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Sovereign debt sustainability in Jamaica: a risk management approach

1. INTRODUCTION

The sovereign risks associated with high levels of public debt and the significant exposure of banking institutions to these debt instruments have received considerable attention from economic policy makers in recent years (see, for example, *World Economic Outlook,* September 2003). Reflecting this growing concern, policy makers have focused attention on developing frameworks which can assess the vulnerability of emerging economies to debt default and mitigate its impact on economic performance and financial stability. The exposure to exogenous shocks inherent in an open economy such as Jamaica, as well as the high level of indebtedness have raised many questions for policymakers and the general public. For example, at what level does public debt become

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too high to be sustainable?[1] What can policy makers do to cushion the economy against the risks that high debt presents, and, perhaps most importantly, what policy actions are needed to ensure that a debt reduction strategy is sustainable?

According to Goldfajn and Guardia (2003), debt sustainability assessments should focus on medium and long-run scenarios, as well as the probabilities associated with the evolution of key variables in the debt accumulation process including, among others, GDP growth, interest rates, and exchange rates. This paper addresses some of the challenges associated with analyzing the sustainability of public debt in Jamaica by focusing on the role of stochastic factors, including contingent liabilities, on debt dynamics. An assessment of the sustainability of Jamaica's public-debt is conducted by constructing a risk measure which is derived from the likelihood of the debt to GDP ratio exceeding a given threshold over a specific time-horizon. The analysis explores whether changes in the GDP growth rate, fiscal balance and real interest rates can be used to predict an improvement or deterioration in the debt sustainability dynamics over the medium-term. This risk measure of debt sustainability, to the extent that it can anticipate deteriorations in the debt dynamics, can be used in conjunction with a stress-testing framework to identify the impact of debt-dynamics on the portfolios of the financial sector and thereby signal the necessary policy action, such as an adjustment to capital adequacy allocation.[2] The predictive power of the risk measure on the Euro-denominated GOJ spreads provides strong corroboration that the methodology captures a significant portion of market perception of the default risk in Jamaican sovereign debt and that it can be used effectively in an early warning framework.

The paper has five sections. Section two gives a brief overview of the mainstream approach to analyzing debt-sustainability. Section three discusses the empirical framework used in this paper to assess the debt-dynamics in Jamaica between 1996 and 2004 and conducts a medium-term scenario-based analysis. The fourth section discusses the results. The final section summarizes the main findings and conclusions.

[1] Economic theory provides little practical guidance on the optimum level of public debt as it is largely dependent on the specification of the model (see Aiyagari and McGrattan, 1998).

[2] See (Lewis 2004) for a stress-testing framework, which assesses the impact of macro-economic shocks on the portfolios of the banking sector in Jamaica.

2. DEBT SUSTAINABILITY: AN OVERVIEW

Much of the debt sustainability literature concentrates on the debt accumulation in equation (1):

$$d_t = (1 + r_t - g_t)d_{t-1} + f_t \quad (1)$$

where d_t is the debt to GDP ratio, r_t is the real interest rate paid, g_t is the growth rate of GDP, and, f_t is the primary balance. This identity is used to determine the primary surplus or growth rate of GDP that would maintain the debt at a certain level and its application has been critical in offering insights into various debt restructuring and stabilization programmes. However, the static application of this identity may understate or overstate implicit risk associated with a given level of indebtedness, to the extent that the variables entering into this identity are stochastic (uncertain) and perhaps, correlated. For purposes of policy, one may be interested in the possible evolution of debt as a result of changes in one of the underlying variables entering into the debt equation. Hence, the framework would have to also account for the likelihood that the other variables would evolve contemporaneously in response to movements in the policy variable of interest. Another drawback of this approach is that it is often predicated on a notion of sustainability as defined by a constant debt-to-GDP ratio, which may not always be either desirable or practical. Garcia (2004) notes that this approach may be of little practical policy use since the purpose of having debt in the first place is to smooth consumption inter-temporally, it would be counter-intuitive to strive to keep the debt to GDP ratio constant. Secondly, and perhaps more contextually relevant for Jamaica, if a country faces significant levels of indebtedness, keeping the debt to GDP ratio constant would not be sustainable.[3]

The evaluation of the debt sustainability from a risk management perspective involves the identification, measurement and assessment of adverse movements of the risk factors as the debt profile evolves. The approach taken in the paper aims to promote insight into banking sector risk exposure to sovereign debt default and to facilitate proactive mitigation of various risk factors from a policy implementation perspective.[4]

[3] A high level public debt in this case would leave the country vulnerable to external shocks, such as a sudden decline in capital flows and GDP growth.

[4] See Chapter III, *World Economic Outlook*, September 2003.

3. RISK MANAGEMENT AND DEBT SUSTAINABILITY: METHODOLOGY AND DATA

The paper follows the approach employed by Garcia and Rigobon (2004) in the computation and assessment of GOJ debt dynamics. Innovative aspects of their approach include the modelling of the impact of contingent liabilities and off-balance sheet items on debt dynamics and the impact of greater relative volatility in the key macroeconomic variables of emerging market economics. As such, the analysis accounts for the fact that the variables entering into the equation are stochastic. Additionally, variables that have *a priori* importance on the evolution of debt, such as the exchange rate and the inflation rate, are included in the analysis.

A reduced form vector auto-regression (VAR) is used primarily to estimate the joint dynamics of the macro-variables in the debt accumulation process. The VAR expresses each variable as a linear function of its own past value, the past values of all other variables being considered, and a serially uncorrelated error term. Each equation is estimated by ordinary least squares (OLS) regression, while the number of lagged values to include in each equation is determined by a number of different methods discussed below. The error terms in these regressions are the 'surprise' movements in the variables, taking past values into account. If these variables are correlated with each other, then the error terms in the reduced form model will also be correlated across equations. The mathematical representation of a simple VAR is:

(2)
$$x_{1t} = \phi_{11} x_{1,t-1} + \phi_{12} x_{2,t-1} + \varepsilon_{1t}$$
$$x_{2t} = \phi_{21} x_{2,t-1} + \phi_{22} x_{2,t-2} + \varepsilon_{2t}$$

where $E(\varepsilon_{1t}\varepsilon_{2s}) = \sigma_{12}$ for $t = s$ and zero for $t \neq s$. One could rewrite this as:

(3)
$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \phi_{11} & \phi_{12} \\ 0 & \phi_{21} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & \phi_{22} \end{bmatrix} \begin{bmatrix} x_{1,t-2} \\ x_{2,t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

or simply:

(4)
$$x_t = \Phi_1 x_{t-1} + \Phi_2 x_{t-2} + \varepsilon_t$$

where $E(\varepsilon_t) = 0, E(\varepsilon_t, \varepsilon_s) = 0$ for $s \neq t$ and:

$$E(\varepsilon_t \varepsilon_t^{'}) = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}$$

The vector, x_t, follows a VAR (2) process. By extension, a general VAR (*p*) process with white noise can be written as:

(5)
$$x_t = \Phi_1 x_{t-1} + \Phi_2 x_{t-2} + \ldots + \varepsilon_t$$
$$= \sum_{j=1}^{p} \Phi_j x_{t-j} + \varepsilon_t$$

or, if the lag operator is used:

$$\Phi(L) = \varepsilon_{t,}$$

where:

$$\Phi(L) = I_k - \Phi_1 L - \ldots - \Phi_p L^p$$

The error terms follow a vector white noise, i.e.:

$$E(\varepsilon_t \varepsilon_s^{'}) = \begin{cases} \Omega & for \quad t = \quad s \\ 0 & otherwise \end{cases}$$

with Ω a $(k \times k)$ symmetric positive define matrix.

The VAR is computed using the macro variables, where the macro variables are given by equation (6)

(6)
$$X_t = c + B(L)X_t + v_t$$
$$X_t \equiv (\tilde{r}_t, \tilde{g}_t, \tilde{f}_t, \tilde{\varepsilon}_t, \tilde{s}_t, \tilde{\pi}_t)$$
$$v_t \sim N(0, \Omega)$$

where $\tilde{r}_t, \tilde{g}_t, \tilde{f}_t, \tilde{\varepsilon}_t, \tilde{s}_t,$ and $\tilde{\pi}_t$ represent the real interest rate, growth rate of GDP, primary balance, debt shocks, real exchange rate, and the inflation rate, respectively. The reduced form residuals, v_t, with a multinomial distribution whose mean is zero and covariance matrix Ω, and *B(L)* are the coefficients of the lags. The lag length, *L,* for the VAR is set at two, which is supported by both the likelihood ratio *(LR)* test and the Akaike Information Criterion.

