switching variable is $e_t$ and $c$ is set equal to zero, the smoothness parameter is 28.04, indicating a very sharp transition from one regime to another. Thus little would be lost by estimating a threshold autoregression. Conversely, the smoothness parameter is only 1.2 when $p_t$ is the switching variable, indicating a fairly smooth transition from high inflation regime to low and vice versa.

<table>
<thead>
<tr>
<th>Switching Variable</th>
<th>Choice of $\gamma$</th>
<th>Choice of $c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_t$</td>
<td>$c=0, \gamma=1.2$</td>
<td>$\gamma=\infty, c=1.01$</td>
</tr>
<tr>
<td>$e_t$</td>
<td>$c=0, \gamma=28.04$</td>
<td>$\gamma=\infty, c=0.01$</td>
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3. IMPULSE RESPONSE ANALYSIS

In this section we use impulse response functions (IRFs) to examine the asymmetric effects of various economic shocks along the three dimensions commonly examined in this literature. First, do positive shocks have different effects than negative shocks? Second, do these shocks have different effects in different states of the economy, such as when inflation is high versus when it is low or stable? Third, do shocks of different magnitudes have disproportionate effects and is asymmetry along the other two dimensions affected by the size of the shock.

However, there are a number of complications that arise when estimating IRFs in nonlinear VARs. In particular, whereas in a linear VAR one set of impulse response function is sufficient to characterise the estimated model, in a nonlinear
case the IRFs are sensitive to initial conditions and the size of the impulses. As such we use the following method proposed by Koop, Pesaran and Potter (1996).

Innovations for periods 0 to q are drawn from the residuals of the estimated LSTVAR. The LSTVAR is then used to produce a forecast of the variables conditional on their initial values and a particular sequence of shocks. This procedure is then repeated (with the same initial values and residual draw), except that the shock in period 0 is fixed at some value (either one or two times the standard deviation of the shock in the linear model). The shocks to the other variables in period 0 remain unchanged. The difference between this forecast and the baseline model is the impulse response for a particular shock and sequence of initial values. Impulse response functions are computed in this way for one thousand draws from the residuals and averaged to produce the impulse response functions conditioned on initial values. These IRFs are averaged over the initial values taken from sub-samples of the data. For example, to compute the impulse response functions for low inflation period, the impulse response functions are averaged over the initial values corresponding to the post-1995 period. The earlier period (pre-1995) defines the high inflation epoch.

3.1. Comparison of linear and non-linear VAR

Figure 1 below shows the estimated response of output growth and inflation to a one standard deviation shock to the growth rate of money supply (M1) and interest rates. The shocks are identified using Choleski decomposition, wherein the ordering is such that innovations to output growth or inflation have no contemporaneous effect on money. The graphs provide evidence of asymmetry in the effects of macroeconomic shocks as the responses differ substantially between the linear and non-linear VAR. The linear model predicts stronger inflation and output growth effects from a monetary shock, while in the LSTVAR model the interest rate shock produces much sharper responses. For growth, the linear model reports an initial jump in output but this is short lived as output growth declines to sub-zero levels before normalizing to
zero. In the LSTVAR, the monetary shock produces a more traditional positive response. Only the non-linear model produces the traditional hump-shape response of output to both monetary policy innovations. The responses reflect the differing channels through which the money shock acts. On the one hand, the credit channel suggests an expansion in output growth as the monetary shock induces an interest rate decline, spurring investment. Eventually, the money shock leads to higher inflation that erodes real wages and lessens workers’ output.

The response to the interest rate shock is sharper in LSTVAR model, with a more long-lived contractionary effect.
For output growth, the maximum effect of the interest rate shock is reached after three quarters in both the linear and non-linear cases. The initial effect of the interest rate shock in the linear model is positive, though declining, and ultimately reflects a nearly zero effect. However, the downturn in growth persists for longer in the LSTVAR, moderating after 9 quarters whereas in the linear case the effect dies out after 5 quarters. Notably, only the linear model produces the *price puzzle*, whereby contractionary monetary policy produces a small and temporary rise in inflation. For the exchange rate shock, the inflation response of the linear model is quickest, rising sharply to a maximum at the second quarter. Thereafter, however, the shock dampens to zero and dies out by the sixth quarter after the initial shock. This is consistent with current assumptions regarding the pass-through of exchange rate changes as in McFarlane (2002), which indicate a maximum impact in the first quarter and smooth dampening thereafter. The LSTVAR model’s response is slower, with a lower maximum magnitude than the linear model but persists for a much longer time period.

