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Neil Mitchell
Wayne Robinson

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

Paper prepared by N. Mitchell and W. Robinson, Research Services Department, Research and Economic Programming Division, Bank of Jamaica. *This paper was presented at the XIII Central Bank Researchers Network of the Americas Meeting, in Mexico City, November 5-7, 2008. The views expressed in this paper are not necessarily those of the Bank of Jamaica.*

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.[1] 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.[2] 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

[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:

$$\Delta y_t^p = \Delta y_0^p + \theta_t \,, \tag{1}$$

where Δy_t^p is the growth rate of potential output in period t and Δy_0^p is a constant and θ 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:

$$\Delta y_t = \Delta y_0 + \delta(\Delta m_t - \Delta p_t) + a_1 \Delta e_t - a_2 i_t + A(L)\Delta X_t + \eta_t \,, \tag{2}$$

where Δm is the growth in money supply, Δp is the rate of inflation, Δy the is output growth, $X = (y, p, m, e, i)'$ is a vector of variables, which includes the exchange rate, e, and interest rate, i. η 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[3] in which it sets the money supply equal to the demand for money for a given pre-determined level of interest rate,

[3] 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,[4] and inflation. As such the money supply evolves according to:

$$\Delta m_t = \Delta m_0 + \phi \Delta y_t + \pi \Delta p_t + B(L)\Delta X_{t-1} + \mu_t , \tag{3}$$

where μ is a monetary shock with expected value zero. The model is completed by the uncovered interest rate parity condition.[5]

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

$$\Delta p_t^* = \Delta m_t + \frac{1}{\delta}((a_1 - a_2)\Delta e_t + A(L)\Delta X_{t-1} + \eta_t - \theta_t) . \tag{4}$$

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:

$$\Delta p_t^* = \frac{(1-\alpha(z_t))}{(1-\alpha(z_t))L}\left\{\Delta m_t + (a_1 - a_2)\Delta e_t + \frac{1}{\delta}(A(L)\Delta X_{t-1} + \eta_t - \theta_t)\right\}. \tag{5}$$

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

$$\boldsymbol{X}_t = \boldsymbol{X}_0 + \boldsymbol{C}_0\boldsymbol{X}_t + \boldsymbol{C}(L)\boldsymbol{X}_{t-1} + D(L)\varepsilon_t , \tag{6}$$

and the corresponding reduced form:

$$\boldsymbol{X}_t = \boldsymbol{X} + G(L)\boldsymbol{X}_{t-1} + u_t , \tag{6a}$$

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

[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 $X_0 = (y_0, 0, m_0, e_0, i_0)'$, $\varepsilon_t = (\theta, \eta, \mu, \varepsilon_e, \varepsilon_i)'$, $X = (I - C_0)^{-1} X_0$, $G(L) = (I - C_0)^{-1} C(L)$, $u_t = (I - C_0)^{-1} D(L)$, $\varepsilon_t = (I - C_0)^{-1} D\varepsilon_t$ and $C_0 =$

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

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 $G(L)\boldsymbol{X}_{t1}$ matrix to obtain the smooth transition vector autoregression model:

$$\boldsymbol{X}_t = \boldsymbol{X} + G(L)\boldsymbol{X}_{t1} + (\theta_0 + \theta(L)\boldsymbol{X}_{t1})\, F(z_t) + u_t,$$

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

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

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 γ, the smoothness parameter. As γ approaches zero, F converges to a constant and the model becomes a standard linear VAR. Alternatively, as γ approaches infinity the model becomes a threshold autoregression model with the dynamics changing abruptly,

depending on whether z_t is greater than or less than the threshold parameter.

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 $X_{it} = \beta_{i0} + \sum_{j=1}^{pk} \beta_{ij} W_{jt} + u_{it}$ and collect the residuals $\hat{u}_{it}$.
Define $SSR_0 = \Sigma \hat{u}_{it}^2$.

ii) Run the regression $u_{it} = \alpha_{i0} + \sum_{j=1}^{pk} \alpha_{ij} W_{jt} + \sum_{j=1}^{pk} \delta_{\boldsymbol{l}} z_t W_{jt} + v_{it}$ and collect residuals $\hat{v}_{it}$.
Define $SSR_1 = \Sigma \hat{v}_{it}^2$.

iii) Compute the test statistic $LM = T(SSR_0 SSR_1) \; / \; SSR_0$, where T is the number of observations and $W_t = (X_{1t-1}, \ldots X_{1t-p}, X_{2t-1} \ldots X_{kt-p})$. Under the null hypothesis, LM is distributed $\chi^2(\text{pk})$. Our sample size is relatively small ($n \leqslant 60$) and as such we the use of the equivalent F statistic, $F = \dfrac{(SSR_0 - SSR_1) / pk}{SSR_0 / (t - (2pk + 1))}$. 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

	F statistic: Dependent Variable				*Likelihood*
Switching variable	*Y*	*m*	*p*	*e*	*Ratio*
p	2.7832	2.1849	5.4074	7.4074	131.454
	(0.0931)	(0.1518)	(0.0169)	(0.0063)	(0.0000)
m	2.5560	2.3773	3.2772	7.4074	103.641
	(0.1115)	(0.1291)	(0.0643)	(0.0063)	(0.0000)
y	3.8778	1.8303	2.6040	4.0995	101.5265
	(0.0423)	(0.2072)	(0.1073)	(0.0366)	(0.0000)
e	3.2453	2.1972	5.9631	8.5102	147.6007
	(0.0658)	(0.1502)	(0.012)	(0.004)	(0.0000)

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 $F(z_t) = 1/(1 + \exp\{-\gamma(z_t - c)/\sigma_z\} - 1/2$. The parameter σ_z is the standard deviation of the switching variable. Its inclusion normalizes the deviations of z_t 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_{t-1} and p_{t-1}, and equal to the average inflation over the full sample for p_{t-2}. The LSTVAR model is then estimated using these values for c, while allowing γ to vary. The value of γ 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 γ 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 2. OPTIMAL VALUES OF SMOOTHNESS AND THRESHOLD PARAMETERS

Switching Variable	*Choice of* γ	*Choice of* c
p_t	c=0, γ=1.2	$\gamma=\infty$, c=1.01
e_t	c=0, γ=28.04	$\gamma=\infty$, c=-0.01

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

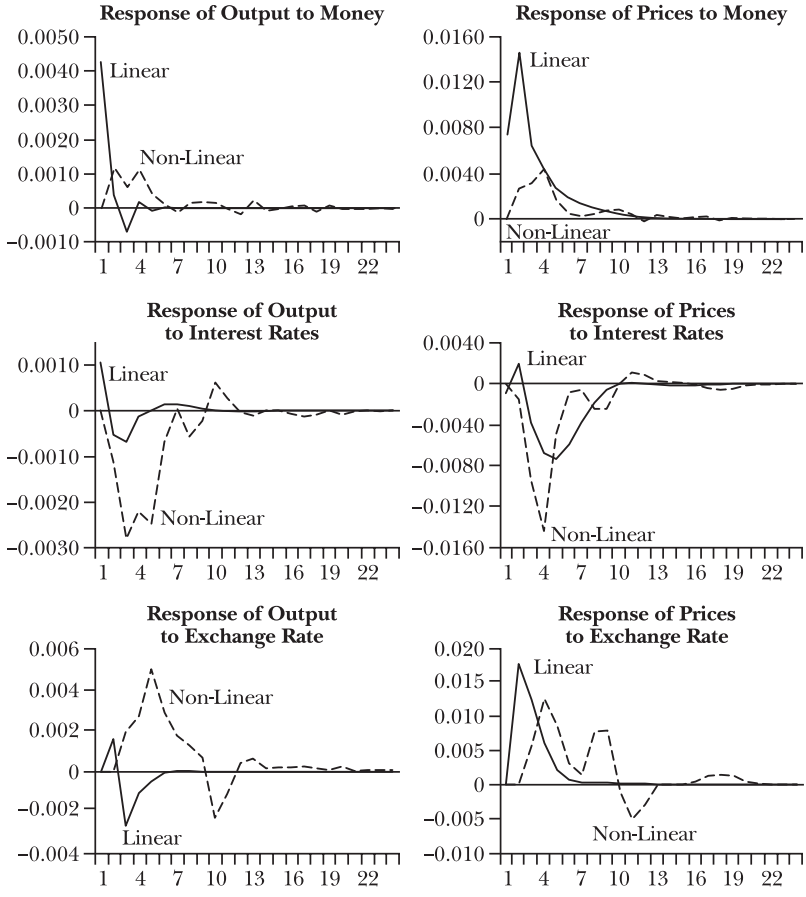
case the IRFs are sensitive to initial conditions and the size of the impulses. As such we use the following method proposed by Koop, Pesaran and Potter (1996).

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

FIGURE 1. COMPARISON OF LINEAR AND NON-LINEAR RESPONSE TO ONE-STANDARD ERROR SHOCKS (VARIABLES REFER TO LOG DIFFERENCES)



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.

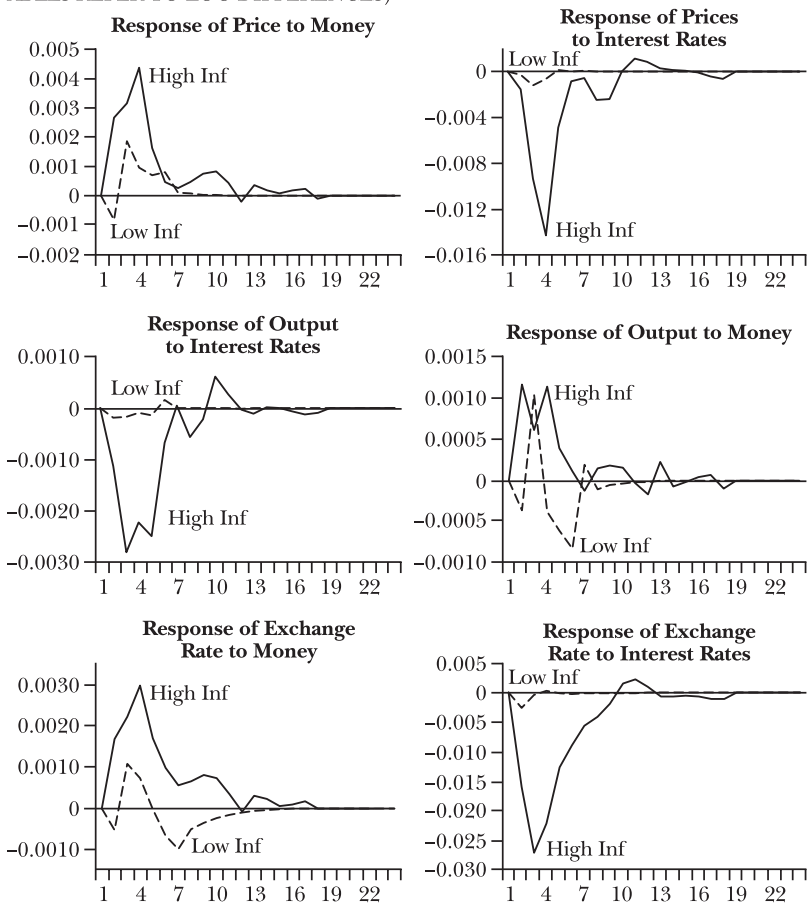
The response to the interest rate shock is sharper in LSTVAR model, with a more long-lived contractionary effect.

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.*

FIGURE 2. EFFECTS OF SHOCKS AT DIFFERENT STATES OF THE ECONOMY (VARIABLES REFER TO LOG DIFFERENCES)