The actual debt data and realizations of the GDP growth rate, interest rate and primary deficit are used to compute the following debt shocks or 'skeletons':

(7) $$\tilde{\varepsilon}_t = d_t - (1 + \tilde{r}_t - \tilde{g}_t) d_{t-1} - \tilde{f}_t$$

The standard practice in VAR analysis is to analyze results from impulse responses, which yield how each variable is affected given a shock at time *t*. These are reported in section 4.

Although impulse responses are examined in the paper, the primary thrust of this approach is to describe the possible evolution of debt. Any Choleski decomposition (i.e. any ordering of the variables in the VAR) will produce the same reduced form covariance matrix, which explains why the ordering of triangular factorization determined by the ordering of the variables is not relevant for risk management applications. Thus the only requirement to conduct the analysis of the evolution of the debt is to produce the contemporaneous correlation as the result of some Choleski decomposition.[5] Using the Choleski decomposition of the reduced form residuals derived from the estimation of equation (6), several paths of the shocks are generated, and using the coefficients from the VAR, the path of the variables in X_t are used to estimate the path of the debt. The model employed to conduct this analysis utilizes the following identity:

(8) $$d_t = (1 + \tilde{r}_t - \tilde{g}_t) d_{t-1} + \tilde{f}_t + \tilde{\varepsilon}_t$$

$$\left\{ \tilde{r}_t, \tilde{g}_t, \tilde{f}_t, \tilde{\varepsilon}_t, \tilde{s}_t, \tilde{\pi}_t \right\} \sim N(\vec{\mu}_t, \Sigma_t)$$

The stochastic variables in the identity are distributed multinomial[6] with conditional mean $\vec{\mu}_t$, and conditional covariance matrix Σ_t.

Using the VAR to estimate possible paths of debt offers some advantages which are worth considering. Variables and shocks that are not part of the debt accumulation equation (1) can still have an impact of the debt dynamics. For example, the exchange rates, the terms of trade, and inflation can be included as variables in the VAR system.[7]

The properties of the covariance matrix produced from the

[5] Most applications on monetary policy are interested in computing impulse responses and identifying structural shocks from the reduced form.

[6] This is a simplification that can be easily corrected in the Monte Carlo exercise. Here it is made mainly for expository purposes.

[7] Even if variables are not included, it is possible that the VAR could summarize their effect in the variance-covariance matrix of the reduced form residuals. Their impact on the debt dynamics will be reflected in GDP, inflation or real exchange rate movements.

Choleski decomposition may also be used to assess the sustainability of debt dynamics. For example, in developed economies recessions (lower growth) are usually accompanied by a decrease in interest rate (expansionary monetary policy). If this is the case, then recession and the deterioration of the primary deficit –which are inimical to debt sustainability– comes with a countervailing impact of a reduction in the interest rates –which facilitates the debt sustainability. Hence, implicit in the debt dynamics is an automatic stabilizer. On the other hand, in many emerging market economies, usually a recession deteriorates the fiscal accounts, increases the real interest rates, induces inflation and depreciates the exchange rate. Additionally, if the Government issues sovereign bonds, the deterioration in fiscal accounts may precipitate a downgrade, requiring higher yields and thereby exacerbating the financial cost of servicing the debt. The increased likelihood of default can also result in capital flight. As such all the variables entering into the debt dynamics equation will contribute to a deterioration. This 'vicious cycle' of debt dynamics therefore arises when the correlations among the factors impacting upon the debt accumulation process cause fiscal policy to become more pro-cyclical. Thus, simulations that postulate independent paths for the relevant variables will neglect the risk inherent in the correlation among these variables which impact significantly upon the debt dynamics in emerging economies.

Using the Choleski decomposition of the reduced form residuals and the coefficients from the VAR one can compute several paths of the variables in X_t which are used to project possible evolutions of the debt stock over time. This procedure employs Monte Carlo techniques to determine standard error bands for the debt profile going forward. The algorithm employs a simultaneous equation representation of an unrestricted VAR (*p*) to evaluate equation (8). Given that the likelihood function of a VAR (*p*) $f(\theta|x_t,\omega_t)$ where $\theta=[\alpha,vech(\Sigma_\upsilon)]$ can be decomposed into a Normal for α conditional on Σ_υ and an inverted Wishart distribution for Σ_υ. It can be shown that the posterior of Σ_υ will have the same inverted Wishart distribution as the likelihood except that now the degrees of freedom are *(T-k),* where k is the number of estimated coefficients in each equation. On the other hand, the posterior of $(\alpha|\Sigma_\upsilon,x_t)$ is a Normal distribution centered at α_{OLS} and variance equal $var(\alpha_{OLS})$. With these results, standard error bands for the stochastic forecast can be constructed using the following algorithm:

- Generate $T-k$ *iid* draws for μ_t from $invN[0, y-A_{OLS}X)^{'}(Y-A_{OLS}X)]$ where $invN$ is the inverse of a normal distribution.
- Form the second moments i.e. $\Sigma^{+} = \frac{1}{T-k}\Sigma_l(\mu^l - \bar{\mu})^2$ where l = 1, 2… L is the number of draws and $bar\mu = \frac{1}{T-k}\Sigma_l\mu$.
- Set $\Sigma^l = (\Sigma^{+})^{-1}$.
- Draw $\alpha^l = \alpha_{OLS} + \upsilon_t,\ \upsilon_t \sim N(0,\Sigma^l)$ where $\alpha = vec(B)$ where B = (B_1, … B_p).
- Compute $B^{'}(l)$ to derive the τ step ahead forecast for each draw l.
- Repeat steps 1 – 5 L times and report relevant percentiles of the distribution of B_τ or compute the mean and the standard deviation of the forecast using simulated draws.

The procedure is also used to estimate rolling regressions- to assess the predictive power of the model and perform out-of-sample tests which use the most recent conditions to compute debt dynamics going forward. In so doing, the framework can be used to derive a measure of debt sustainability based on the likelihood of the debt ratio exceeding a given threshold over given time horizon.

The variables employed in the analysis of debt dynamics in Jamaica are the GDP growth rate, the primary balance, the contingent liabilities or 'skeletons', the real interest rate and the real exchange rate. The data are monthly observations for the sample period 1996:06 to 2004:08. Each of these variables is represented as a share of GDP,[8] with exception of growth in GDP, the real interest rate, and the real exchange rate. As indicated in equation (7), the skeletons are computed as the deviation of the actual debt to GDP ratio from that implied by the debt accumulation equation given by equation (1).[9] The real interest rate is computed as the 6-month Treasury bill rate minus the inflation rate and the real

[8] The monthly GDP series are derived from extrapolating the quarterly GDP figures obtained from the Statistical Institute of Jamaica.

[9] The 'skeletons' are a critical component of the analysis as they can have the (accounting) effect of leading to a deterioration in debt profile, which would otherwise not be captured as fiscal outlays for purposes of calculating the public sector borrowing requirement (PSBR).

exchange rate is computed as the nominal depreciation minus the inflation rate.[10, 11] The spread on Euro-denominated GOJ Bonds is used to measure country risk.

4. EMPIRICAL ANALYSIS OF JAMAICA'S DEBT SUSTAINABILITY OUTLOOK

4.1 Covariance of reduced form residuals

Table 1 presents the covariance of the reduced form residuals in the upper triangular region and the corresponding correlations in the lower triangular region. Inflation is negatively correlated with the growth rate of GDP, the real interest rate and the

TABLE 1. COVARIANCES AND CORRELATION MATRIX

	Real interest rate	*Growth rate*	*Primary deficit*	*Debt shocks*	*Real exchange rate depreciation*	*Nominal inflation*
Real interest rate	2.56E-05	7.65E-07	6.93E-07	-2.55E-06	1.22E-05	-4.07E-06
Growth rate	10.13%	2.23E-06	3.01E-07	5.04E-07	-2.17E-06	-3.73E-07
Primary deficit	9.71%	14.28%	2.00E-06	6.28E-06	-3.53E-07	-2.49E-07
Debt shocks	-2.15%	1.43%	18.88%	5.54E-04	9.17E-06	-4.35E-06
Real exchange rate dep.	27.23%	-16.41%	-2.83%	4.41%	7.81E-05	-1.99E-06
Nominal inflation	-47.20%	-14.65	-10-36%	-10.85%	-13.20%	2.90E-06

NOTE: Covariance matrix of the 'reduced from residuals' are on the upper triangular, and the correlations are on the lower portion.