### 3.2. Asymmetry in the effects of shocks at different states of the economy

Figure 2 below provides evidence to support the hypothesis that economic shocks have different effects depending on the state of the economy. Positive shocks to M1 appear to have a stronger effect on growth, inflation and exchange rate changes in an inflationary period. Additionally, in all cases, the horizon over which the shock dies out is longer under the high inflation regime. This horizon is at least 2 quarters longer than the impulse response under the low inflation regime. The non-linear response to a positive interest rate shock of growth and inflation (see below) in an inflationary period dwarfs the responses in the low inflation period. The maximum impact on output growth and inflation from the interest rate shock is observed after 3 and 4 quarters, respectively. Hence, it appears that *positive nominal (both money and interest rates) shocks have a stronger impact in a high inflation environment.*
3.3. Asymmetry of positive and negative shocks in different phases

Figure 3 and 4 below show the response of the economy to positive and negative shocks in different states or phases of the economy. They demonstrate that the effects differ depending on the state of the economy. Figure 3 depicts responses of selected variables during a low inflation period. Negative interest rate shocks increase output growth more significantly in an environment of low inflation. Similarly, a negative money shock in a low inflation period depresses output growth more significantly with a much quicker response.
(after one quarter). This suggests that signals are interpreted more clearly and quickly without the distortion of price signals that occur in a period of high inflation. But what of positive shocks generating a proportionately lower response in a low inflation environment? An explanation could stem from sticky prices akin to what would prevail in a period of low inflation. In this scenario, as in Cover (1992), only negative money supply shocks affect output. This comes from the assumption that aggregate supply is independent of both expected and unexpected prices (that is, it is vertical at the full employment level of output) and that aggregate demand has a negative slope. Reference can also be made to the particular

**FIGURE 3. EFFECTS FROM POSITIVE AND NEGATIVE SHOCKS IN A LOW INFLATION PERIOD (VARIABLES REFER TO LOG DIFFERENCES)**

<table>
<thead>
<tr>
<th>Response of Price to Interest Rates</th>
<th>Response of Prices to Money</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Response of Price to Interest Rates" /></td>
<td><img src="image2.png" alt="Response of Prices to Money" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Response of Exchange Rate to Money</th>
<th>Response of Exchange Rates to Interest Rates</th>
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<tbody>
<tr>
<td><img src="image3.png" alt="Response of Exchange Rate to Money" /></td>
<td><img src="image4.png" alt="Response of Exchange Rates to Interest Rates" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Response of Output to Money</th>
<th>Response of Output to Interest Rates</th>
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<tbody>
<tr>
<td><img src="image5.png" alt="Response of Output to Money" /></td>
<td><img src="image6.png" alt="Response of Output to Interest Rates" /></td>
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circumstances that characterised the inflationary episodes of the post-liberalisation era. The response of inflation to the negative interest rate and monetary shocks are also more rapid and significant in the low inflation regime. However, the impulses die out at approximately the same time (8 quarters). The responses of the exchange rate changes to the money and interest rate shocks are consistent with the findings for the other variables. It can be said, unequivocally, that negative shocks produce sharper responses in an environment of low inflation.

For the high inflation scenario, depicted in figure 4, the opposite effect is observed. The positive monetary and interest
rate shocks elicit stronger responses from the variables under analysis. However, the differences in magnitudes of these shocks are not as pronounced as in the case of the low inflation regime. Nonetheless, it is also unambiguous that positive shocks produce sharper responses in an environment of high inflation.