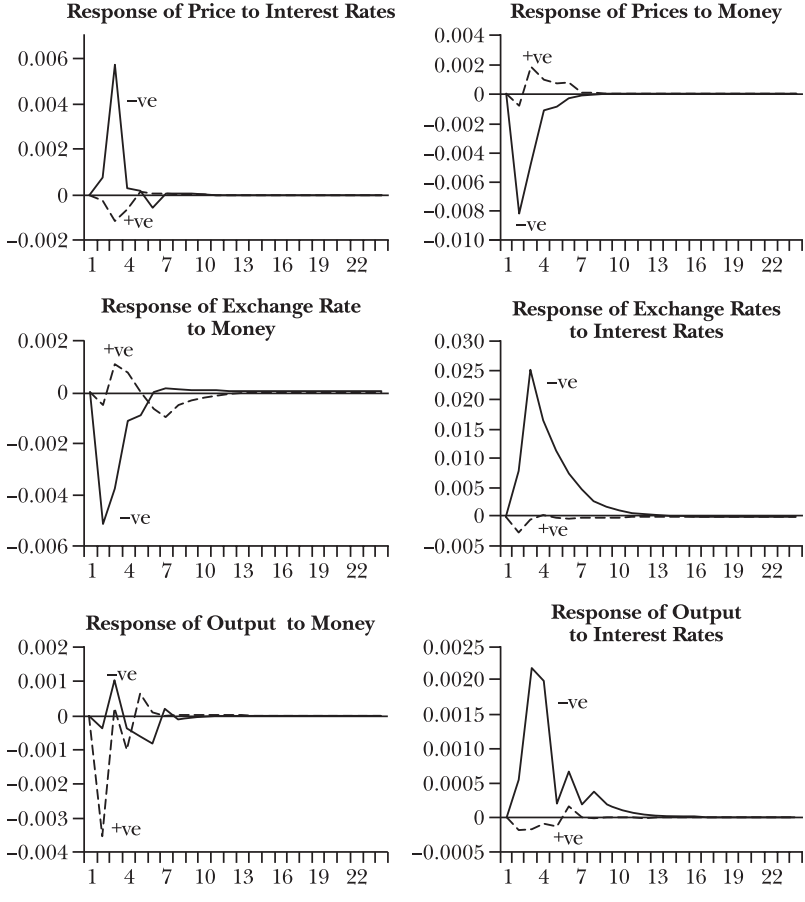


3.3. Asymmetry of positive and negative shocks in different phases

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

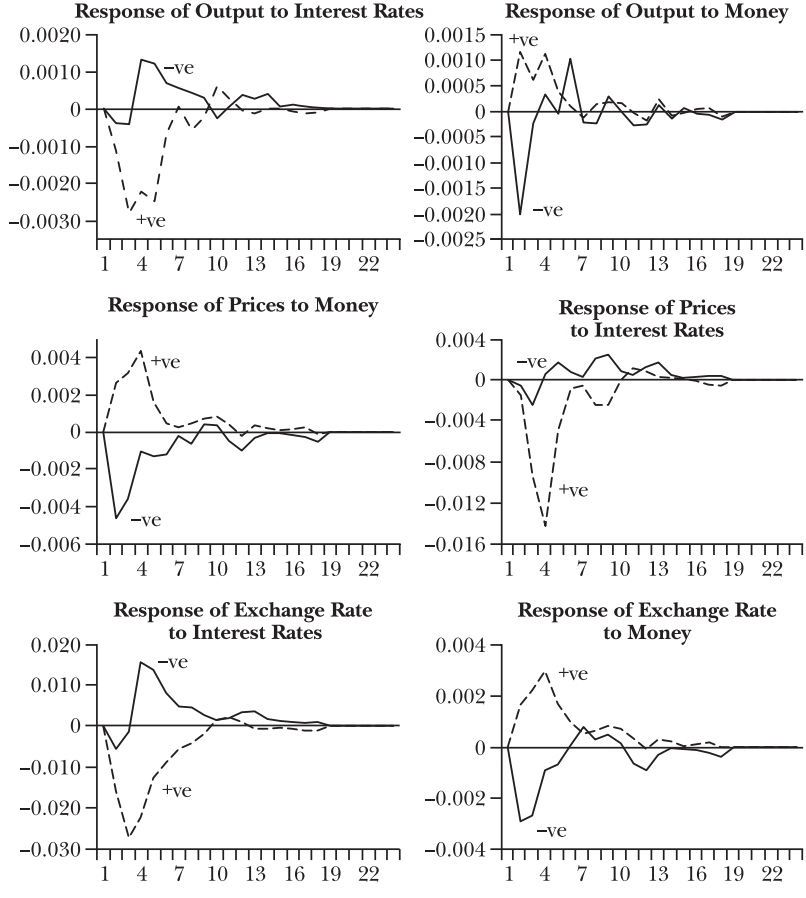
FIGURE 3. EFFECTS FROM POSITIVE AND NEGATIVE SHOCKS IN A LOW INFLATION PERIOD (VARIABLES REFER TO LOG DIFFERENCES)



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

FIGURE 4. EFFECTS FROM POSITIVE AND NEGATIVE SHOCKS FROM A HIGH INFLATION PERIOD (VARIABLES REFER TO LOG DIFFERENCES)

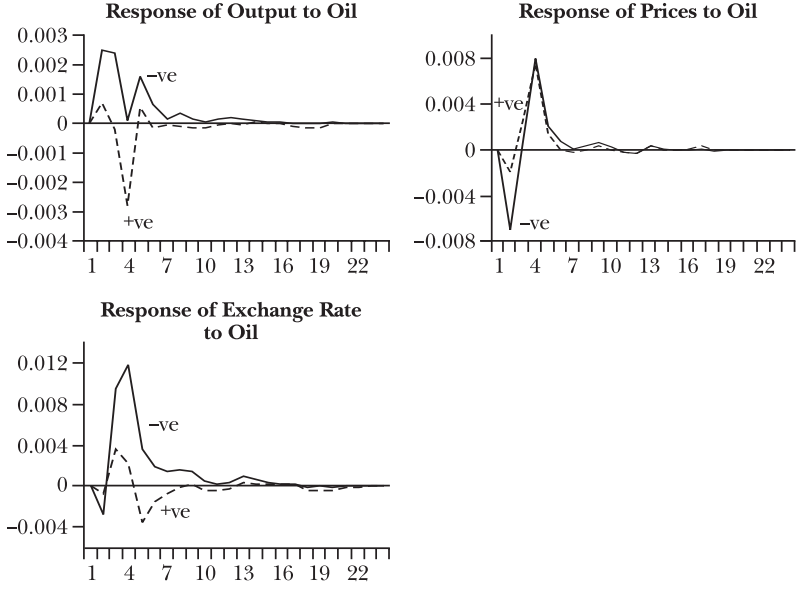


rate shocks elicit stronger responses from the variables under analysis. However, the differences in magnitudes of these shocks are not as pronounced as in the case of the low inflation regime. Nonetheless, it is also unambiguous that *positive shocks produce sharper responses in an environment of high 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

FIGURE 5. ASYMMETRY IN THE EFFECTS OF OIL PRICES SHOCKS (VARIABLES REFER TO LOG DIFFERENCES)

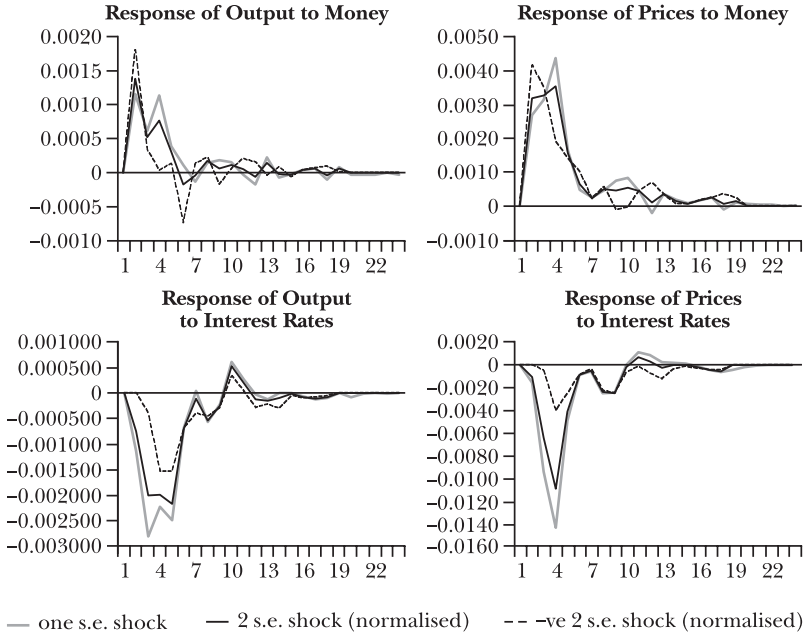


being nearly zero. The response of the exchange rate to a negative oil shock is initially negative but soon becomes strongly positive, reaching a maximum after one year. The channel through which the oil shock affects the exchange rate is assumed to be through the balance of payments. Hence, the negative 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

FIGURE 6. THE EFFECTS OF LARGE VERSUS SMALL SHOCKS (VARIABLES REFER TO LOG DIFFERENCES)



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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Daniel Boamah
Winston Moore

External debt and growth in the Caribbean

1. INTRODUCTION

It is widely recognised in the economic literature that a developing country in the early stages of development requires significant inflows of foreign resources to enhance its growth. The rationale is that developing countries are, in the main, unable to attract the required levels of foreign capital necessary to sustain growth, and as such debt flows would help to close resource gaps, stimulate investment and thus maintain economic growth at reasonable levels.

Nevertheless, external inflows, whether in the form of equity or borrowed funds, constitute a charge on the country's future resources through either debt service payments or dividends to foreign shareholders. Therefore, adequate income should necessarily be generated with foreign resources to allow for their future repayments. This is even more pertinent

Paper prepared by D. Boamah, Central Bank of Barbados, Tom Adams Financial Centre, Bridgetown, and W. Moore, Department of Economics, University of the West Indies, Cave Hill Campus, Barbados. (Emails: ⟨doboamah@centralbank.org.bb, winston.moore@cavehill.uwi.edu⟩.)

for borrowed funds since they impose contractual obligations, which must be met. There are severe macroeconomic consequences for debt default including real output losses. The experiences of many developing countries before the onset of the debt crisis of the early 1980s point to situations where too rapid an increase of external debt relative to GDP led to sharp increases in debt servicing obligations which reduced otherwise growing economies into shrinking ones.

There is a growing literature on the long-term macroeconomic impact of external debt on growth. The general consensus is that while a reasonable level of borrowing by a developing country is likely to enhance economic growth, high and increasing levels of accumulated debt can lead to lower growth. This suggests that there exists a maximum level of debt beyond which accumulated debt begins to be a drag on economic growth, implying that there exists a quadratic or an inverted-U relationship between debt and growth. The literature refers to this relationship as *debt Laffer curve* and recent studies have sought to establish its existence (see Patillo, Poirson and Ricci, 2002; Elbadawi, Ndulu and Ndung'u, 1997).

The former study involved a group of African countries, the majority of which are severely debt stressed.[1] The authors find that the debt to GDP ratio beyond which further external debt accumulation started to have negative effect on growth is about 97%. In the more recent study, Pattillo, Poirson and Ricci (2002) estimated this growth inhibiting level to be about 40% for a larger group comprising 97 developing countries. However, their study excludes countries of population of 400,000 or less and hence excludes most Caribbean countries.

In the Caribbean region, only Guyana with a debt to GDP ratio of 327.7% (1987-2000) has been officially declared as a heavily indebted poor country. Nevertheless, a few others, including Jamaica (79.9%), Antigua and Barbuda (61.7%) and Dominica (42%) may be considered as debt stressed. While most of the debt ratios in the Caribbean fall way outside the average 97% growth-inhibiting ratio that is obtained for Africa,

[1] Of the 32 developing countries classified as heavily indebted poor countries, 26 were in sub-Sahara Africa.

many are well within the ratio (35%-40%) for the larger group of countries obtained by the Pattillo, Poirson and Ricci's (2002) study. Therefore any research that adds some weight to the evidence identifying the critical debt ratios beyond which external debt becomes a drag on economic growth in the Caribbean would be useful. It would serve to provide guidance to governments and public debt managers as to what level and rate of growth in their external debt portfolios are fundamentally sustainable.

The main interest in this paper is to determine what relationship exists between external debt and growth in the Caribbean and if a debt Laffer curve can be identified for the countries of the region. The paper adds to the current research in the area by explicitly considering the role that *good* policies play in increasing the return, in terms of growth in real gross domestic product (GDP), on borrowed funds. The rationale is that external resources, whether in the form of grants or loans, act as income transfer to the recipient countries and are more likely to produce growth in an environment of sound economic policies. The beneficial macroeconomic impact of external debt is reduced where such resources are dissipated in unproductive government consumption. The impact policies on debt is examined by interacting debt and debt squared terms with a policy index, which attempts to capture the monetary, fiscal and trade policies in place in a given country. The framework also allows one to estimate the growth maximising level of debt, beyond which increased debt starts to have a deleterious impact on growth.

The structure of the paper is as follows. Section 2 surveys the empirical literature on debt and growth in the Caribbean, section 3 summarises the methodology while section 4 discusses the main results of the study. In section 5 some policy options available to the region are discussed using the debt profile of two of the countries considered relatively more debt stressed. Section 6 concludes with some suggestions on ways to assist these countries in their debt managements endeavours.

2. LITERATURE REVIEW

Blackman (1988) provides a descriptive look at the effects of external debt on growth and development in the Caribbean. The author examines why CARICOM countries did not benefit from the debt build-up in the late 1970s and early 1980s. The author cites four main reasons. First, around this time some states moved to nationalise their productive, distributive and financial sectors. This over-extended the administrative and financial resources of the regional governments and also subdued private sector activity. Secondly, the relative lack of efficiency in many regional state enterprises led to the destruction of most of the imported capital. Additionally, a significant proportion of the external debt contracted was used for consumption purposes instead of growth-enhancing investment. Finally, the collapse of the Caribbean attempt at political integration did not permit the creative use of these resources to further the development of the region. These four factors combined explain why rather than enhancing growth, the debt accumulation of the period actually had a negative impact on growth.

Boamah (1989) arrives at similar conclusions in his article, which surveys the debt issues facing the Caribbean countries after the debt crisis of the 1980s. The author notes that in an attempt to cover debt service payments, possible growth-enhancing investments have usually been cut, since these are easier to reduce than raising taxes, especially in an environment where forceful trade union advocacy makes it difficult to contain wage increases. In addition, the debt servicing obligations are likely to run down external reserves, which precludes the use of these funds to purchase inputs for the productive sectors.

Bourne and Nicholls (1990) present a more formal examination of the effects of external debt on growth. The authors study the effects of shocks on the real debt service of Barbados and Trinidad and Tobago using a small macro econometric model, which is estimated for each country using two stage least squares, and data covering the period 1968 to 1987. Three experiments are conducted. The first examines the impact of a 25% reduction in debt service commitments. In

this scenario real GDP rose by 4.8% in Barbados compared to 0.2% in Trinidad and Tobago. Similar results, but with opposite signs, are obtained when the analysis is conducted for a 25% increase in debt service obligations, in the case of the second experiment. This outcome is attributed to the linear structure of the model. In the final experiment, Bourne and Nicholls examine the effect of a 125% rise in debt service obligations. This scenario is meant to mimic the effects of a bunching of external debt commitments. The authors' results suggest that in this case, Trinidad and Tobago's output is more responsive than Barbados', to the extent that real GDP in Barbados declined by 9.9%, compared to a 23% fall in Trinidad and Tobago. The main shortcoming of the paper lies in its limited scope. It shows what are the implications of a change in the debt service payments of the countries under discussion but gives no indication as to what levels of debt are sustainable.