[10] Since the US inflation has very low variance in the sample, it is excluded from the real exchange rate calculation. Within the VAR framework, the constant term in the regression takes care of the effect of the US inflation on the real exchange rate.

[11] One adjustment to the data was the transformation to six-month moving averages. This is because much of the untransformed series are quite volatile. For example, for the primary deficit, if some expenses were concentrated in a given month, the monthly series would reflect periods with significant deficits, while the moving average series would better reflect the overall fiscal stance.

real exchange rate.[12] The primary deficit, on the other hand, is positively correlated with the real interest rate and the GDP growth rate.[13] Finally, real foreign exchange rate depreciation is associated with an increase in real interest rates and declines in the GDP growth rate and the primary deficit.

4.2 Impulse responses

In this section, a triangular decomposition of the reduced form shocks is utilized to analyze the possible impact of a shock to one of the variables on the other variables. It is assumed that the ordering of the equations is as follows: real interest rate, GDP growth rate, primary deficit, debt shocks (skeletons), real exchange rate, and inflation. The order implies that inflation affects all the variables contemporaneously, while real interest rate changes take effect with a lag. An inspection of these impulse response functions indicates that this ordering yields a reasonably satisfactory description of debt dynamics.[14] Figures 1 to 6 present the impulse responses derived from shocks to all variables.[15]

Figure 1 illustrates the impulse response to a one standard deviation increase in the real interest rate. This shock lasts for approximately 10 months followed by a 14-month contraction before returning to its steady state level. The increase in the real interest rate increases the real exchange rate and reduces the inflation rate. For the period corresponding to the real interest rate shock, the GDP growth rate declines and then normalizes after 10 months. The net effect on the debt path implied by the shock to interest rates, given the initial conditions, is a steady increase in the debt for up to 12 months after the initial shock. The deterioration in the debt dynamics is substantially reversed when the real interest rate declines significantly (to negative values)

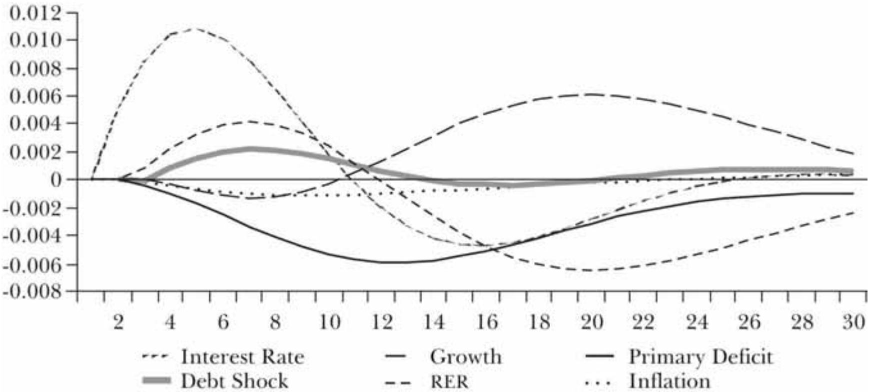
[12] This suggests that inflation 'scares' are recessionary and serve to reduce real interest rates.

[13] This is compatible with standard Keynes fiscal multiplier effects.

[14] Stock and Watson (2001) point out that structural inference and policy analysis are inherently more difficult because they require differentiating between correlation and causation; this is known as the 'identification problem' in the econometrics literature. They note that this problem can be addressed by relying on economic theory and institutional knowledge.

[15] The impulse response on the debt accumulation is calculated using the response of each of the shocks, the initial conditions at the end of the sample, and the debt accumulation equation.

FIGURE 1. IMPULSE RESPONSE TO AN INCREASE IN THE INTEREST RATE

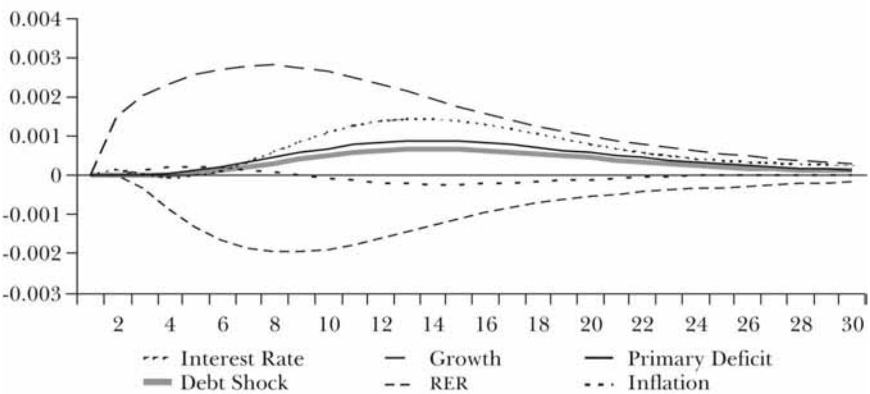


before returning to its steady state at the end of 25 months.[16]

Figure 2 depicts the impulse response to a one standard deviation increase in the GDP growth rate. This shock is associated with an increase in the real interest rate, which occurs with some delay, followed by a subsequent decline in the real interest rate. The inflation rate increases marginally with the shock to the GDP growth rate and declines after the fourth month. In addition, the shock results in a currency appreciation and decrease in the primary balance. The net impact is a permanent, though marginal, reduction in the debt to GDP ratio (see Figure 7).

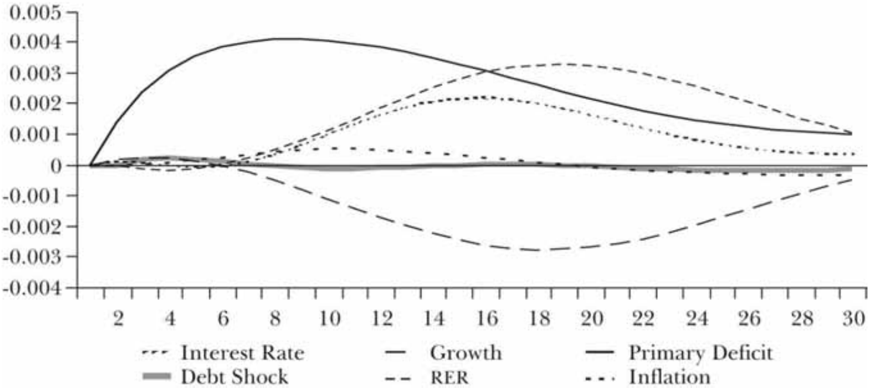
Figure 3 displays the impulse response to an increase in the pri-

FIGURE 2. IMPULSE RESPONSE TO AN INCREASE IN THE GROWTH RATE OF MONTHLY OUTPUT



[16] The implied path for the debt arising out of each shock is displayed in Figure 7.

FIGURE 3. IMPULSE RESPONSE TO AN INCREASE IN THE PRIMARY DEFICIT



mary deficit. In this case, the increase in the primary deficit is associated with real exchange rate depreciation after the fifth month that lasts for around 25 months, an immediate increase in inflation rate (which lasts for approximately 18 months) and an increase in the real interest rate with protracted reduction in GDP growth rate, both after the fifth month.