3.4. Asymmetry in the effects of oil price shocks

The figures below (figure 5) show the response of output growth, inflation and exchange rate changes to a one standard deviation shock to oil prices (proxied by the fuel index). As expected, lower (higher) oil prices will lead to higher (lower) growth. However, a negative shock has a larger cumulative effect than a positive shock. Although inflation initially declines marginally, a positive oil price shock elicits a strong response, largely between three and six quarters. Inflation also initially declines following a negative oil price shock, however, the domestic prices recover almost completely by the fourth quarter. This pattern is consistent with the observed price behaviour: decreases are soon reversed with sharper increases with the net effect on prices from a decline.
being nearly zero. The response of the exchange rate to a negative oil shock is initially negative but soon becomes strongly positive, reaching a maximum after one year. The channel through which the oil shock affects the exchange rate is assumed to be through the balance of payments. Hence, the negative oil shock facilitates greater consumption of cheaper oil imports, allowing greater imports of complementary goods which lead to greater overall imports. The resulting deterioration in the goods balance and balance of payments increases pressure on the exchange rate and then leads to depreciation.

3.5. Asymmetry in the effects of large versus small shocks

Up to this point, all shocks were of a one standard deviation magnitude. To test the hypothesis that the effects of shocks may vary disproportionately with the size of the shock, a comparison is done between the responses to one-standard-error and two-standard-error shocks. The responses to two-standard-error shocks are normalised by dividing by two so they can be readily compared with the responses to one-standard-error shocks. Additionally, negative shocks are multiplied by \(-1\) for ease of comparison with the responses to positive shocks. The figures below show the responses of inflation and output growth to a monetary and an interest rate shock. There appears to be very little difference between the responses of growth to the one- and two-standard-error positive money shocks. However, the negative two-standard-error shock produces sharper, more pronounced responses than both the positive shocks. Nonetheless, the maximum effect is seen, in all cases, at the second quarter after the initial shock. There is some amount of congruence, however, after eight quarters. The inflation responses from the varying monetary shocks (shown in the second panel of figure 6) are essentially proportionate. However, the responses of output growth and inflation to the interest rate impulses appear distinctly disproportionate. Of note, while the large positive shocks produce similar results to the smaller shocks, the negative two-standard-error shock elicits proportionately smaller responses from both the growth and inflation variable. Similarly, the small inflation response to the interest rate decline could be
related to the fact that higher income or the greater availability of credit would not induce an increase in consumption of the basic goods that dominate the CPI, but apply more to luxury goods.

The finding of disproportionate adjustments to large shocks is consistent with Weise (1999) and Ravn and Sola (1996). Our findings suggest that the high inflation effect is dominant over the whole sample period and is plausible given the legacy of high inflation. Hence, over the full sample, the result that positive (both money and interest rates) shocks have stronger impact on the macroeconomic variables under consideration in a high inflation environment dominates the finding of stronger responses to negative shocks in a low inflation state.

4. CONCLUSION

The results in this paper support the finding that there is asymmetry in the effects of macroeconomic shocks, which is a
function of the state of the economy and direction of the shock. Positive monetary shocks have a stronger impact on output, prices and exchange rates in an inflationary period. However, negative shocks produce sharper responses in an environment of low inflation. Similarly, negative monetary shocks depress output growth more quickly. The paper also finds evidence of asymmetric effects from oil price shocks, though the impact on inflation is nearly symmetric. There is also evidence that large shocks produce disproportionate effects.

Although we remain guarded about the results, we think they raise important questions about the nature of the transmission mechanism in different phases of the economy. One such question is why is it that the effect of increasing interest rates is less potent in a low inflation regime. A possible explanation could be that the economy has not had a long enough period of low inflation to entrench credibility and that based on past experiences we have become accustomed to large interest rate changes during periods of economic turbulence. One implication of these results is that given that Jamaica is presently in a low inflation environment the monetary authorities may need to be cognizant of the differing responses that may be elicited from policy action. That is, the action of contracting money supply or reducing interest rates could have more pronounced effects than before. A more gradual and forward looking policy adjustment may be required. This, as unanticipated sharp policy actions are more likely to induce overshooting in a stable environment.

A natural extension of the current work is the examination of macroeconomic shocks in different phases of the business cycle. In particular, an examination of whether there are differences in the responses in high and low growth periods will be undertaken. A potential challenge is that the economy has had low or no growth for most of the sample period. The use of average impulse responses could be affected by outliers, hence further work will involve a comparison with median estimates. Finally, it is proposed to introduce an error correction mechanism to account for short-run equilibrium adjustment.
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