Fraser (2000) examines the issue of debt sustainability in the case of the Bahamas. The author uses a modified version of the debt sustainability identity proposed by Blanchard and Fischer (1993), which defines a relationship between debt/GDP ratio, the primary fiscal deficit to GDP ratio, seigniorage, real rate of interest and the rate of economic growth. In this framework, if the rate of increase in the real interest rate exceeds the growth of the economy, then the national debt is growing faster than the government's ability to repay. This illustrates that the issue of debt sustainability is not just achieving a specific target level of debt, but it requires coordinating factors of growth and monetary policy in order to maintain debt at a sustainable level. The author's empirical results suggest that if the Bahamas is to maintain a sustainable level of debt of 33% of GDP, this would require a fiscal deficit below 2.7% and real growth of approximately 6%. The level of debt identified as sustainable in this study, however, is not derived from any model-based techniques but is an estimate of what the authors thought is a sustainable target for the national debt.

Taking a more descriptive approach to the issue of debt sustainability in the Caribbean, Marquez (2000) examines the experience of the group of countries in the Eastern Caribbean

linked by a common currency under the ambit of the Eastern Caribbean Central Bank (ECCB). The author attributes the apparent healthy debt to GDP ratios of these countries to debt rescheduling and forgiveness. Marquez, therefore, argues for more structured debt management policies, strongly advocating that foreign borrowing should be so utilized as to raise productivity and growth in order for it to be sustainable. The author also recommends that, as far as possible, countries should negotiate for loan terms with significant grant element and in which interest rates are fixed to minimise foreign exchange risk.

3. METHODOLOGY

3.1. The model

To examine the relationship between debt and growth a standard neo-classical growth model is specified and the external debt to GDP ratio is added to the equation to test if it exhibits a significant explanatory influence in the region's growth process. Let g_{it} represent the growth rate of real per capita GDP of country i during period t, the empirical growth equation can be expressed as:

$$(1)\ g_{it} = \mu_i + \beta_1 debt_{it} + \beta_x X_{it} + \delta_1[debt_{it} \times policy_{it}] + \delta_2[debt_{it}^2 \times policy_{it}] + \varepsilon_{it},$$

where μ_i are the country specific fixed effects, X_{it} is a vector of exogenous variables and ε_{it} is the error term which is assumed to have normal statistical properties. The interaction term between debt and policy permits one to examine whether debt has a greater impact in countries with *good* economic policies. In addition, the quadratic specification allows one to test for the existence of a debt policy Laffer curve, which would suggest that in a *good* policy environment, debt at low levels has a positive influence on growth; however, after a certain point, the stress of excessive debt begins to have a toll on growth irrespective of the policy environment and increased debt tends to have a deleterious impact on growth. If there exists a debt policy Laffer curve, the coefficient on the debt policy interaction term is expected to be positive while

the debt squared policy variable should be negative.

In order to obtain a policy index, the study utilises the approach suggested by Burnside and Dollar (2000) where one regresses real economic growth on indicators of fiscal, trade and monetary policies and derives the policy index from the estimated coefficients. The exogenous variables include: the change in external price competitiveness (as proxied by the real effective exchange rate), openness (defined as the ratio of total trade to GDP), inflation, investment ratio as well as the ratio of government consumption to GDP. In general, increases in the real effective exchange rate would suggest declining external competitiveness and hence would be negatively related to growth. However, openness and investment should be positively associated to growth to the extent that increased trade boosts productivity through transfers of knowledge while increased capital accumulation would normally have beneficial effect on growth. On the other hand, inflation and rising government consumption are expected to be negatively associated with growth. Rising prices impede efficient decision making by distorting the signalling role of relative prices while greater public consumption activity could crowd out private activity

In Equation (1) it is likely that debt and investment are endogenous. If a country suffers a shock that could negatively affect growth, the country may attempt to secure additional debt to assist in rebuilding. Similarly, investment activity is more likely to grow faster in a growing economy and to taper off during periods of recession. This would imply that ordinary least squares (OLS) would yield biased coefficient estimates. Therefore, this study uses the two-stage least squares (2SLS) estimator augmented with country specific and time dummies, to account for the endogenous debt variable.

3.2. Data description and sources

The data consists of a panel on twelve Caribbean countries (Antigua and Barbuda, Barbados, Belize, Dominica, the Dominican Republic, Grenada, Guyana, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago) over the period 1975 to 2000 and are compiled

from various sources. Real GDP is taken from the IMF's International Financial Statistics (IFS) CD-Rom, the Eastern Caribbean Central Bank's Economic and Financial Review (various issues) and the Central Bank of Barbados' Annual Statistical Digest 2001. The real effective exchange rate, a proxy for competitiveness, is compiled from the IFS CD-Rom, however, for Barbados and Jamaica the estimates generated by Maxwell and Moore (2004) are utilised. Total nominal trade flows (imports plus exports) is acquired from the IFS CD-Rom and then deflated by the GDP deflator, which provides an estimate of real trade, and a proxy for openness. Total external debt is obtained from the World Bank's World Development Indicators (WDI) CD-Rom (2000), Barbados (Annual Statistical Digest), Belize (Annual Reports), Dominican Republic (WDI, CD-Rom 2000) Guyana (Annual Reports), Jamaica (Annual Statistical Digest), Trinidad and Tobago (Annual Statistical Digest) and the CARICOM Secretariat (2002). The WDI database provides the source of the public sector variable, government consumption, along with the change in the GDP deflator, which serves as a proxy for inflation, and investment.

TABLE 1. DESCRIPTIVE STATISTICS

	Description	*Mean*	*Standard Deviation*
Growth	The change in the natural logarithm of real per capita GDP	0.024	0.086
$\Delta REER$	The change in the natural logarithm of the real effective exchange rate	0.011	0.120
Openness	The natural logarithm of real trade flows	15.036	6.615
Inflation	The change in the GDP deflator	8.460	15.533
Investment	The natural logarithm of investment as a percent of GDP	3.303	0.313
Government consumption	The natural logarithm of government consumption as a percent of GDP	2.837	0.389
Debt	The natural logarithm of total external debt as a percent of GDP	3.761	0.710
Policy	Index based on the regression coefficients of inflation, government consumption and openness in a growth equation	0.290	0.093

The policy index used in this study is obtained from the following expression:

(2) $Policy = 0.327 - 0.095 \times Gov.Cons + 0.016 * Openness - 0.001 * Inflation.$

The index can be interpreted as the country's likely growth rate given the policies chosen. Descriptive statistics for all the variables are given in Table 1 and Table 2 provides the regression from which the coefficients of the policy index are derived.

TABLE 2. PANEL REGRESSIONS OF THE DEBT-GROWTH RELATIONSHIP

	Dependent variable: growth in GDP per capita			
	(A)	*(B)*	*(C)*	*(D)*
$\Delta REER$	0.034	0.039	-0.101	-0.151
	(0.018)	(0.018)[b]	(0.021)[a]	(0.019)[a]
Openness	0.017	0.054	-0.000	-0.010
	(0.009)	(0.021)[b]	(0.012)	(0.011)
Inflation x 10^{-2}	-0.088	-0.077	-0.023	-0.010
	(0.018)[a]	(0.015)[a]	(0.010)[b]	(0.011)
Investment	0.010	-0.001	-0.038	-0.024
	(0.027)	(0.028)	(0.012)[a]	(0.013)
Government consumption	-0.095	-0.079	-0.016	-0.028
	(0.023)[a]	(0.023)[a]	(0.018)	(0.015)
Debt	-	-0.398	-0.295	-0.148
		(0.170)[a]	(0.113)[b]	(0.109)
Debt x Policy	-	-	0.834	1.431
			(0.081)[a]	(0.139)[a]
Debt x Policy^2	-	-	-	-0.111
				(0.020)[a]
R^2	0.751	0.757	0.845	0.859
Sigma	0.047	0.047	0.038	0.036
Observations	202	202	202	202

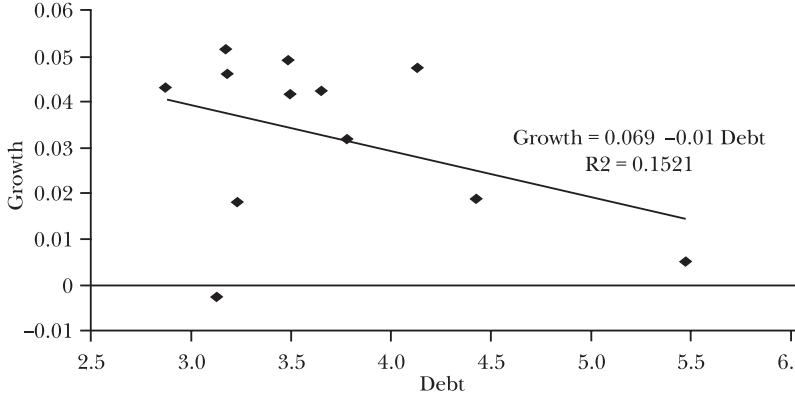
NOTES: Robust standard errors are given in parentheses. Time dummies are included in all regressions.

[a], [b] Indicate significance at the 1 and 5% levels, respectively.

To examine the bivariate relationship between external debt and growth in the Caribbean, average debt ratios and GDP growth rates for each country are calculated and plotted in the scatter diagram shown in figure 1. It depicts an inverse relationship between debt and growth in the region. However,

since this relationship may be spurious because of the likely exclusion of other significant third factor effects, which may influence growth, multivariate regression framework that takes these other variables into account has been employed. The following section examines this and other related issues.

FIGURE 1. DEBT-GROWTH RELATIONSHIP



4. EMPIRICAL RESULTS

Table 2 gives the estimated coefficients in a cross-country growth regression for the Caribbean with and without the debt-policy interaction terms. The basic growth model (regression A) successfully accounts for approximately 77% of the growth in Caribbean economies. Inflation and government consumption are significant at classical levels of testing and carry the expected signs. The coefficient on the inflation variable suggests that an inflation rate of 10% will reduce real GDP growth by only three-fifths of a percentage point; however, a level of inflation of 50% will reduce the real rate of economic expansion by almost three percentage points. This demonstrates the importance of maintaining levels of monetary expansion that are conducive to low levels of inflation, especially in flexible exchange rate economies in the region. Government consumption also has a significant negative influence on growth in economic activity in the region. This occurs because high levels of government consumption shift resources from the private to the public sector and *crowds-out* or reduces private sector activity.

The debt variable is then introduced into the basic growth equation and regression B provides the estimated results of the augmented growth model. Debt enters with a significant negative sign and suggests that debt acts as a drag on growth even at very low levels. While this negative impact of debt on growth in a linear model concords with what has generally been found for other studies, proponents of the *debt overhang* theory have argued that a linear relationship is inadequate to identify the overall impact of debt on growth and that the relationship is more likely to be non-linear. For instance, authors such as Elbadawi, Ndulu and Ndung'u (1997) and Patillo, Poirson and Ricci (2002) have proposed the idea of a *debt Laffer curve* whereby the effect of debt on growth could be positive at low levels of growth but negative when external indebtedness becomes excessive.

This study also examines the non-linear relationship between debt and growth but we also argue that any positive impact at low levels of debt is more likely to be attained within an environment of good macroeconomic policy. For example, the gains from increasing external debt in terms of greater public capital and social welfare may be eroded by high rates of inflation or through increased government consumption not matched by a correspondent increase in tax revenues. As a result, non-linear interaction terms between debt and a policy index are included in the basic growth regression model. Regressions C and D provide the estimates of the model with the policy interaction terms. A Wald test of the joint significance of the interaction terms rejects the null hypothesis that these variables have zero coefficients at the 1% level of testing. The coefficient of the debt policy interaction term appears to give credence to the view that in countries with *good* policies, accumulating manageable levels of external debt can have a significant and positive influence on growth. The negative sign of the debt squared policy interaction term, however, suggests that even with good policies, accumulating unmanageable levels of debt can have a significantly negative impact on growth.

One can also estimate the marginal impact of debt on growth by partially differentiating[2] equation (1) to arrive at the expression:

[2] In other words, we have controlled for the effect of all the other growth determinants.

$$\varepsilon_g = \beta_1 + \delta_1 policy + 2\delta_2 policy \times debt, \quad (3)$$

where ε_g represents the partial derivative of the growth equation with respect to debt. Using the sample mean for the policy index and the debt variable one can derive the point where a 1% increase in debt begins to have a negative impact on growth. This value was estimated at 63% for Caribbean countries.[3] The estimated growth-maximising debt threshold is higher than the 35-40% reported by Pattillo, Poirson and Ricci (2002), but is also significantly lower than the 97% reported for a sample of African countries by Elbadawi, Ndulu and Ndung'u (1997). The differences are not surprising given the fact that our results only reflect conditions in the Caribbean but more importantly, the model employed in this study differs from those employed in both studies listed above. Moreover, our estimated value of 60-63% generally accords with recent macroeconomic experience in the Caribbean.