The innovation from an increase in skeletons results in a deterioration in the primary deficit, a transitory appreciation in the real exchange rate and transitory reduction in the real interest rate (see Figure 4). While the initial responses are difficult to reconcile intuitively, the simulations show that the subsequent increase in real interest rate, deterioration in GDP growth rate and fiscal deterioration result in a persistent increase in the debt to GDP ratio (see Figure 7). This result is consistent with *a priori* ex-

FIGURE 4. IMPULSE RESPONSE TO AN INCREASE IN THE SKELETONS

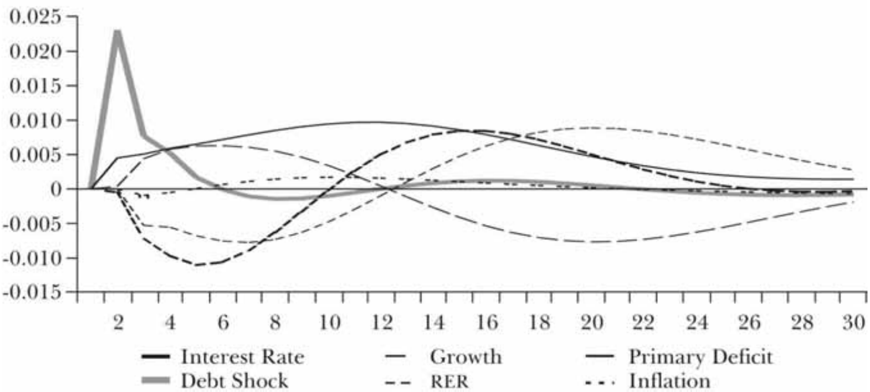
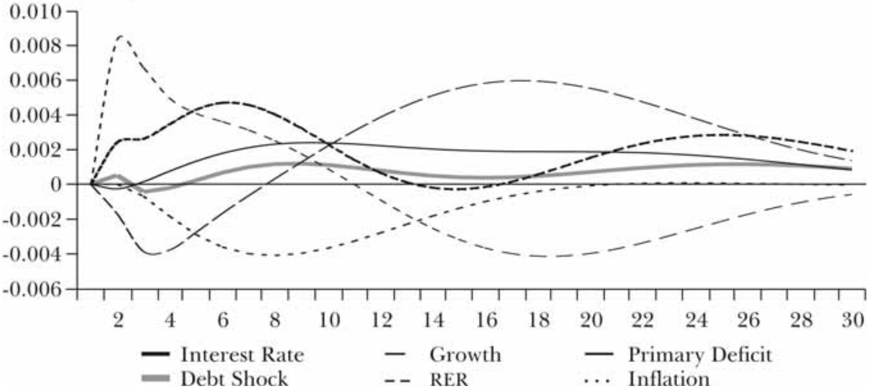


FIGURE 5. IMPULSE RESPONSE TO AN INCREASE IN THE REAL EXCHANGE RATE (depreciation)



pectations of the impact of the recognition of hidden liabilities (skeletons) on debt dynamics.

As shown in Figure 5, a one standard deviation increase in the real exchange rate is accompanied by an increase in the GDP growth rate after the first 7 months, a moderate increase in interest rates, and a mild, but persistent, deterioration of the primary deficit. In the end, the positive effects out-weigh the negative effects and the debt to GDP ratio increases (see Figure 7).

The impulse response to an increase in the inflation rate is shown in Figure 6. This shock is associated with depreciation in the exchange rate and declines in the real interest rate, the GDP growth rate and the primary deficit. The movements of all the variables result in an increase in the debt to GDP ratio, as reflected in the simulation (see Figure 7).

FIGURE 6. IMPULSE RESPONSE TO AN INCREASE IN THE INFLATION RATE

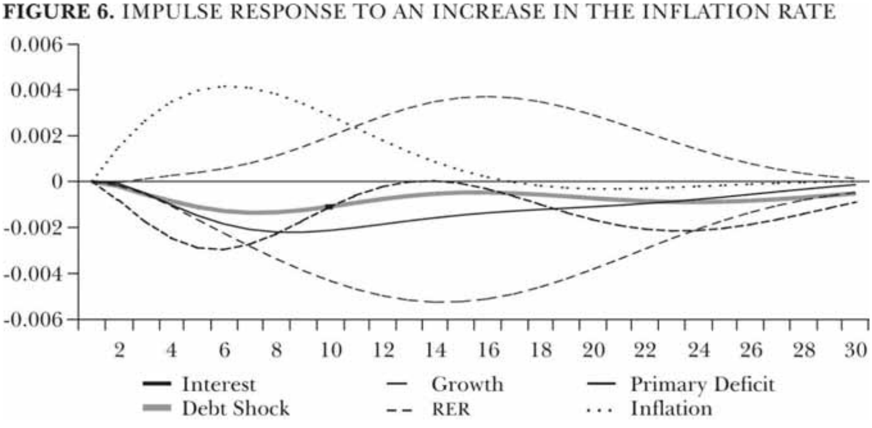
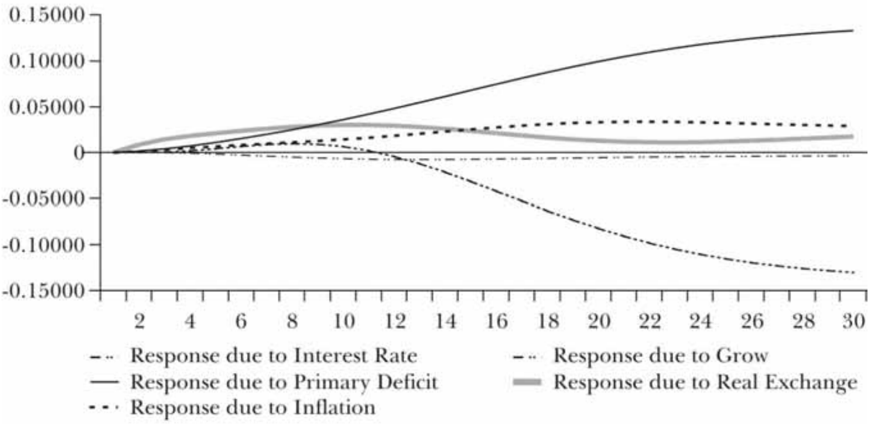


FIGURE 7. NET IMPACT ON DEBT OF IMPULSE RESPONSES



The co-movements observed in the variables of interest and the debt dynamics are close to *a priori* expectations. The innovations to the primary deficit and the interest rate have the largest impact on the debt dynamics, followed by the innovation to inflation and the real exchange rate.

4.3 Analysis of debt sustainability prospects in the absence of risk

In order to assess the debt path in the absence of risk considerations, the 9-month averages of the variables entering the debt accumulation equation are used to determine the initial conditions.[17] In other words, the debt accumulation equation is computed using the interest rate, primary deficit, growth rate of the previous 9 months and the final debt at time *t*. Figure 8 illustrates the 24-month horizon of the debt to GDP ratio using the initial conditions computed at the end of September 2004.

Starting from almost 138.0 per cent, the debt to GDP ratio would decline to 121.0 per cent, after 24 months.[18] It is possible to conclude from this exercise that Jamaica's sovereign debt, in the context of the current macroeconomic environment, would be increasingly sustainable.

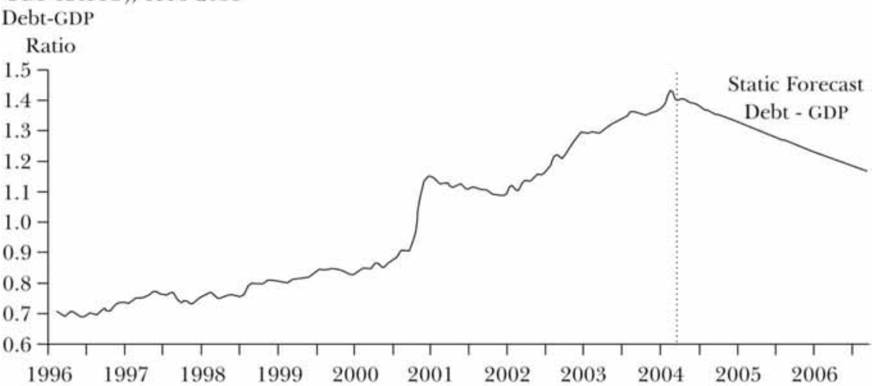
Goldfajn and Guardia (2003) argue, however, that the numer-

[17] Similar paths were estimated using 6-month and 12-month horizons. However, the results were not significantly affected by the change in the time horizon.

[18] The debt to GDP ratio would gradually fall to just above 100.0 per cent of GDP 30 months hence. (Not shown in Figure 8).

ous future possibilities for the relevant variables –GDP growth, real interest rates, and real exchange rates– may lead to different assessments. In addition, the estimates may overstate the case for increasing sustainability of the debt by not taking into account the uncertainties that face governments in emerging market economies. Conversely, the estimates may understate the case for increasing sustainability by invoking assumptions for key parameters which are based on transitory adverse market swings resulting in an equally biased assessment.

FIGURE 8. DEBT SUSTAINABILITY IN THE ABSENCE OF RISK (HISTORICAL DEBT-GDP RATIO), 1996-2006



4.4 Risk based analysis of debt sustainability – Monte Carlo simulations

The application of Monte Carlo analysis to the debt model described in section 3 provides an alternate approach to the assessment of debt dynamics in the medium-term. The analysis utilizes the estimates of the VAR with data up to September 2004 to derive covariance matrix of the shocks, and generates several paths for the debt using Monte Carlo simulations (1000 replications of 24 months). Figure 9 provides plausible paths for the debt over 24 months, along with the maximum and the minimum debt within two standard deviations of the average value. The juxtapositon of Figure 8 and Figure 9 shows the marked difference in the projections of the sustainablity of the debt to GDP ratio between the two approaches. The former approach assumes that the inputs into the debt accummulation equation remain constant, are not dynamically interrelated, and that the economy will not be exposed to exogenous shocks over the forecast horizon. In short, the analysis invokes the *ceteris paribus* assumption for the variables entering into the debt accumulation model. On the other hand, the latter approach utilizes the impact of all data up to that point to estimate the VAR and the covariance matrix which is used to compute the implication on debt dynamics going forward. The analysis, by concentrating on the contemporaneous covariance of the residuals, facilitates the study of the impact on debt arising from a *typical* mixture of shocks that have hit the Jamaican economy in the past.

FIGURE 9. DEBT SUSTAINABILITY IN THE ABSENCE WITH RISK, 2005-2006

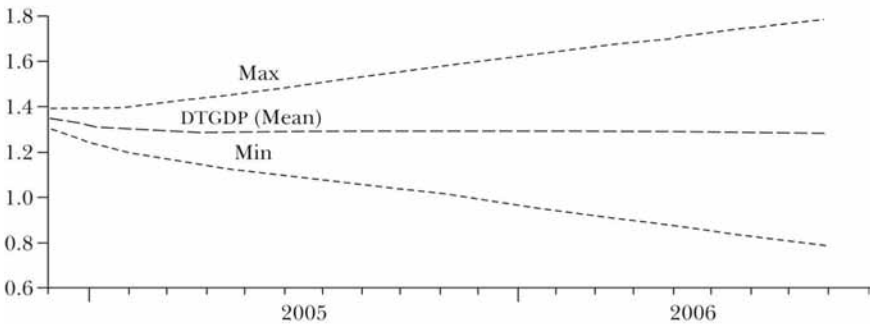


Figure 9 demonstates that the risk measure, derived from that non-trivial proportion of debt to GDP realizations above 150.0 per cent over the 2-year horizon, would be increasingly unsustainable.[19] The evolution of the debt dynamics indicating an increasing level of debt unsustainabilty is a direct result of evolutions wherein the real interest rate exceeds growth rates of GDP generating an exploding debt path. Additionally, this scenario incorporates the impact of a recognition of a hypothetical mixture of hidden GOJ liabilities (skeletons) equivalent to almost 8.0 per cent of GDP over the forecast horizon.[20] The means of the stochastic variables given the data up to September 2004, point to

[19] Assessing debt sustainability requires analyzing the current institutional framework. Given that innovations in the institutional framework are still nascent in Jamaica it is likely that their full impact have not yet been captured in the reduced form residuals.

[20] See Figure 1 in the Appendix for the stochastic inputs into the debt accumulation equation that produce the stochastic paths for the debt dynamics displayed in Figure 9 Without such recognition of 'skeletons' the debt dynamics would appear differently. Nonetheless, the recognition of past debt is in line with the policy of improving transparency in the government accounts.

a stabilization of the debt to GDP ratio at approximately 128.0 per cent over the following 24 months. This, however, should not be interpreted as a *point* forecast for the outturn of debt-ratio going forward, but rather as a probable outturn in the absence of ongoing adjustments to the fiscal and monetary path.

The wide dispersion about the average debt to GDP ratio indicates that the medium-term projections of a decline in the debt ratio are plausible, though subject to considerable uncertainty. Moreover, the risk-based analytical approach underscores the importance of several initiatives undertaken by the Government of Jamaica (GOJ) during FY 2004/5 such as the Memorandum of Understanding (MOU)[21] as well as significant expenditure curtailment. These have brought about significant improvement in the fiscal stance in Jamaica. These developments, as well as the Bank of Jamaica's commitment to macro-ecnomic stability have promoted a path towards improving debt-sustainability prospects going forward.

4.5 Sensitivity analysis[22]

Several hypothetical scenarios of debt shocks are evaluated in this section to examine their impact on debt dynamics. Tables 2 to 4 show the different paths followed by the debt to GDP ratio under alternative initial debt shocks of 7.4 per cent, 7.6 per cent, and 12.20 per cent, respectively.[23] In the first instance, Table 2 shows the impact of the assumed shock of 7.4 per cent of GDP on the other variables entering into debt accumulation process as determined by the estimated VAR as well as its impact on the debt to GDP ratio over 24 months.

The analysis shows that the initial debt shock of 7.4 per cent of GDP coupled with constant primary surpluses of 11.4 per cent

[21] The MOU was an agreement between the Government of Jamaica and the Jamaica Confederation of Trade Unions which realized a reduction in the cost of salary/salary related and ancillary benefits granted to all public sector employees for the period April 1, 2004 to March 31, 2006.

[22] Sensitivity analysis involves changing an input (independent) variable to see how sensitive the dependent variable is to the input variable. In this section the independent variables are shocks to the debt stock, primary surplus and the dependent variable is the debt to GDP ratio. The simulation framework allows for internally consistent paths for the other independent variables entering into the debt accumulation process.

[23] These shocks were generated based on the historical evolution of shocks over the sample period.

TABLE 2. INITIAL DEBT SHOCK OF 7.4 PER CENT OF GDP AND CONSTANT PRIMARY SURPLUSES

	2004M9	*2004M12*	*2005M3*	*2005M6*	*2005M9*	*2005M12*	*2006M3*	*2006M6*
Inflation	12.73	10.30	8.86	8.42	8.67	9.07	9.27	9.15
GDP growth	2.71	2.59	2.67	2.95	3.31	3.60	3.78	3.85
Primary surplus (% GDP)	11.46	11.46	11.46	11.46	11.46	11.46	11.46	11.46
Real exchange rate	(10.74)	(8.08)	(6.05)	(4.88)	(4.85)	(5.19)	(5.44)	(5.30)
Real interest rate	1.70	2.21	3.64	4.65	4.79	4.50	4.42	4.64
Shock to debt (% GDP)	7.42	11.17	10.32	9.25	9.33	9,89	10.30	10.12
Debt GDP ratio	1.35	1.29	1.29	1.29	1.29	1.29	1.28	1.28

would still be consistent with increasingly sustainable levels of debt although the debt would decline at a slower pace. This scenario would be consistent with continued stability in the foreign exchange market, a sound fiscal framework and healthy banking system which would all be consistent with a low interest rate environment. It should be noted that in the simulation, the maintenance of high primary surpluses, coupled with low positive real interest rates and low inflation are critical factors fomenting the improvement in the debt dynamics. In contrast, Table 3 shows the impact of an initial debt shock of 7.6 per cent coupled with primary surpluses *declining* to 8.4 per cent of GDP at the end of the simulation horizon. In this scenario, the impact of significantly higher real interest rates coupled with higher levels of inflation result in a gradual deterioration in the debt dynamics.

The final exercise, reported in Table 4, shows the combination of a debt shock in excess of 12.0 per cent of GDP coupled with declining primary surpluses. The compounding of the two effects has a significant consequence on the debt dynamics. As shown in Table 4, the twin-shock would likely result in increasingly unsustainable debt dynamics.

4.6 Debt sustainability and sovereign spreads

The assessment of the sustainability of Jamaica's public debt burden is conducted by constructing an index, derived from the likelihood of the simulations of the debt to GDP ratio exceeding a given threshold over a specific time-horizon. Specifically, the paths of the debt to GDP realizations are computed using Monte Carlo simulations with 1000 replications for a five-year out-of-sample forecast based on the estimates from the VAR and the debt accumulation equation.[24] This path is then used to compute the probability that the debt to GDP ratio exceeds a given threshold. The exercise is repeated from January 2002, for months $t+1$ up to and including data to September 2004. The exercise performed here is similar to that of a stress test. Figure 10 shows the result for the probabilities of reaching a debt attaining a debt ratio larger than 150.0, 180.0, and 200.0 per cent of GDP during the five-year horizon.