Table 3 reports some macroeconomic and debt indicators of the countries that form the Caribbean Common Market over the period 1990 to 2003. The average debt-GDP ratio for the group as a whole declined gradually from about 79% in 1990 to approximately 41% in 2000. The steady decline was heavily influenced by debt movements in Guyana, as that country benefited from debt write-downs in 1996 and in subsequent years. It is interesting to note, as reported in table 3 that the average real growth rates are generally higher for those years after 1995 when the debt-GDP ratios fell below 60-65% where, according to our results, increased external debt tends to have a deleterious impact on economic growth. For instance, over the subperiod 1991 to 1994, the average debt ratio was 75.7% and real growth averaged minus 2.4%. On the other hand, the average growth rate was a substantial 5.6% over the subperiod 1995 to 2000 when the debt ratio averaged only 47.4%.

While conceding the fact that other factors are at play, available evidence suggests that on average countries in the

[3] In an alternative scenario in which the policy index was formed from a combination of government consumption, inflation and import duties, the estimated turning point at which increased debt begins to inhibit growth was estimated to be 60%.

TABLE 3. SOME DEBT INDICATORS FOR CARICOM COUNTRIES, 1990-2000

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
CARICOM											
Disb. Debt as % of GDP	78.9	79.4	76.8	75.4	71.3	61.8	50.8	46.2	44.6	40.4	40.6
Debt Serv. as % of XGS[a]	21	19.4	21.1	20.2	17	14	13.3	13.3	12.8	11.1	9.1
Est. Ave. Growth (%)		-8.1	-2.8	-2.4	3.7	8.9	8.2	5.6	2.6	3.2	5.3
Antigua & Barbuda											
Disb. Debt as % of GDP	75.6	70.9	66.2	57.8	55.4	58	51	59.9	64.1	64.5	64.6
Debt Serv. as % of XGS[a]	3.9	2.2	2.1	1.8	2	3.6	2.3	2.3	2.9	2.9	5.7
Debt Serv. as % of CGCR[b]	15.7	9.6	9.4	8.3	8.4	13.7	7.7	8.3	10.8	10.8	21.6
Guyana											
Disb. Debt as % of GDP	459.3	532.4	526.1	419	377.8	330.9	218	203.7	228.5	176.7	166.2
Debt Serv. as % of XGS[a]	112.1	67.2	61.9	49.6	59.8	51.4	46.1	55.3	64.3	34.6	36.3
Debt Serv. as % of CGCR[b]	135.2	105.8	142.2	171.7	166	210.3	249	237.3	202.3	202.8	228.4
Jamaica											
Disb. Debt as % of GDP	97.7	110.9	115.5	94.7	90.1	71.3	55.1	49.2	49.3	44.4	48.7
Debt Serv. as % of XGS[a]	28.5	27.3	27.1	22.6	17	16.7	16.6	14.7	17.9	17.3	10.7
Debt Serv. as % of CGCR[b]	65.3	114.9	70.8	62.3	45.4	44.4	33.1	30	33.1	31.3	22.3

SOURCE : CARICOM Secretariat (2002) External Public Debt of CARICOM Countries
[a] Exports of goods and services. [b] Central government current revenue.

group have also been operating in much better policy environment over the latter subperiod. For instance, Guyana, the most debt-stressed of the countries in the group has had to adopt tough macroeconomic measures since 1996 to qualify for the highly indebted poor countries (HIPC) debt write downs. Similarly, Jamaica and a few other Caribbean countries have undergone a series of structural adjustment programmes in the 1990s. Inflation has generally been on a declining path, with Jamaica posting an average inflation rate of 9.2% in the five years to 2000, compared to 41.2% between 1990 and 1994. Over the same comparative period, Guyana's average inflation rates were 5.9% and 20.6%, respectively.

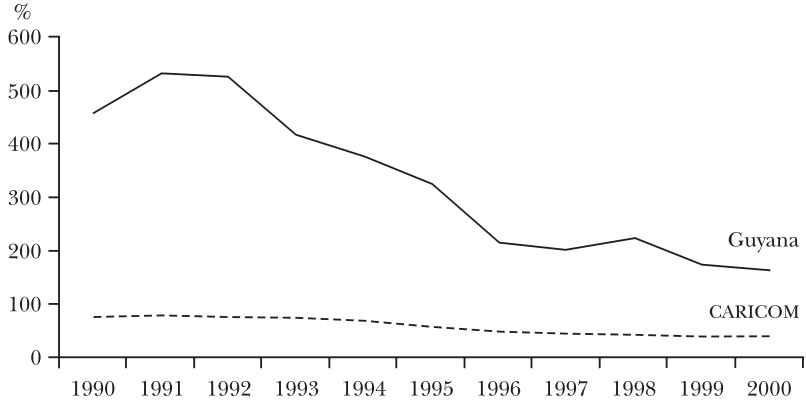
There has also been some measure of discipline in public finances, particularly in Guyana. Government current expenditure ratio in Guyana, which averaged about 35% in the six years to 1988 (when the external debt was growing rapidly), slowed to an average 29.7% between 1990 and 1994, and 24.9% in the five year period to 2000.

5. POLICY OPTIONS FOR CARIBBEAN COUNTRIES

It is appropriate to discuss any policy options available to the Caribbean countries from the viewpoint of the factors that led to the debt build up. We use the background data from Guyana and Jamaica, the two countries considered the most debt-stressed in the Caribbean over the period of the analysis. We start from the premise that the existing debt stock in a country largely reflects the accumulated past fiscal imbalances while current debt service obligations have a direct impact on the current fiscal imbalances. So, in essence, there is an interlocking relationship between debt and fiscal imbalances. We would use the examples of Guyana and Jamaica, two of the most debt-stressed countries in the Caribbean, to elucidate this point of view.

Figures 2 and 3 represent the external debt profiles of Guyana and Jamaica, respectively compared to CARICOM average over the period 1990 to 2000. Guyana as the most debt-stressed among the CARICOM member countries, is the only country in the Caribbean participating in the Highly Indebted

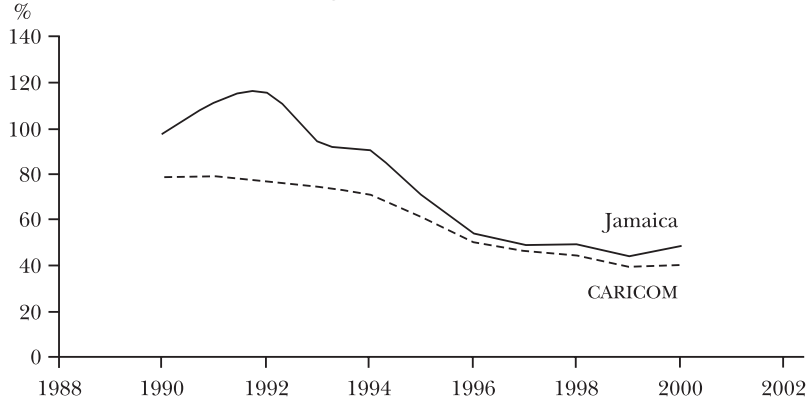
FIGURE 2. EXTERNAL DEBT IN GUYANA VS. CARICOM (% OF GDP), 1990-2000



Poor Country (HIPC) Initiative. While Guyana's external debt to GDP ratio peaked at 532% in 1991, the proximate cause of the rapid debt build-up could be traced to unsustainable economic policies in the late 1980s. In the ten years to 1990, the Guyanese economy was in recession, as real GDP declined at an estimated average rate of 3.6% per annum.

Faced with a deteriorating balance of payments position, the Government embarked upon expansionary fiscal policies, largely financed with foreign borrowings. The fiscal deficit to GDP ratio averaged 35.3%. A greater part of the borrowed foreign resources went into consumption activities, as government current expenditure averaged a significant 35% of GDP. Indeed, over the 6 year period to 1988 when the external debt grew the fastest (12% per annum) the fiscal deficit to GDP

FIGURE 3. EXTERNAL DEBT IN JAMAICA VS. CARICOM (% OF GDP), 1988-2002



ratio averaged a significant 45.4%. From 1987 to 1990 when the significant debt overhang made it difficult to access further foreign loans, the country resorted to financing its fiscal deficit through rapid money creation, fuelling inflation rates, which averaged 62.2% per annum in the 5 years to 1991.

Like Guyana, Jamaica's sustained a rapid build-up of external debt in the early to mid-1980s. In the five years to 1988, the external debt to GDP ratio averaged 119.1%, peaking at 134% in 1985. Although not as robust as in Guyana, fiscal excesses played a major part in Jamaica's debt evolution. Between 1982 to1986, the average fiscal deficit was 7.8%. While this ratio may not be considered as excessive as was with the case in Guyana, a significant 74% of the deficit was foreign financed, as a result of significant balance of payment support loans.

From 1992, the external debt to GDP ratio declined gradually, reaching a low 46.3% in 1999. Significant revenues from bauxite levy boosted traditional revenue sources, enabling the country to maintain fiscal surpluses averaging 2.7% of GDP from 1989 to 1995. However, the external situation remained weak mainly because of heavy debt servicing obligations. Indeed, significant fiscal weaknesses from 1996 to 2000 did exacerbate the build-up of external debt in the period up to 2004. There are a number of policy implications that could be deduced from the preceding analysis.

One key factor that would help to minimise unsustainable debt build-up is to reduce fiscal excesses to the minimum. Countries should endeavour to adopt counter-cyclical fiscal policies, running fiscal surpluses in periods of economic expansion to allow for moderate expansionary policies when the country is in recession.

Borrowed funds should as far as possible be used for growth-enhancing investment rather than for consumption purposes, if debt servicing difficulties are to be avoided.

Shifting the financing of persistent fiscal deficits to domestic sources when external sources of finance dry up could create further problems. For instance, increasing domestic debt financed by rapid money creation could stoke inflationary pressures and stifle growth while persistent borrowing from the domestic banking system could raise real interest

rates and subdue private sector activity by crowding out credit to the private sector.

Careful attention needs to be paid to the countries' total debt profile, while ensuring that the external debt to GDP ratio stays within sustainable (i.e. 60% to 65%) limits. This would require that a good debt recording and monitoring system be put in place as early as possible.

6. CONCLUSIONS

This paper has examined the relationship between external debt, economic policies and growth using data on twelve Caribbean countries over the period 1970 to 2000. The empirical results suggest that in the initial stages as countries seek to complement *t* domestic savings with foreign savings, external debt could have a positive impact on growth in a *good* policy environment. However, after a certain threshold, persistent high levels of debt can have a negative drag on growth, even in a *good* policy environment. The results of this study for the group of Caribbean countries under review suggest that persistent debt to GDP ratios above 63% would tend to have a negative influence on growth.

Policy makers in the region have long recognised the importance of maintaining prudent debt ratios. However, what level one considers *low* was never fully established. This paper provides such a benchmark, which most Caribbean countries must try to maintain. However, the estimated benchmark is derived under the assumption of a *good* policy environment of low inflation, manageable fiscal positions and open trade policies. Since not all countries in the region are necessarily able to maintain such a good policy mix, the 63% debt ratio should indeed be considered an upper limit.

For those countries already debt stressed, the economic policies such as have been outlined in the previous sections, are necessary but may not be sufficient to attain long-term debt sustainability. They must be combined with structural policies geared towards sustained economic expansion and economic diversification. As these countries endeavour to put such structural policies in place, new inflows of capital

may be needed for investment and for servicing their foreign debt. Any foreign debt contracted must be with sufficient grant element to make interest payments manageable and ought to be of such favourable maturity as to allow for ample time for the proceeds, invested in growth promoting projects, to start generating returns.

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Pablo Pincheira
Roberto Álvarez

Evaluation of short run inflation forecasts and forecasters in Chile

1. INTRODUCTION

Central banks conduct monetary policy based upon multiple pieces of information that enable them to envisage scenarios about the possible evolution of the economy. Some of these pieces of information are in the form of sets of inflation forecasts at several horizons. It is reasonable to think that a successful monetary policy depends at least in part on the quality

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of these inflation forecasts. On the basis of this reflection, in this paper we evaluate one of the many series of short-term inflation forecasts built by the Central Bank of Chile, which we will call Auxiliary Inflation Forecasts (AIFs). This corresponds to six series of forecasts over horizons going from one to six-months-ahead.

We focus on comparisons of predictive accuracy using quadratic loss, but we are also interested in testing for bias, weak efficiency and encompassing.

When comparing predictive accuracy, the timeline in the construction of forecasts may play an important role. We expect a forecast built on more information to be at least as accurate as a forecast built on less information: if the new information revealed is useless, then forecasts should be equally accurate; otherwise, the forecast using more information should be more accurate. Because the benchmarks we use to compare the AIFs are built at different moments in time, and since we are not sure if useful information was revealed during the construction of forecasts, we do not expect the AIFs to beat all the benchmarks. We rather expect a performance coherent with the timeline in the construction of forecasts: the AIFs should be at least as good as forecasts built on less information, but also forecasts built on more information should be at least as good as the AIFs.

To motivate our discussion, Figures 1 and 2 show the evolution of forecast errors, defined as the difference between effective inflation and predicted inflation. Figure 1 shows the one-month-ahead prediction error of the AIFs and other analysts. As expected, there are substantial differences between the forecasts and actual inflation.[1]

This simple evidence reveals that the magnitude of one-month-ahead prediction errors has changed over time and can reach economically significant values with occasional peaks of 70 basis points.[2]

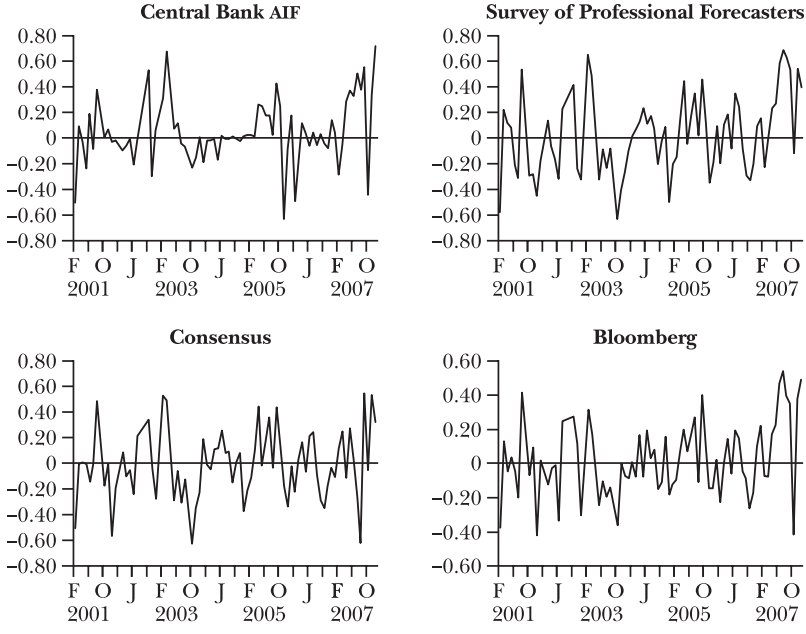
Figure 2 shows six-months-ahead prediction errors made

[1] The evidence is similar no matter if the median or mean forecast is taken when information comes from several analysts, as in the cases of the Survey of Professional Forecasters and Bloomberg.

[2] This means that if the predicted year-on-year inflation were 3.0%, effective inflation would reach about 3.7%.

by the AIFs and Consensus Forecasts. Three aspects are worthy of mention. First, forecasting errors in the last months of the sample period are the largest for both the AIFs and Consensus Forecasts. Secondly, both series of errors display a similar behaviour including a downward bias. Thirdly, AIFs errors have been somewhat larger than those of Consensus Forecasts in the last months of the sample.

FIGURE 1. ONE-MONTH-AHEAD FORECAST ERRORS, 2001-2007

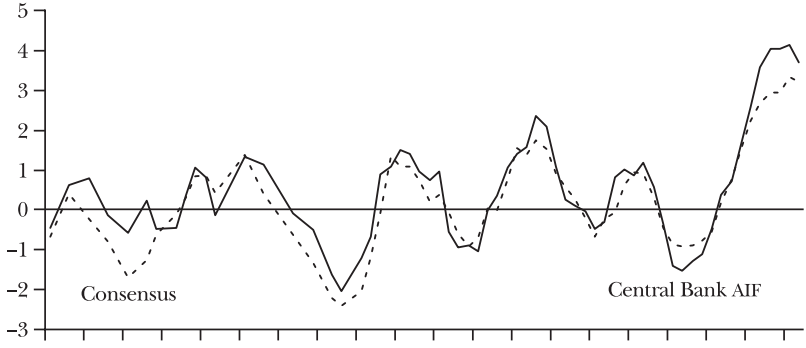


Based on this evidence, we ask three empirical questions: *i)* Is the accuracy of the AIFs consistent with the timeline in the construction of the forecasts? *ii)* Are the AIFs unbiased and weakly efficient? *iii)* Could the AIF benefit from private analysts' forecasts?

To answer these questions, we first compare the AIFs with alternative forecasts from private analysts and simple time series models. Secondly, we test for weak efficiency and no bias in the AIFs. Thirdly, we make an encompassing analysis to detect whether the AIFs could benefit from other analysts' forecasts.

We would also like to point out an interesting additional

FIGURE 2. SIX-MONTHS-AHEAD FORECAST ERRORS, 2001-2007



finding. Unlike the evidence of a vast amount of articles dealing with combination of forecasts, the simple average of a set of forecasts from the Central Bank of Chile's Survey of Professional Forecasters (SPF) behaves quite discreetly compared to individual forecasts. This result is valuable because it provides evidence in conflict with to the so-called *combination puzzle* (see Stock and Watson, 2004; Smith and Wallis, 2008).

Our paper is structured as follows: the next section presents a review of the literature; section 3 describes the data; section 4 presents the methodology; in section 5 we evaluate the relative performance of the AIFs comparing them with private analysts' forecasts and those derived from simple time series models; in section 6 we test for bias and weak efficiency; section 7 shows the encompassing analysis; and, finally, we present our conclusions and a brief summary of the article in section 8.

2. LITERATURE REVIEW

Some of the questions raised in the introduction have already been asked for a number of countries in the literature on predictive ability. Nevertheless, none of these articles seem to care about the timeline in the construction of competing forecasts.

Most of these papers simply consider some measure of prediction error (e.g., mean square prediction error or absolute prediction error) to compare the accuracy of two or more forecasts. Some of these articles also carry out forecast

efficiency tests along the lines described by Elliot and Timmermann (2008).

Groen et al. (2009), for instance, show that the Bank of England's inflation forecasts outperform a variety of time series benchmarks, whereas GDP growth rates forecasts are generally less accurate than traditional univariate benchmarks.

Another article evaluating forecasts by a central bank is due to Andersson et al. (2007). In this paper, the authors evaluate the relative performance of the Central Bank of Sweden's inflation forecasts. In general, they find that the Swedish Central Bank's forecasts are more accurate than forecasts provided by the National Institute of Economic Research, but the difference is not statistically significant. Moreover, their results suggest that the Swedish Central Bank performs quite well compared to Consensus Forecasts.

Another interesting paper for several economies by Oller and Barot (2000) compares growth and inflation forecasts from the OECD and research institutes for 13 countries. Their findings show that there are no significant differences between the prediction errors of these two sources of forecasts.

In another article, Loungani (2001) evaluates GDP growth prediction errors from Consensus Forecasts in several developed and developing countries. She finds some evidence of inefficiency and overestimation and shows a high correlation between the forecasts of international institutions (i.e., World Bank, IMF and OECD).

More recently, Bowles et al. (2007) evaluate the European Central Bank Survey of Professional Forecasters' predictions over eight years. One of their conclusions is that the respondents systematically underestimate inflation throughout the evaluation period.[3]

Some research has also been carried out in Chile. In particular, the recent work of Bentancor and Pincheira (2008) shows that inflation forecasts from the Central Bank of Chile's Survey of Professional Forecasters (SPF) display a significant

[3] On similar lines, Ang et al. (2007) in an out-of-sample exercise evaluate four traditional methods of predicting inflation in the United States and conclude that survey-based measures achieve the best results. Croushore's (1998) analysis of various US inflation forecasting sources also finds that the prediction errors have tended to diminish over time.

downward bias and excess of autocorrelation in the second half of their sample period. By correcting this autocorrelation in an out-of-sample exercise, the authors achieve significant reduction in mean square prediction error (MSPE) and bias.

Also for Chile, Chumacero (2001) analyses private forecasters' estimates of GDP growth rates during the period 1986-1998. His results show that forecasters systematically underestimate the true growth rate of the economy.

This brief and selective review of the literature shows two interesting facts: most public and private forecasts display some degree of inefficiency. This is true for forecasts of several macroeconomic variables in developed and developing economies. Secondly, none of these articles seem to care about the timeline in the construction of competing forecasts. In the following sections we will see how our results fit in with the existing literature.

3. DATA

We use monthly data for the period from January 2001 to December 2007. We consider one to six-months-ahead forecasts. This period is chosen due to series availability: on the one hand, construction of the AIFs started in January 2001, on the other hand, information only up to December 2007 was provided for this research.

We consider four different sources of forecasts: The first is the SPF carried out periodically by the Central Bank of Chile. Each individual analyst's inflation forecast is recorded at the beginning of the month for which forecasts are made. This survey considers one- and three-months-ahead forecasts. Our second data source is Consensus Forecast, which conducts a mid-month survey, implying that forecasts for the current month are half-step-ahead forecasts. Consensus only delivers the average forecasts across all respondents for horizons going from one to six months.

A third data base is built from Bloomberg's periodic surveys. Most of these forecasts are published just a few days before the actual inflation rate is released. Although this horizon is much shorter than one month, we treat them as if they

were one-month-ahead forecasts. In this case we do have information from each analyst.

The fourth data source is built from the automatic selection of an autoregressive moving average model (ARMA(p,q)) estimated period by period using rolling windows of 30 observations.

The forecasts database has some missing observations. This is partly because some private analysts rarely provide forecasts for every single month during the sample period. We do not deal with missing observations in a formal statistical way but we do attempt to mitigate it by ensuring that we compare the AIFs with private forecasts with at least 50% of the AIFs available observations, and by restricting our data to only include observations corresponding to dates on which neither the AIFs nor private forecasts display missing values.[4] For example, to evaluate the mean square prediction error, if the AIFs include forecasts for January, February and March 2005, but a given private analyst reports forecasts only for January and March 2005, we calculate the AIF mean square prediction error omitting the data for February 2005.[5] In this way, we avoid a potential bias associated with the possibility of strategic omission when the inflation scenario looks uncertain.

4. METHODOLOGY

As we mentioned in the introduction, the purpose of this paper is to evaluate in multiple dimensions the accuracy and quality of the AIFs. To do so, we first compare the AIFs with alternative forecasts from private analysts and simple time series models. Secondly, we evaluate the AIFs by implementing two different tests: a no bias test and a weak efficiency test. Thirdly, we make an encompassing analysis to detect whether the AIFs could benefit from other analysts' forecasts. The following three subsections describe these stages in detail. An

[4] This is to avoid making comparisons with only a few observations which therefore might not adequately represent the relative behaviour of the two series of forecasts.

[5] The AIFs can therefore present different moments when they are compared to different analysts' predictions.

additional fourth subsection explains the way in which we treat the heterogeneity of the information sets used to construct each forecast.

4.1. Comparison with private forecasters and simple time-series methods

Here we compare the AIFs to different benchmarks using Mean Square Prediction Error (MSPE) as a measure of predictive accuracy.[6] The MSPE is defined as follows:

$$MSPE(e) = E(e^2)$$

where e denotes the prediction error, defined as the actual value minus the predicted value. We evaluate predictive ability using year-on-year inflation π_t approximated as follows:

$$\pi_t = \ln(CPI_t) - \ln(CPI_{t-12})$$

where CPI_t stands for the Consumer Price Index level at time t. Unless otherwise stated, the MSPE comparative graphs display the ratio of a benchmark MSPE over the AIFs' MSPE. Thus a ratio lower than 1 indicates that the AIFs have been outperformed. Conversely, a ratio higher than 1 indicates the the AIFs have performed better than the corresponding benchmark.

We follow the evaluation framework proposed by Giacomini and White (2006) to evaluate if differences in MSPE are systematic or random. Although in practice and under specific operational assumptions this paradigm can be reduced to that proposed by Diebold and Mariano (1995) and West (1996), there are relevant conceptual differences. In fact, the tests proposed by Giacomini and White (2006) aim to evaluate a forecasting method and not a forecasting model. This distinction, albeit subtle, is relevant to our work because we use survey-based inflation forecasts that are not necessarily associated with specific models.

[6] Although most of the literature uses error measures drawn from statistics, McCulloch and Rossi (1990), Leitch and Tanner (1991) and West et al. (1993) use economic-based measures. This is the case of evaluations where the loss functions are associated with economic criteria such as profits or measures of welfare. This kind of evaluation goes beyond the scope of this paper.

We use a version of the Giacomini and White (2006) tests originally attributed to Diebold and Mariano (1995) and West (1996) with the following consideration: no correction is made for parametre uncertainty since we want to evaluate not a model with population parametres but a forecasting method. The following statistic is built:

$$t_{n(h)} = n(h)\frac{\Delta\overline{L_{n(h)}}}{\sigma_{n(h)} / \sqrt{n(h)}}$$

with

$$\Delta\overline{L_{n(h)}} = \frac{1}{n(h)}\sum_{t=1}^{n(h)}\Delta L_t$$

in which h represents the forecast horizon, $n(h)$ represents the number of forecasts for the corresponding horizon, ΔL denotes the loss differential between the AIFs and one specific benchmark and $\sigma_{n(h)}$ is an estimator of the asymptotic standard deviation of the statistic numerator weighted by the square root of $n(h)$. For all practical effects, we proceed using HAC estimation according to Newey and West (1987) with automatic lag selection according to Newey and West (1994).

Under the null hypothesis of equal predictive ability and assumptions described in Giacomini and White (2006), the $t_{n(h)}$ statistic is asymptotically normal.

To complement our analysis, we also compare the AIFs with forecasts from simple time-series models. Following a preliminary evaluation process, we use an ARMA(p,q) model estimated with rolling windows of 30 observations and automatic parametre selection according to Akaike's criteria. The estimation is carried out imposing the constraint that long-term inflation exactly matches the Central Bank of Chile's inflation target (3%). In preliminary exercises, this constraint rendered the lowest out-of-sample MSPE at most of the horizons considered.

4.2. Bias and weak efficiency

We also evaluate two properties associated with an optimal prediction error: zero bias and weak efficiency. While

the evaluation of a zero bias is easily accommodated into Giacomini and White's (2006) framework, measuring it simply as the expected value of prediction errors, the efficiency test we use was originally introduced by Mincer and Zarnowitz (1969) and it is based on a simple regression between the prediction error and the predictor itself. The null hypothesis is that the predictor has no statistically significant coefficient associated to it. If the null hypothesis is rejected, we conclude that the prediction has not been efficient in the sense of using all the available information.

4.3. Encompassing

We also evaluate whether private forecasters' predictions can contribute to improve the AIFs. This is usually done using forecast encompassing tests. Granger and Ramanathan (1984) suggest an encompassing test by regressing a forecast's errors over a constant term and an alternative forecast. If this alternative forecast is able to explain the original forecast errors, then this initial forecasting method does not encompass the alternative method.