TABLE 3. INITIAL DEBT SHOCK OF 7.6 PER CENT OF GDP AND DECLINING PRIMARY SURPLUSES

	2004M9	*2004M12*	*2005M3*	*2005M6*	*2005M9*	*2004M12*	*2006M3*	*2006M6*
Inflation	12.74	10.31	9.11	9.05	9.58	10.11	10.33	10.23
GDP growth	2.72	2.59	2.64	2.83	3.06	3.24	3.35	3.45
Primary surplus (% GDP)	11.53	11.28	10.57	9.78	9.15	8.77	8.60	8.48
Real exchange rate	(10.72)	(8.02)	(6.23)	(5.65)	(5.82)	(6.43)	(6.88)	(7.02)
Real interest rate	1.71	2.23	4.01	5.86	7.11	7.75	8.18	8.38
Shock to debt (% GDP)	7.62	11.11	9.03	6.32	4.74	4.13	3.73	3.89
Debt GDP ratio	1.35	1.30	1.30	1.31	1.34	1.38	1.44	1.53

[24] Thus a five-year out-of-sample forecast of the debt-GDP based on the VAR is computed with the available data up to month t.

TABLE 4, INITIAL DEBT SHOCK OF 12.2 PER CENT OF GDP AND DECLINING PRIMARY SURPLUSES

	2004M9	*2004M12*	*2005M3*	*2005M6*	*2005M9*	*2004M12*	*2006M3*	*2006M6*
Inflation	12.73	10.20	9.06	9.07	9.47	9.65	9.55	9.36
GDP growth	2.74	2.73	2.99	3.32	3.54	3.64	3.66	3.65
Primary surplus (% GDP)	11.46	10.90	10.07	9.37	8.88	8.52	8.24	8.05
Real exchange rate	(11.02)	(8.16)	(6.36)	(5.86)	(6.11)	(6.33)	(6.26)	(6.05)
Real interest rate	2.42	4.70	6.03	6.71	7.19	7.90	8.58	9.08
Shock to debt (% GDP)	12.20	9.07	6.93	5.69	5.41	4.42	3.55	3.02
Debt GDP ratio	1.41	1.43	1.47	1.51	1.57	1.65	1.76	1.91

For February 2002, given the initial conditions at that time, the real interest rate and the covariance matrix estimated until the previous month, the analysis indicates that the probability of a debt to GDP ratio larger than 180.0 per cent is 83.0 per cent. At February 2004, the probability fell to 60.0 per cent, indicating a lower risk profile associated with the sustainability of GOJ debt relative to February 2002.

FIGURE 10. PROBABILITY OF DEBT TO GDP RATIO REACHING MORE THAN THRESHOLD IN FOLLOWING FIVE YEARS, 2002-2004

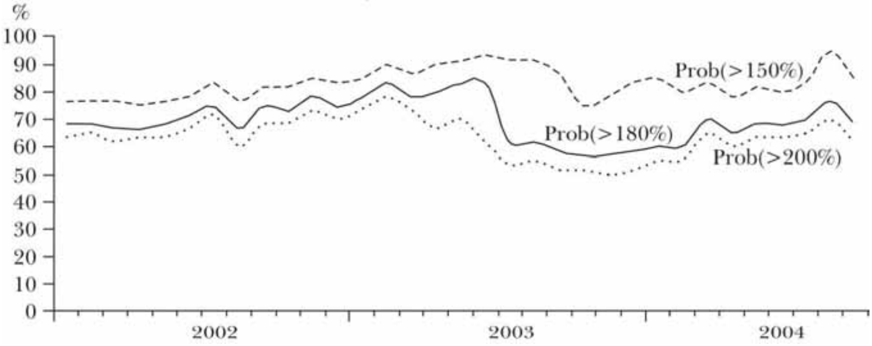


FIGURE 11. PROBABILITY OF TOTAL DEBT TO BE LARGER THAN 180 PERCENT OF GDP AT ANY TIME IN THE FOLLOWING 5 YEARS AND THE GOJ BOND SPREAD, 2002-2004

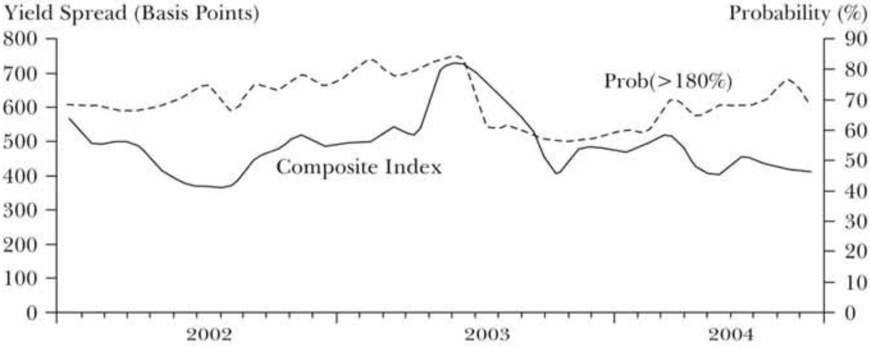


Figure 11 shows the close relationship between the probability of a debt to GDP ratio in excess of 180.0 per cent and the GOJ Eurobond yield spread. It is clear from Figure 6 that the probability of the debt exceeding 180.0 per cent and the spread on the GOJ yields are closely related. The correlation between the two series is 61.0 per cent. Furthermore, regression analysis shows that the risk measure has strong predictive power on both the 1-month-ahead and the 2-month-ahead GOJ composite spread.

The estimation of an AR(2) model produces:

$$s_t = \underset{3.80}{3.951 p_{t-1}} + \underset{2.70}{2.772 p_{t-2}} + [\,AR(1) = \underset{5.02}{0.877}, AR(2) = \underset{-1.00}{-0.146}\,]$$

where s_t is the Euro spread in levels, and p_t is the probability that the debt reaches some threshold identified in the Monte Carlo exercises. Both the first p_{t-1} and the second lagged probability measure, p_{t-2}, are statistically significant at the 5.0 per cent level and the R-squared of the regression is 54.8 per cent.

These results indicate that the methodology captures a signifciant share of the market perception of the default risk in Jamaica's soveriegn debt, given that the risk measure is strongly correlated with the GOJ sovereign risk spread. As such, the risk measure constitutes an effective method to assess the vulnerabilty of the financial sector to the risk of default.

5. CONCLUSION

Changes in the primary deficit and the real interest rate have the largest impact on the debt dynamics in Jamaica. These are followed by changes in the inflation rate and the real exchange rate. This underscores the importance of the co-ordination between fiscal and monetary policies towards attaining increasing levels of debt sustainability. Futhermore, the analysis shows that small improvements in macroeconomic economic conditions and a continuation of the country's recent fiscal improvements would push Jamaica's debt stock in the right direction.

Sensitivity analysis conducted within the risk-based framework developed suggests that a debt shock of approximately 7.0 of GDP, coupled with primary surpluses maintained at 11.4 per cent would still be consistent with increasingly sustainable levels of debt. However, a debt shock in excess of 12.0 per cent of GDP, coupled with primary surpluses declining to approximately 8.0 per cent of GDP, would lead to increasingly unsustainable debt dynamics. Moreover, should the trends in real interest rates, growth rate of GDP and primary surpluses during 2004 be maintained over the medium-term, the debt to GDP ratio would start declining over the next few years. This outlook is corrobarated by the risk-based asssessment showing a non-trivial portion of realizations which indicate that this ratio could steadily decline.

This paper puts forward a stochastic measure reflecting the underlying relations among the variables that affect the debt accumulation process to compute future paths for the debt to GDP ratio. Further, the significant correlation and predictive power of the 'risk probabilities' derived in this paper on GOJ Euro-bond spreads indicates that the measure constitutes an effective method to assess debt sustainability.