4.4. Dealing with different information sets

Discussions with analysts reveal that their forecasts are often revised in the light of news on key variables such as oil prices and exchange rates. This would imply that prediction errors should tend to be lower when forecasts are made further into the month, when forecasters have more relevant information at their disposal.

The timeline of the construction of forecasts indicates that ARMA predictions are built using the smallest information set since they are only based on past effective inflation. On the other hand, the SPF forecasts are usually built during the first week of the month so they could potentially use more information than ARMA predictions. At the time when the AIFs are finally revised, the SPF information is already known so the AIFs potentially count on more information than the SPF. Later, the mid-month Consensus Forecasts survey is released and finally, towards the end of the month, the results of Bloomberg's survey are published. Consequently, if there

were no significant differences in the analysts' ability to predict, we could naturally expect that:

1. On average, Bloomberg's predictions would be at least as accurate as all the others.
2. Consensus Forecasts' predictions would be at least as accurate as those of the SPF, the AIFs and the ARMA models.
3. The AIFs would be at least as accurate as those of the SPF and the ARMA models.
4. The SPF's predictions would be at least as accurate as those from ARMA models, and
5. ARMA forecasts would be the weakest of them all.

Any deviation from this pattern will indicate that one forecaster has higher predictive ability than its competitors.

Accordingly, for instance, the AIFs should not be outperformed by the SPF forecasts in terms of MSPE. Consequently, the finding of superior accuracy of the AIFs over the forecasts from the SPF cannot be considered as evidence of better predictive ability of the forecasters in charge of the AIFs, because they probably build their forecasts on more information.

From now on we will refer to this expected order of predictive accuracy as hypothesis 1 (H1). This hypothesis is summarised as follows:

$$H1: Bloomberg >> Consensus >> AIF >> SPF >> ARMA$$

in which the double inequality operator should be read from left to right as "at least as accurate as." In the following section we look for statistically significant deviations from H1.

5. COMPARISON WITH PRIVATE ANALYSTS AND SIMPLE TIME SERIES MODELS

In this section we compare the AIFs with private analysts' forecasts. In the first subsection we rank the AIFs' predictive accuracy according to their out-of-sample MSPE. In the second subsection we use inference to detect statistically significant differences in the out-of-sample MSPE of different forecasts. We also check in this subsection whether the AIFs and the

different benchmarks satisfy our hypothesis H1. In the third subsection we briefly discuss some intriguing results regarding the simple average of forecasts from the survey of professional forecasters.

5.1. Predictive accuracy

Table 1 shows the relative rank of the AIFs among all the benchmarks. A number 1 means that the AIFs display the lowest out-of-sample MSPE for a given predictive horizon and benchmark.[7]

TABLE 1. DESCRIPTIVE ANALYSIS OF PREDICTIVE EVALUATION

Horizon	*ARMA*	*SPF*	*Consensus*	*Bloomberg*
1 month	1	1	1	6
2 months	1	na	1	na
3 months	1	3	2	na
4 months	1	na	2	na
5 months	1	na	2	na
6 months	2	na	2	na
N	*2*	*37/36*	*2*	*7*

SOURCE: Authors' calculations.

NOTES: Each cell displays the rank of the Central Bank of Chile Auxiliary Inflation Forecasts (AIFs) in terms of MSPE compared to different forecasts at different horizons. N stands for the number of competing forecasts. For instance, N=2 when the AIF are compared to ARMA forecasts and N=7 when the AIF are compared to Consensus Forecasts. N= 37/36 means 37 forecasts were considered for one-month-ahead comparisons and 36 were considered for three-months-ahead comparisons. na stands for not available.

The second column in table 1 shows that the AIFs display lower MSPE than ARMA forecasts for predictions one- to five-months ahead. Nevertheless, six-months-ahead ARMA forecasts are more accurate than the AIFs.

Compared to the SPF, the AIFs rank first for predictions one-month-ahead, and third for predictions three-months-ahead.

Compared to Consensus Forecasts, the AIFs display lower MSPE at horizons of one and two months, but higher MSPE

[7] In the cases of the SPF and Bloomberg's surveys, we have considered the mean and the median of the forecasts as two more analysts.

(less accuracy than Consensus Forecasts) at longer horizons of three, four, five and six-months-ahead.

The comparison with Bloomberg's forecasts is not as benevolent as with the other competing forecasts. The AIFs come sixth out of seven in the one-month-ahead forecast, which is the only horizon surveyed by Bloomberg.

In summary, according to the evidence thus far, the AIFs behave in line with our hypothesis H1, with the following important exceptions:

1. For predictions one-month and two-months-ahead, the AIFs behave better than expected. This is because they are not only more accurate than forecasts built with less available information, but they are also more accurate than Consensus Forecasts and those from five analysts considered in the Bloomberg survey. This is an evident deviation from our H1 hypothesis, because Consensus Forecasts and those from the Bloomberg survey are built counting on information not available when the AIFs are constructed.

2. For predictions three-months-ahead, the AIFs forecast are outperformed by two SPF analysts. This is surprising given that the AIFs consider more information than that available at the time when the SPF is carried out. Similarly, for predictions six-months-ahead, we see that ARMA forecasts are more accurate than the AIFs. This is also a deviation from our H1 hypothesis, because ARMA forecasts are built on the smallest information set and therefore should not be more accurate than the AIFs.

In the following subsection we will see if these exceptions are statistically significant.

5.2. Statistical inference

Table 2 summarises the Giacomini and White's (2006) predictive ability tests comparing the accuracy of the AIFs to different benchmarks. This table indicates the number of statistically significant MSPE comparisons at the 10% significance level.

Interestingly, table 2 shows that all the results from table 1 that might conflict with H1 are not statistically significant: The

TABLE 2. STATISTICAL INFERENCE

Predictive horizon						
1	*2*	*3*	*4*	*5*	*6*	
Restricted ARMA						
1/1	1/1	0/1	0/1	0/1	0/1	[AIF is more accurate]
0/1	0/1	0/1	0/1	0/1	0/1	[AIF is less acurate]
Survey of professional forecasters						
30/36	-	21/35	-	-	-	[AIF is more accurate]
0/36	-	0/35	-	-	-	[AIF is less acurate]
Consensus forecasters						
0/1	0/1	0/1	0/1	0/1	0/1	[AIF is more accurate]
0/1	0/1	0/1	0/1	0/1	1/1	[AIF is less acurate]
Bloomberg						
0/6	-	-	-	-	-	[AIF is more accurate]
2/6	-	-	-	-	-	[AIF is less acurate]

SOURCE: Authors' calculations.

NOTES: Each cell displays findings of statistically significant differences in MSPE between the Central Bank of Chile Auxiliary Inflation Forecasts (AIFs) and different sources of forecasts. For instance, the expression 1/1 in the upper row on each panel means that the AIC is more accurate than the respective competing forecast at the 10% significant level. The same expression 1/1 located in the lower row in the same panel means that the AIC is less accurate than the respective competing forecast at the 10% significant level. Displayed results are evaluated at the 10% significance level.

lower MSPE of the ARMA forecasts at predictions six-months-ahead is not statistically different from the AIFs' MSPE. The same occurs with the two forecasters from the SPF that beat the AIFs for predictions three-months-ahead: the lower MSPE of their forecasts is not statistically different from the MSPE of the AIFs. Similarly, the AIFs no longer beat any forecaster surveyed by Bloomberg or Consensus Forecast at predictions one and two-months-ahead. In other words, results from table 2 are fully consistent with our H1 hypothesis.

To summarise, our results indicate that the relative performance of the AIFs is generally within expectations. Not statistically significant exceptions may suggest that the AIFs appear to perform better than expected at horizons of up to two months and a little worse than expected at longer horizons, but table 2 shows that these exceptions are not statistically significant.

5.3. Combination of forecasts from the SPF

Another interesting point to note is that the two series of forecasts from the SPF that display lower MSPE than the AIFs for predictions three-months-ahead, come from individual analysts. That is, they do not correspond to either the mean or the median of the analysts. In fact, if we look at figures A.1 and A.2 in the Annex, we see that the simple average and the median forecasts fare only moderately well in the predictive accuracy ranking.

Figure A.1 shows the ratio between the MSPE of each one-month-ahead series of forecasts of the SPF and the MSPE of the AIFs. Figure A.2 is similar but using three-months-ahead forecasts. These figures show that the simple average of the individual forecasts behaves very much the same as the median, and that both statistics show moderate performance in terms of predictive accuracy. For one-month-ahead predictions, the mean and the median rank 10^{th} and 9^{th} among all the SPF respondents. At predictions three-months-ahead, they do worse: 13^{th} and 14^{th}, respectively.

This result is remarkable because the relevant literature indicates that predictive accuracy may be improved by an adequate combination of forecasts and that the combined forecast can be more accurate that the best individual forecast. Additionally, this literature sets forth the so-called *combination puzzle* which claims that simple combination methods in general behave better than optimal or more complex methods. If this were really so, then the empirical evidence presented here would indicate either that the average is not an adequate way of combining or that no combination can outperform the best individual prediction. Both of these assertions are in contradiction with the traditional forecasting combination literature.

6. BIAS AND EFFICIENCY

6.1. Bias

Forecasts are unbiased if the expected prediction error is equal to zero. This is a property that in theory should satisfy

optimal prediction errors under quadratic loss. In this article we will say that a forecast is biased if the hypothesis Ho: $\alpha = 0$ is rejected in the following regression:

$$(Y_t - Y_t^f) = \alpha + \varepsilon_t$$

in which Y_t denotes the series to be forecast, Y_t^f corresponds to the forecast of Y_t and ε_t represents a random shock. Results of the bias analysis are shown in table 3. In general, we see that we cannot reject the hypothesis of no bias for the great majority of benchmarks under analysis, although the statistics' signs indicate that all of them tend to under-predict inflation.

TABLE 3. FORECAST BIAS

	1	*2*	*3*	*4*	*5*	*6*
Panel A. BIAS						
Central Bank of Chile AIF	0.04	0.07	0.20	0.36[a]	0.47[a]	0.52[a]
Restricted ARMA	0.16	0.21	0.27	0.28	0.30	0.30
Survey of professional forecasters	0.03	-	0.10	-	-	-
Consensus forecast	0.00	0.05	0.10	0.15	0.18	0.20
Bloomberg	0.02	-	-	-	-	-
Panel B. Number of unbiased forecasters						
Survey of professional forecasters	33/36	-	34/35	-	-	-
Bloomberg	6/6	-	-	-	-	-

SOURCE: Authors' calculations.

NOTE: Results displayed in panel A for the Survey of Professional Forecasters and the survey carried out by Bloomberg are calculated for the median forecaster.

[a] Rejection at 10%.

In the particular case of the AIFs, the no bias hypothesis is rejected for four, five and six-months-ahead forecasts. We also notice a growing tendency to under-predict inflation as the horizon lengthens, reaching over 50 basis points when forecasting six months ahead.

It is outstanding that none of the six forecasts from Bloomberg is statistically biased. We also note that only three forecasts one-month-ahead and one forecast three-months-ahead from the SPF display a positive and statistically significant bias.

6.2. Efficiency

Efficient data processing requires that prediction errors have no correlation with past available information. This property is also a distinctive feature of optimal prediction errors under quadratic loss. Following Mincer and Zarnowitz (1969), here we use a weak efficiency concept that restricts the available information set to a constant term and the series of forecasts. We estimate the following regression:

$$(Y_t - Y_t^f) = \beta_1 + \beta_2 Y_t^f + \nu_t$$

where Y_t denotes actual inflation, Y_t^f represents a series of forecasts and ν_t is a random shock. Prediction errors, and hence the series of forecasts, are considered efficient if the null hypothesis $\beta_2 = 0$ cannot be rejected.

Table 4 shows that, in general, the null hypothesis of weak efficiency cannot be rejected. The only exceptions are one of the six Bloomberg forecasts, a few SPF forecasts, ARMA forecasts five and six-months-ahead and the AIFs six-months-ahead.[8]

TABLE 4. FORECAST EFFICIENCY

	1	*2*	*3*	*4*	*5*	*6*
Panel A. Weak efficiency						
Central Bank of Chile AIF	0.03	0.03	–0.02	–0.10	–0.23	–0.39[a]
Restricted ARMA	0.05	0.16	0.24	–0.10	–0.59[b]	–0.94[c]
Survey of professional forecasters	0.03	-	–0.04	-	-	-
Consensus forecast	0.01	0.02	–0.04	–0.07	–0.12	–0.20
Bloomberg	0.03	-	-	-	-	-
Panel B. Rate of weakly efficient forecasters						
Survey of professional forecasters	32/36	-	26/35	-	-	-
Bloomberg	5/6	-	-	-	-	-

SOURCE: Authors' calculations.

NOTE: Results displayed in panel A for the Survey of Professional Forecasters and the survey carried out by Bloomberg are calculated for the median forecaster.

[a] Rejection at 10%. [b] Rejection at 5%. [c] Rejection at 1%.

[8] We use a rolling window estimate of 30 observations to obtain ARMA forecasts, which considerably reduces the number of observations available for inference. This means that bias and efficiency results for ARMA forecasts are not directly comparable with the results obtained for the rest of the methods.

7. ENCOMPASSING

Forecast A is said to encompass forecast B if the information in B is not useful to explain the prediction error of forecast A. To test whether forecast A encompasses forecast B, we run the following regression:

$$(Y_t - Y_t^A) = \lambda_1 + \lambda_2 Y_t^B + u_t$$

where Y_t denotes actual inflation, Y_t^A corresponds to forecaster A's prediction, Y_t^B corresponds to forecaster B's prediction and u_t represents a random shock. We conclude that A encompasses B if H_0: $\lambda_2 = 0$ cannot be rejected.

TABLE 5. ENCOMPASSING ANALYSIS

	1	*2*	*3*	*4*	*5*	*6*
Panel A. Encompassing tests						
Restricted ARMA	0.03	0.03	–0.04	–0.17	–0.31	–0.39
Survey of professional forecasters	0.04[a]	-	0.00	-	-	-
Panel B. Rate of encompassed forecasters						
Survey of professional forecasters	24/36	-	33/35	-	-	-

SOURCE: Authors' calculations.

NOTES: Results displayed in panel A for the Survey of Professional Forecasters are calculated for the median forecaster. Panel B summarises results of the encompassing tests at the 10% significance level.

[a] Rejection at 10%.

We test whether the AIFs encompass the forecasts available at the time when the AIFs are made. In other words, we test whether the AIFs could benefit from the information available in other forecasts. The evidence in table 5 shows that the AIFs encompass the median of the SPF only for predictions three-months-ahead. Furthermore, the AIFs encompass an important number of individual forecasts of that survey when one-month-ahead forecasts are considered. For predictions three-months-ahead, the AIFs encompass most of the individual forecasts of the survey. Nevertheless, this analysis also reveals that there is information contained in a few SPF forecasts that could be useful for reducing AIF prediction errors.

8. SUMMARY AND CONCLUSIONS

In this article we evaluate the Central Bank of Chile's Auxiliary Inflation Forecasts (AIFs), comparing them with forecasts from simple time series models and forecasts from three additional sources: the Survey of Professional Forecasters, Consensus Forecasts, and Bloomberg. We also carry out encompassing tests and evaluate properties of bias and weak efficiency.

We pay special attention to the timeline in the construction of forecasts when evaluating predictive accuracy. We expect forecasts made with more information to be more accurate than forecasts based on less information. Our results indicate that the AIFs perform as expected given the information available at the moment they are made, although some not statistically significant exceptions are detected.

We also find that at short horizons the AIFs survive both tests of bias and weak efficiency. Nevertheless, at longer horizons the AIFs show a growing tendency to under-predict inflation and the null hypothesis of weak efficiency is rejected.

Interestingly, the encompassing test suggests that the AIFs could benefit from the information contained in a few forecasts from the Survey of Professional Forecasters.

Finally, we would like to point out an interesting collateral finding. Contrary to what is shown in much of the forecast combination literature, the simple mean of the set of forecasts coming from the Central Bank of Chile's Survey of Professional Forecasters has a quite moderate performance compared to the individual forecasts. This result is valuable because it reveals concrete empirical evidence against the so-called *combination puzzle*.

Annex

FIGURE A.1. MSPE RATIO BETWEEN SPF AND AIF (SPF/AIF)

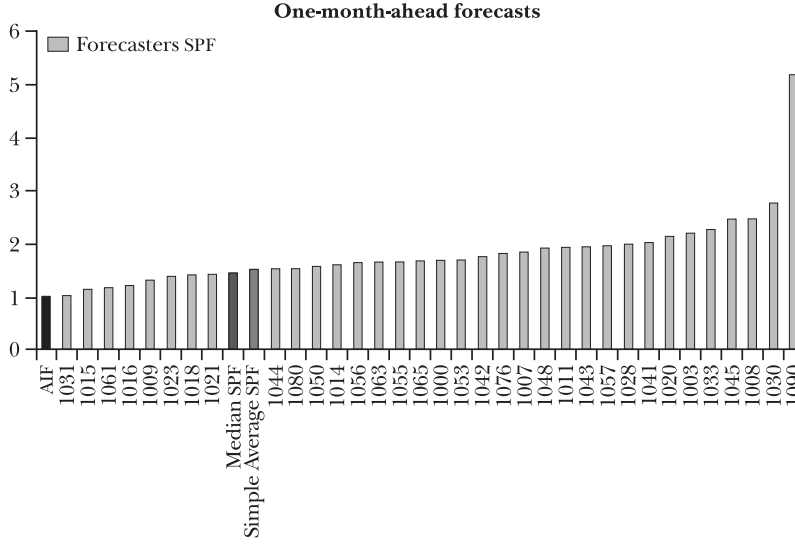
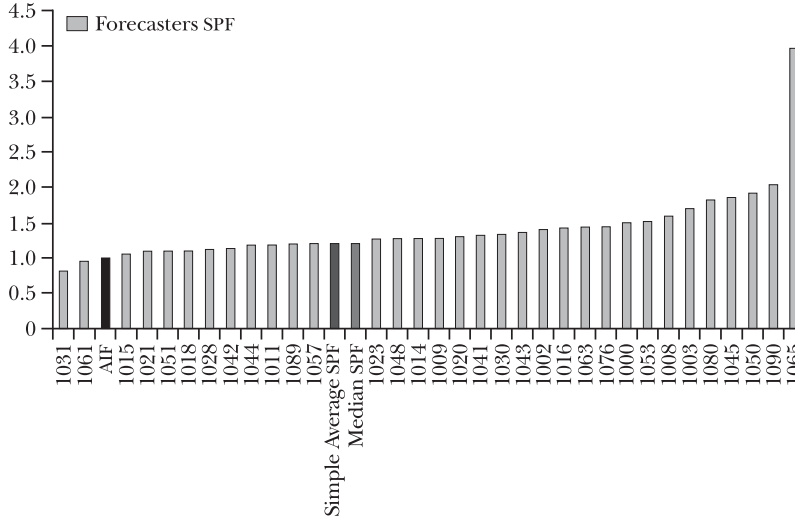


FIGURE A.2. MSPE RATIO BETWEEN SPF AND AIF (SPF/AIF)



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Trevor Campbell

Workers remittances and their impact on economic growth in Barbados

1. INTRODUCTION

Workers' remittances are transfers of funds by workers residing and working abroad to their relatives living in their home countries. Indeed, remittances are an extremely popular topic in international finance literature on account of their volume and their potential to reduce poverty. Consequently, they have become an important source of income for many developing countries and may have substantial impacts on their economic growth and stability. It is argued that in developing countries, remittances may improve problems such as credit market failures, inequality in income and also in opportunities. Further, they may assist in supplying resources necessary for property acquisitions as well as in providing funds in areas such as health and education. On the contrary, there is a school of thought that it is possible that they may

Paper prepared by T. Campbell, Former Senior Economist, Central Bank of Barbados. (Any written correspondence should be addressed to Grazettes Terrace, St. Michael, Barbados, BB 12034, West Indies. Email: (tdacampbell@hotmail.com).)

lead to a reduction in labour market participation and, by extension, productivity, which is not recommended.

Migrants usually send money to their home countries through formal channels (such as money transfer operators and banks) and informal channels. However, while this is considered the accepted practice, language barriers and other related costs for the formal services may deter other remitters using this procedure and they tend to resort to informal means such as by placing money in letters and in suitcases, to name a few. It is not difficult therefore to conclude that for the most part, workers' remittances are underreported.

In Barbados, information on workers' remittances is captured by direct inquiry, that is, by data supplied by commercial banks and the Barbados Post Office [see Campbell (1995)]. These remittances are provided by Barbadians residing mainly in the USA, Canada and the UK. It was only during the last ten (10) years that some interest seemed to be expressed in workers remittances. Data recorded in the external current account of Barbados' balance of payments documents indicated that over the last five years, amounts remitted to Barbados from overseas had been surpassed only by earnings from that country's major foreign exchange earner, tourism, as well as merchandise exports. This placed workers remittances as the third largest category of foreign exchange receipts for that country. Such a category therefore cannot be underestimated. It is because of the above-mentioned important factors that a study of this nature was thought to be necessary.

The remainder of this paper will be set out as follows: section 2 will look at previous research on workers remittances and the extent to which they affected economic growth and this will be followed in section 3 with the trends in workers remittances as they relate to Barbados from 1976 to 2007. In section 4, an impulse response function will be determined to ascertain the impact of workers' remittances on economic growth in Barbados. This will involve mainly the choosing of independent variables, model specification, estimation procedures and specifying the type of methodology. Section 5 discusses the results of the study. A conclusion will then follow.

2. PREVIOUS RESEARCH ON THE IMPACT OF WORKERS REMITTANCES ON ECONOMIC GROWTH

When we examined previous work on workers' remittances and how these impacted on economic growth, the findings were quite interesting. Faini (2002) found that remittances overcame capital market imperfections and allowed migrant households to accumulate positive assets. Chami et al. (2005) argued that remittances could indirectly affect labour supply by encouraging some remittance-recipient households to work less. This could reduce labour participation and economic growth. He further added that remittance transfers took place under conditions of asymmetric information in which the remitter and recipient of the transfer were separated by long distances. This could lead to significant moral hazard problems where the latter was likely to be reluctant in participating in the labour market, limiting their job search and reducing labour effort.

The paper by Glytsos (2005) built a Keynesian type econometric model with a dynamic perspective and a sound theoretical basis for investigating the impact of remittances on consumption, investment, imports and output. It estimated short and long run multiplier effects of exogenous shocks of remittances with data from five (5) Mediterranean countries. The findings pointed to different inter-country priorities of remittance spending and to an asymmetric impact of remittance changes, in the sense that the good done to growth by rising remittances was not as great as the bad done by falling remittances.

Using a standard cross-country growth regression framework for one hundred and one (101) countries over an extended period 1970-2003, the International Monetary Fund, IMF (2005) found no statistical link between remittances and per capital output growth.

Ang (2007) focused on the impact of remittances on growth in the Philippines, one of the countries in the world with a long history of sending workers abroad. The Philippines rank as the third largest recipient of remittances in the world after India and Mexico. He found that at the national level, remittances gave rise to improvements in economic

growth. However, when he disaggregated his study to include the regional level in the hope that those findings might support the national results, there was an inverse relationship between remittances and economic growth. Ang concluded that remittances had to be translated into value-added activities and investment which were more foundational sources of development and growth.

Jongwanich (2007) examined the impact of workers' remittances on growth and poverty reduction in developing Asia-Pacific countries using panel data over the period 1993 to 2003. The results showed that while remittances did have a significant impact on poverty reduction through increasing income, smoothing consumption and easing capital constraints of the poor, they had only a marginal impact on growth, operating through domestic investment and human capital development.

The study by Fayissa and Nsiah (2008) explored the aggregate impact of remittances on economic growth within the conventional neoclassical growth framework using an unbalanced panel data spanning from 1980 to 2004 for thirty-seven African countries. They discovered that remittances boosted growth in countries where financial systems were less developed by providing an alternative way to finance investment and helping overcome liquidity constraints.

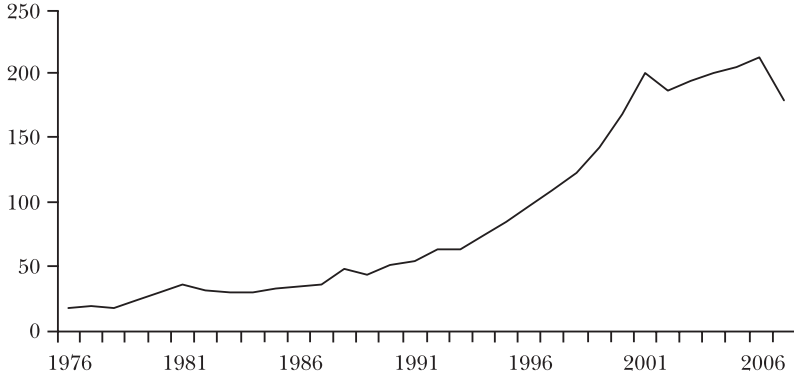
Karagoz (2009) set out to ascertain whether workers' remittances had any growth impact on the Turkish economy by using panel data from 1970 to 2005. His time series regressions showed that remittance flows to Turkey impacted negatively on growth in that country. Consequently, remittances in the case of Turkey did not seem to be a significant source of capital for economic development unlike for some other developing countries.

3. TRENDS IN THE INFLOWS OF WORKERS REMITTANCES TO BARBADOS

Between 1976 and 1989, workers remittances into Barbados averaged around BBD 30 million (or 60% of inflows from current transfers), the highest being BBD 47.5 million in 1988.

They reached the BBD 50 million mark one year later in 1990 (figure 1). The 1990-92 period was one in which Barbados was affected by the international recession and was forced to seek financial assistance from the IMF mainly for balance of payments support (see Central Bank of Barbados' Annual Report). Although the major foreign exchange sectors were under extreme pressure during these two years, workers remittances to Barbados continued to increase. In 1991, these moved upwards from BBD 52 million to BBD 54.4 million and by the end of 1992, had expanded by BBD 10 million to BBD 64 million (figure 1).

FIGURE 1. WORKERS REMITTANCES IN BARBADOS, 1976-2006 (in BBD millions)



SOURCE: Central Bank of Barbados.

From 1993 to 2000, real economic activity in Barbados grew for eight consecutive years. Workers remittances, after a small decline to BBD 62.9 million in 1993, jumped from that figure and reached the BBD 100 million mark four years later in 1997 and by end-2000 had totalled BBD 168.3 million (figure 1). That figure in 2000 represented some 3% of GDP (see Campbell, 2006).

In 2001, Barbados was affected by another international recession and recorded a contraction in real economic activity of 2.6% with decreases occurring in both the foreign exchange-earning and foreign exchange-using sectors. Despite this, workers remittances to Barbados grew by 20% to reach BBD 200 million. However, in the following year, the recession continued and economic activity continued to be sluggish. On this occasion, workers' remittances fell to BBD 186.5

million. During 2003, with the international recession at an end, workers' remittances recovered to total BBD 193.8 million and by the year 2006, had reached BBD 212.5 million (see balance of payments of Barbados). However, one year later, workers' remittances fell to BBD 179.7 million.