Appendix

FIGURE A.1. DEBT SUSTAINABILITY WITH RISK: STOCHASTIC INPUTS, 2005-06

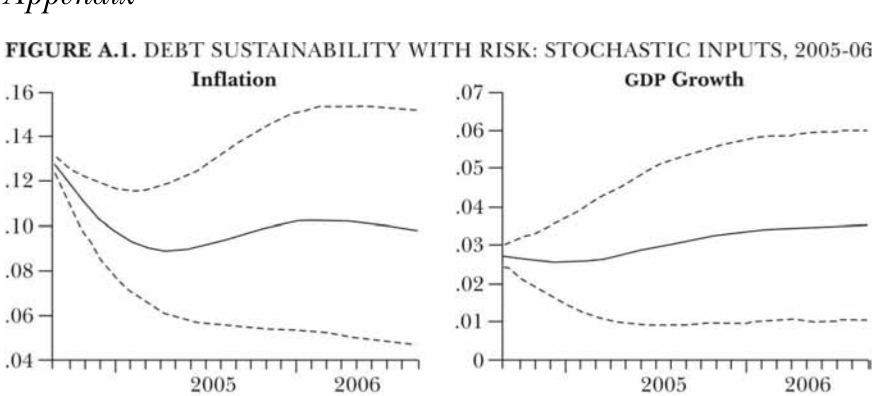
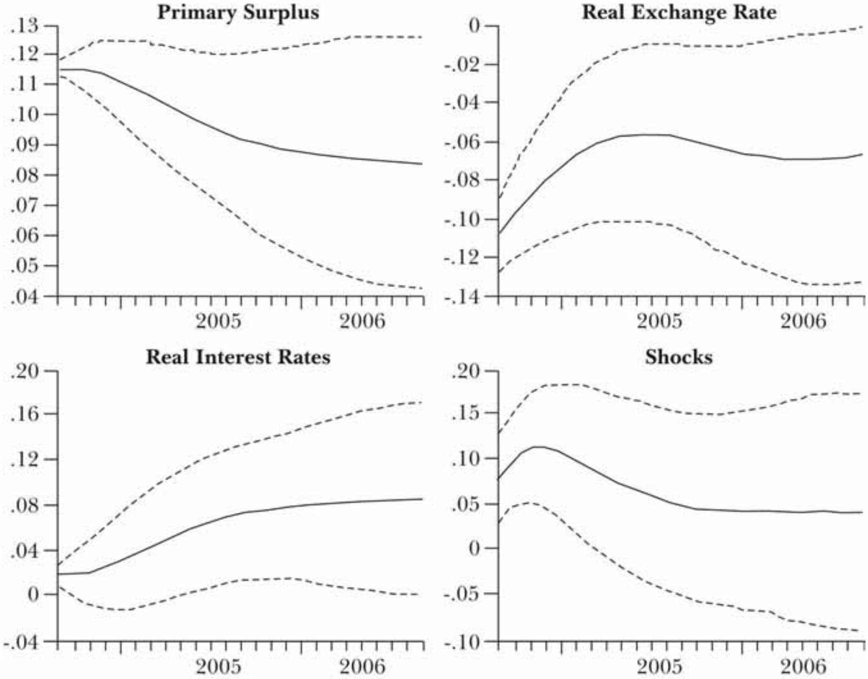


FIGURE A.1 *(conclude)*



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Jorge Salas M.

Non-linear effects of monetary policy and real exchange rate shocks in partially dollarized economies: an empirical study for Peru

I. INTRODUCTION

Starting from the first Neo-Keynesian theories related to nominal rigidities which emphasized the fact that changes in nominal wages are rigid downwards, the presence of menu costs and the existence of output capacity constraints (surveyed by Gordon, 1990), monetary policy literature has focused some attention to the asymmetries that arise when this policy operates. Altogether, these issues have suggested the existence of a convex aggregate supply curve. Additionally, another group of theories have indicated the possibility that the reaction of the demand curve could be asymmetric in the presence of borrowing constraints and also as a consequence, along with other supply effects, of non-homothetic preferences (surveyed by Castillo and Montoro, 2005).

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By using modern econometric techniques, several studies for developed economies[1] have shown that the response of inflation and output can differ depending on the state of the economy as well as on the size and sign of monetary shocks. These asymmetries have been found to arise depending on the position of a given variable (e.g., in terms of the position of the business cycle) –we will refer to this one as the "transition" or "state" variable in the rest of the paper. Particularly appealing is the evidence reported by Weise (1999), who suggests the existence of a convex supply curve in the US as the main element in determining asymmetries, by using a Smooth Transition Vector Autoregression (STVAR).

To our knowledge, though of great importance for monetary policy analysis in partially dollarized economies, not many studies regarding asymmetries have been carried out with data from these countries. In this paper, we try to fill this gap. Also, we depart from the traditional exclusive study of monetary shocks as we also analyze the asymmetric dynamics derived from real exchange rate shocks, since we believe that monetary policy in highly dollarized economies is tightly linked to exchange rate disturbances. In particular, we show how monetary policy and exchange rate shocks operate depending on the position of the business cycle in Peru, an economy with a high degree of dollarization. For each of these situations, we draw different impulse response functions that vary in sign and magnitude using the same methodology employed by Weise (1999).

The value of this study, we believe, is not only in terms of testing the existence of asymmetries (and in posing consequent observations for monetary policy management), but since partially dollarized economies may present different dynamics than "single-currency" ones, we can also establish comparisons on how do these two type of economies respond to shocks of similar nature. *A priori*, in dollarized economies, a relevant difference is probably the presence of a negative balance sheet effect associated to real exchange rate depreciations. This issue is very relevant for our study since it could be a key element generating additional asymmetries to those observed in developed economies. The balance sheet effect occurs whenever a country characterized by agents who are highly indebted in foreign currency –and where assets are mostly denominated in domestic currency– experiences

[1] De Long and Summers (1988), Cover (1992), Morgan (1993), Thoma (1994), Karras (1996), Weise (1999), Karamé and Olmedo (2002), among others.

a large real exchange rate shock that weakens the economy's balance sheet, usually in the non-tradable sector. Moreover, in the presence of frictions in the financial system, the "financial accelerator" mechanism (Bernanke and Gertler, 1989) predicts a strong negative effect in terms of aggregate demand (Céspedes et al., 2004). An additional implication for liability-dollarized economies is that a change in the central bank's reference rate may trigger a movement in the real exchange rate that, by activating the balance sheet effect, could bring about a variation on output of the opposite sign to the expected by monetary authorities. As it is widely known, as well, in these economies, central bank's intervention in the exchange rate market is very likely. In fact, shocks in this variable can also operate asymmetrically as a consequence of policy intervention and not just because of a latent balance sheet effect directly.

To round up the idea, in the case of an economy such as Peru, asymmetries may surge as a result not only of the traditional supply and demand arguments, but also of the presence of the balance sheet effect. This effect might have direct implications on output and prices or indirect ones *via* monetary policy intervention.[2] By studying the role of asymmetries, we try to elucidate the importance of this mechanism and consequently, to more clearly identify distinctions among monetary policy in both types of economies (i.e., non-dollarized and highly dollarized). Besides, it is worth to take into account the difficulty to conclude that the balance sheet effect is only activated after devaluations or rather, in general, after shifts in the real exchange rate regardless of their direction; on the other hand, it could be also important to contrast whether the size of the shock is relevant to activate such effect. These are additional reasons, which justify the use of a non-linear econometric technique.

In sum, the main objective of our research is to answer two relevant questions for monetary policy: first, what are the asymmetries in terms of monetary and real exchange rate shocks present in dollarized economies, and second, how different are these from those that have been found in "single-currency" economies? The Peruvian economy is of particular interest as a case study since dollarization has reached about 70% of deposits while mac-

[2] This intervention could eventually be an evidence of "fear of floating" from the central bank (Calvo and Reinhart, 2002), this is, fear of large currency swings due to their pervasive consequences in terms of output and, among other possible reasons, a higher pass-through effect than in non-dollarized economies.

roeconomic conditions have remained stable and inflation has remained at developed economy standards for several years.[3] We believe that the shape of asymmetries found in this country may shed light on the questions posed in this paper.

We arrange the document as follows: in section II we discuss related literature; in section III we explain the formal framework of the methodology, while in section IV the impulse response functions of the baseline linear model are shown. We test the presence of asymmetries in section V and report and explain the results of the STVAR estimation in section VI. We conclude in section VII.

II. RELATED LITERATURE

Among the literature related to the convexity of the supply curve, Ball and Mankiw (1994) build a theoretical model to explain the asymmetric dynamics of inflation. In short, they use menu costs for firms so when inflation is positive, negative shocks can bring relative prices back to their optimal level. As a result, firms will tend to adjust prices only when negative shocks are big enough to compensate menu costs. In contrast, when shocks are positive, relative prices depart further from their optimal level; thus, changes in nominal prices are more probable. Hence, under the presence of menu costs one could expect positive shocks to be more likely to induce shifts in inflation than negative ones.

Along with nominal price rigidities, if firms are confronted to capacity constraints their marginal cost should be more elastic to aggregate demand shocks when the economy is closer to its short-run output capacity, meaning that price adjustments would be more likely. In opposition, nominal wage rigidities would render inelastic marginal costs that make demand shocks more responsive in terms of output than prices.