4. IDENTIFYING AN IMPULSE RESPONSE FUNCTION

In attempting to identify an impulse response function for this study, we shall firstly set out to select explanatory variables, which are likely to influence economic growth. Additionally, it is necessary to specify the model and then examine the methodology prior to reaching our decision. We have opted to select for this paper the following variables that may influence economic growth; namely, workers' remittances and foreign direct investment (FDI). Whether workers' remittances are positively or negatively related to economic growth will depend on whether remittances are used primarily to increase opportunities in which case the relationship between the two variables should be positive or whether they are used to promote leisure over labour in which case there should be an inverse relationship between the two variables. This relationship is therefore ambiguous.

FDI has played a crucial role in internationalising economic activity and it is a primary source of technology transfer and economic growth. Indeed, this major role is stressed in several models of endogenous growth theory (see Borenzstein et al., 1998). FDI and economic growth should move in a similar direction.

4.1. Model specification

Formally, our model of economic growth can be expressed as:

$$Y = f(\underset{?}{WR},\ \underset{+}{FDI}), \tag{1}$$

where Y is real income, WR represents workers' remittances and FDI represents foreign direct investment. The signs show the anticipated relationship of the independent variables

with the explanatory variable, Y. The ordinary least squares technique is being applied to the model, which will be estimated in logarithms.

4.2. Data and variables

The study uses annual data from 1976 to 2007 from various sources of the Annual Statistical Digest and the Balance of Payments of Barbados, both prepared by the Central Bank of Barbados. Real GDP is being used as a proxy for real income with 1990 as base year. The econometric software package EVIEWS 6.0 has been chosen to perform the estimations.

4.3. Methodology

A cointegration approach is being used for the estimation of the model. This involves *a)* testing for cointegration, *b)* testing over and exact identifying restrictions, and *c)* using generalised impulse response analysis. This procedure is based on the maximum likelihood estimation of a vector autoregressive (VAR) system. Consider the following VAR of order p in the $(n+1)$ – vector of variables z_t:

$$z_t = a + c_t + \sum_{i=1}^{p} \phi_i z_{t-1} + \xi_t, \quad t = 1,2,3, \tag{2}$$

where a and c are $(n+1)$ – vector of intercepts and trend coefficients and ϕ_i, $i = 1,...p$, are $(n\text{-}1) \times (n+1)$ matrices of coefficients. Z_t is partition as $z_t = [E_t X'_t]$ where E_t represents the dependent variable, real economic growth, and X_t is an n-vector of forcing variables, $t = 1, 2, \ldots$ ξ_t is a vector of Gaussian errors. The very important assumption made here is that the roots of:

$$| I_{n+1} - \sum_{i=1}^{p} \Phi_i z^i | = 0 ,$$

either lie outside the circle unit $|z| = 1$ or satisfy the condition $z = 1$. Such an assumption allows the elements of z_t to be of order zero, one or cointegrated. By the process of reparameterizing, the unrestricted vector error correction form of (2) is given by:

$$\Delta z_t = a + c_t + \Pi z_{t-1} + \sum_{i=1}^{p-1} \acute{\Gamma}_i \Delta z_{t-1} + \xi_t, \quad t = 1,2,..., \tag{3}$$

where $\Pi = -(I_{N+1} - \sum_{i=1}^{p} \Phi_i)$ and $\acute{\Gamma} = \sum_{j=i+1}^{p} \Phi_j$, where $i = 1, ..., p-1$, are the $(n+1)$ x $(n+1)$ matrices of long-run multipliers and short-run dynamics coefficients respectively.

Since the matrix Π controls the cointegration properties, the rank *(r)* of Π determines the number of cointegrating vectors in the system. There are three cases:

Case 1: Π has full rank and any linear combination of z_{t-1} is stationary. This allows us to estimate our normal VAR in levels.

Case 2: Π has reduced rank, which implies that there are some linear combinations of z_t that are stationary, so that z_t is cointegrated. VAR in levels is consistent but inefficient (Koop et al., 1996) and a VEC must be estimated.

Case 3: Π has zero rank, so that no linear combinations of z_{t-1} are stationary. Δz_t is stationary with no integration. In this case, a normal VAR in first differences can be estimated.

In case 2, the matrix Π can be expressed as $\Pi = \alpha\beta'$ where α and β are both $(k+1)$ x (r) matrices of full column rank; β is the matrix of cointegrating vectors and α is the matrix of *weighting elements.*

The test statistics for determining the cointegrating rank, based on the hypothesis that the rank is at most $(k-r)$ against the alternative that the rank is $(k-r-1)$, are the trace statistics given by:

$$Q_t = -T \sum_{i=T-1}^{k} \log(1 - \lambda_i) \tag{4}$$

and the maximum eigenvalue statistic given by $Q_{\max} = -T \log (1 - \lambda_{T-1}) = Q_t - Q_{t-1}$ where λ_i is the largest eigenvalue. The critical values in both cases can be found in Osterwald-Lenum (1992).

Once the model has been estimated, its dynamism is investigated with the use of the impulse response (IR) function to measure the time profile of the effect of shocks on future

states of the system. An IR function traces the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables. The responses which occur in the initial periods after the shock will explain the behaviour of the system in the short run, whereas the responses which occur in later periods will provide insights about the long run effects.

Two different IR functions can be computed, namely the standard Orthoganalised IR function advanced by Sims (1980) and the generalised IR function by Koop et al. (1996) and, Pesaran and Shin (1996). The orthogonalised IRs are not unique and depend on the particular ordering of the VAR. This is so because the orthogonalised IRs are obtained by first employing a Cholesky decomposition of the covariance matrix of the shocks ξ_t in equation 2 above, which creates a problem because the Cholesky decomposition is non-unique. Generalised IRs, by construction, circumvent the problem of dependence of the orthogonalised IRs on the ordering of the VAR. Emphasis is therefore being placed on the generalised IR in this study.

5. RESULTS

Since the main justification in order to embark on cointegrating analysis is to study the long-run co-movement of a group of variables, an investigation of the order of integration of the individual variables has to be undertaken. Table 1 shows that with the use of the Augmented Dickey-Fuller (ADF) unit root test, all of the variables have been found to be integrated of the first order, that is, $I(1)$.

Our attention is now turned to selecting the order of the VAR. Both the Akaike Information Criteria (AIC) and the Schwarz Bayesian Criteria (SBC) indicate an order of one (1) with an intercept. However, for the purpose of this exercise, the SBC has been selected. Further, we need to ensure that there are no problems of serial correlation with this order. The results of the autocorrelation LM test (showed immediately under table 1) show that there is no presence of serial correlation, therefore this order has been chosen.

TABLE 1. AUGMENTED DICKEY-FULLER (ADF) UNIT ROOT TEST

	Intercept (Level)	*95% Critical Value*	*Lag Length*	*Intercept (First Difference)*	*95% Critical Value*	*Lag Length*
LY	–0.97	–2.96	1	–3.12	–2.96	0
LWR	–0.94	–2.96	0	–4.89	–2.96	0
LFDI	–2.54	–2.96	0	–4.90	–2.96	2

NOTES: Autocorrelation LM test = 5.056361, Prob = 0.8294.

Table 2 provides the results for the test for cointegration based on the trace eigenvalue statistics. These strongly reject the null hypothesis that there exists no cointegration relationships between the variables (namely that r equals zero) but indicate that there is one cointegration relationship between them. The maximum eigenvalue statistics were also calculated but were not reported since they yielded the same conclusions.

TABLE 2. TESTS FOR THE NUMBER OF COINTEGRATING VECTORS (TRACE STATISTICS)

Null	*Alternative*	*Eigenvalue*	*Statistic*	*95% Critical Value*
$r = 0$	$r \geqslant 1$	0.691592	48.10632	35.19275
$r \leqslant 1$	$r \geqslant 2$	0.345258	13.99270	20.26184
$r \leqslant 2$	$r = 3$	0.057286	1.710788	9.164546

In table 3, maximum likelihood estimates of the cointegrating vector are obtained by imposing Johansen exactly identifying restrictions and we obtain the results of the long-run equation normalised on real economic growth. The main interest in these estimates is that the explanatory variables are statistically significant at the 5% level. It shows that a one percent increase in the rate of workers' remittances will boost real economic growth by 0.08% while a similar percentage rise in FDI will drive up real economic growth by 0.04%.

TABLE 3. LONG-RUN COINTEGRATING EQUATION (NORMALISED ON REAL ECONOMIC GROWTH)

LY	1.0000
LWR	0.076708 (0.01728)
LFDI	0.044302 (0.01409)
INTERCEPT	–6.363687

NOTE: Standard Errors given in parentheses.

In table 4, we note that the explanatory variables, workers' remittances and FDI are all weakly exogenous variables since, when the system is in disequilibrium, equilibrium will be achieved by the response of one or a combination of these variables. The error correction coefficient is both negative and significant as required and its value of 0.34 suggests that any disequilibria experienced by this model will be corrected approximately 34% for a period of almost three years.

TABLE 4. SPEED OF ADJUSTMENT FROM DISEQUILIBRIA

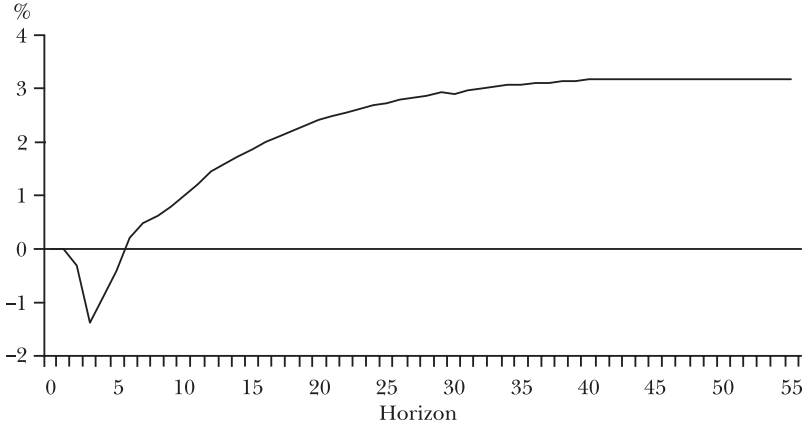
LY	–0.337622 (0.07923)
LWR	–0.747653 (0.38696)
LFDI	7.083607 (3.72685)

NOTE: Standard Errors given in parentheses.

Our attention is now focused on the impulse response function, which in this case, is the response of economic growth following a positive shock to the standard errors of workers' remittances. This takes us now to figure 2. We observe that with a positive or upward shock to the explanatory variable, workers' remittances, there will be a marginal decline of just under 1% in economic growth in the first two periods and this will deteriorate to 1.4% in the period that immediately follows. This implies that during the first three years, workers' remittances to Barbados would have been used primarily for leisure at the expense of productive opportunities. By the end of year 5, the decline in economic activity will be virtually eliminated and from year 6, economic activity will expand continuously until a new equilibrium of 3.2% has been attained in the fortieth year. This means that after year 5, the recipients of workers' remittances will adjust their focus from leisurely and non-productive activities to boosting economic growth by engaging in areas such as property acquisitions and providing funds for health and education, to name a few. Since this new equilibrium lies above the original equilibrium, then the shock to workers' remittances will be desirable for Barbados. This confirms the widely-held view of

the importance of workers' remittances to the growth and development of Barbados.

FIGURE 2. RESPONSE OF ECONOMIC GROWTH TO CHANGES IN WORKERS REMITTANCES



6. CONCLUSION

The purpose of this paper was to look at workers' remittances in Barbados and to see to what extent these remittances impacted on economic growth in that country. Most of the workers' remittances to Barbados are provided by Barbadians residing in the USA, UK and Canada. Also, within the last few years, the importance of workers' remittances has received substantial attention from successive governments and members of the Barbadian public alike and as far as the external current account is concerned, the foreign exchange from this category is now only surpassed by tourism receipts and foreign earnings from merchandise exports.

With annual data from 1976 to 2007, we used an impulse response function to determine how economic growth would respond to a shock to workers' remittances in Barbados. The results showed that when a shock was applied to workers' remittances, economic growth would contract to 1.4% by the end of the third year, which suggested that workers' remittances to Barbados would be used more for activities that discouraged work than for labour market participation. In the next two years, this contraction would come to an end and

from the following year, year 6, continuous expansions in economic growth would occur until a new equilibrium of 3.2% occurred in the fortieth year. This model implies that from year 6, Barbadians in receipt of remittances from abroad would focus on using these remittances in productive activities such as property acquisitions and increase their labour market participation, which will generate higher growth in the country. Since this new equilibrium exceeds the original equilibrium, then, according to this model, any shock to workers' remittances will enhance Barbados' economic growth.

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2. The topics of the papers must bear upon the functions and aspects of direct interest to regional central banks. Among other topics, papers on monetary policy, macroeconomic stability, financial stability, central bank operations, financial cooperation between Latin American and Caribbean countries or the repercussions of international financial events on the region may be submitted.

3. The papers that are submitted must be original and unedited, and must be final versions. In other words, they must not have been published in print or electronically, either individually or in a journal, book or

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4. The papers may be submitted in Spanish, French, English or Portuguese, accompanied if possible by an English or Spanish translation, in order to facilitate the work of the panel of judges. The papers may not exceed 20 000 words or 50 pages (whichever comes first), including the cover, abstract, introduction, development, conclusions and appendices or annexes.

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