More recently, Castillo and Montoro (2005) build a Neo-Keynesian model in which a concave aggregate supply curve co-exists with non-homothetic preferences –which proxy borrowing constraints. Their analytical study can be used to explain asymmetries in any direction since asymmetric shocks in the supply side are counteracted by asymmetric demand responses. In any

[3] This performance is in line with the analysis of Reinhart et al. (2003), who find evidence that a high degree of dollarization does not seem to be an obstacle to monetary control or to disinflation.

case, the prevalence of one of these effects (depending on the state of the economy) will rely upon the chosen parameterization. They conclude that for their set of parameters, monetary policy is more effective in terms of output in booms. Asymmetries are higher when deviations from the steady state come from supply shocks rather than demand shocks.

These authors also survey evidence on the asymmetric effects of monetary policy for developing countries. They divide the empirical literature into two categories. Within those that report evidence for differentiated responses in terms of size and sign, De Long and Summers (1988), Cover (1992) and Morgan (1993) argue that in the US, expansionary monetary shocks have no effect on output, whereas negative ones show some impact in economic activity (the first two use money aggregates while the latter uses the Federal Funds rate). Karras (1996) finds similar evidence for several other industrial countries. In contrast, Ravn and Sola (1996) disagree with those results since they state that it is not a different sign which causes asymmetries but rather their size. They conclude that small unanticipated changes in money supply are non-neutral whereas big unanticipated shocks have no effects.

In the second category of studies surveyed by Castillo and Montoro (2005), the asymmetries follow the state of the economy at a given point in time. For instance, they discuss the work of Thoma (1994).[4] Using rolling causality, this study suggests that the relationship between income and money becomes stronger when activity declines and weaker when it increases, implying the existence of a non-linear response of income to monetary policy shocks. Additionally, when testing differences between negative and positive shocks, the author finds that negative shocks have stronger output effects during high-growth periods than in the opposite case. On the other hand, positive shocks do not seem to cause distinct effects.

Highly dollarized economies may present a third source of asymmetries if a balance sheet effect is latent.[5] Thus, additional asymmetries may appear as a consequence of the interaction between policy rate and the exchange rate when the balance sheet becomes a threat. Specifically, as explained in the previous section, reductions in the policy rate could have no expansionary ef-

[4] Caballero and Engel (1992), Agénor (2001) and Holmes and Wang (2002) are other studies cited by Castillo and Montoro (2005).

[5] For instance, Castro and Morón (2004) explore both analytically and empirically the asymmetric responses of output and prices to exchange rate shocks.

fects in the presence of this channel if it caused real exchange rate depreciations.

Regarding this last point, several studies have exposed that in spite of the so-called Fear of Floating,[6] a high level of dollarization has not completely inhibited the role of monetary policy (Reinhart et al., 2003). Peru has been no exception: despite maintaining an average of over 70% of credits and liquidity in dollars during the past 10 years, monetary policy has proven effective. For instance, Winkelried (2004) concludes by using an error correction model, that in the event of a restrictive monetary shock of 1%, the GDP (output gap) reacts by falling between 0.5% and 0.6% within a year. In Bigio and Salas (2004), it is stated that an increase of 1% in the rate of the Deposit Certificates of the Central Reserve Bank of Peru triggers a fall in the product. Such fall lasts between the 6th and 8th month after the shock, with a considerable average impact of -0.4%. When it comes to inflation response, the evidence has also shown monetary policy effectiveness (Quispe, 2000; Rossini, 2001). Winkelried (2004) finds that a 1% shock in the reference rate lowers inflation in a magnitude around 0.3% within a year.

Concerning the effects of exchange rate shocks in partially dollarized economies, the international evidence on the question of whether competitiveness effect –this is, the classical effect in which export-related sectors is boosted by currency depreciations– offsets the balance sheet effects is not conclusive, as surveyed by Carranza et al. (2003). However, these authors' own firm-level analysis focuses in the Peruvian case and they find evidence contrary to a significant competitiveness effect and in favor of a negative balance sheet effect.[7] By using aggregate Peruvian data, Winkelried (2004) arrives to the same conclusion regarding the balance sheet effect, but this paper does suggest a significant competitiveness effect in the long term.[8]

Castro and Morón (2004) have analyzed the non-linear effect

[6] See Calvo and Reinhart (2002).

[7] Loveday et al. (2004) have also found empirical support for a latent balance sheet effect in Peru in the level of non financial firms.

[8] Céspedes (2005) uses a large sample of devaluation episodes for a group of emerging and developed countries and he finds that balance sheet effects have a significant and negative impact on output, but in the medium term, the expansionary effect of the real devaluation tends to prevail. Interestingly, he also suggests that countries with deeper financial markets experience lower output losses after devaluations.

of real exchange rate shocks on output. This work suggests that the higher the shock, the more negative the response becomes –a symptom of the presence of a balance sheet effect. In terms of prices, the results reported in this study are intriguing since the greater the real exchange rate shock, the smaller (and even negative!) the rate of pass-through would be.[9] A kind of similar pattern has been found in Carranza et al. (2004), although they focus on the effect of nominal rather than real exchange rate shocks over inflation. By employing univariate threshold models this document shows evidence that in dollarized emerging economies a negative pass-through coefficient would prevail during economic downturns. Nonetheless, a more exhaustive analysis concerning pass-through in Peru has been carried out in Winkelried (2003), where the presence of asymmetries is proven but according to this paper, the asymmetries do not behave in the manner proposed by Carranza et al. (2004), in the sense that the pass-through coefficient would always be positive. By using a STVAR approach, the study states that once the nominal exchange rate has already depreciated, an additional increase in the exchange rate has a pass-through rate about 10% higher, and that in expansionary periods depreciations have around 30% more pass-through rate than in recessions.[10] Finally, an interesting result of this paper is that a reduction in the rate of dollarization reduces the pass-through rate.

Of course, not only the latent balance sheet effect but also the uncertainty of its consequences has been enough incentive for central banks' interventions in the exchange rate market. As well, as a consequence of the high dollarization, since a greater pass-through level of exchange rate over domestic inflation should be expected, these economies have relied upon dirty floating (Parrado and Velasco, 2001).[11] It is feasible to expect exchange rate

[9] It is worth to mention that these authors carry out a similar methodological approach than ours, but they employ a monetary aggregate as the instrument of monetary policy, while we use an interest rate, given that this is the tool controlled by the Peruvian Central Bank since some months previous to the Inflation Targeting Regime adoption (in January 2002) –see more discussion about the monetary policy interest rate in the Appendix–. This fact may imply a misspecification of their VAR. Additionally, they do not include any exogenous variable nor do they report any confidence bands.

[10] Another study by Miller (2003) employs a linear VAR analysis and states that for 100% devaluation, inflation would increase by 16%.

[11] As pointed in the Fear of Floating literature, not only a higher pass-through coefficient would be the exclusive reason behind this type of central

shocks to be followed by monetary policy responses that quickly neutralize them.[12]

Policy reactions after real exchange rate shocks has been vastly analyzed; as a matter of fact, an open debate has been recently present in the economic literature on what should be the optimal monetary policy followed by small open economies (see, for instance, Galí and Monacelli, 2004). Despite a relative consensus among recent studies favoring an absolute free floating, it is worth to note that many of them compare extreme situations, i.e., flexible exchange rate against fixed exchange rate. On the contrary, Parrado and Velasco (2001) build a stochastic model concluding that the optimal monetary policy is that by which external shocks to interest rates are accompanied by raises in domestic interest rates less than proportional to their size. Lahiri and Végh (2001), and more recently Morón and Winkelried (2005), have suggested that the optimal policy to be followed by monetary authorities should be asymmetric, where large fluctuations in the exchange rate should be counterbalanced in greater proportion than smaller ones since only large shocks trigger balance sheet effects, while intervention as a response to small sized shocks would incentive a raise in dollarization.

III. METHODOLOGY: SMOOTH TRANSITION VAR

The origin of the STVAR methodology goes back to the Time-Varying Smooth Transition Autoregressive models presented originally by Terasvirta and Anderson (1992). These autoregressive models rely on the specification of a function related to a transition or state variable (or set of variables in more elaborate versions) that will determine the dynamics of the difference equation that conform the models. Extending them into their VAR formulation is straightforward. Different functional forms can be

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banks' behavior in dollarized economies, but also the possible loss of access to international capital markets and the restrictive balance sheet effects after large devaluations, and the negative consequences for import activities and the "Dutch Disease" threat in the case of currency revaluations.

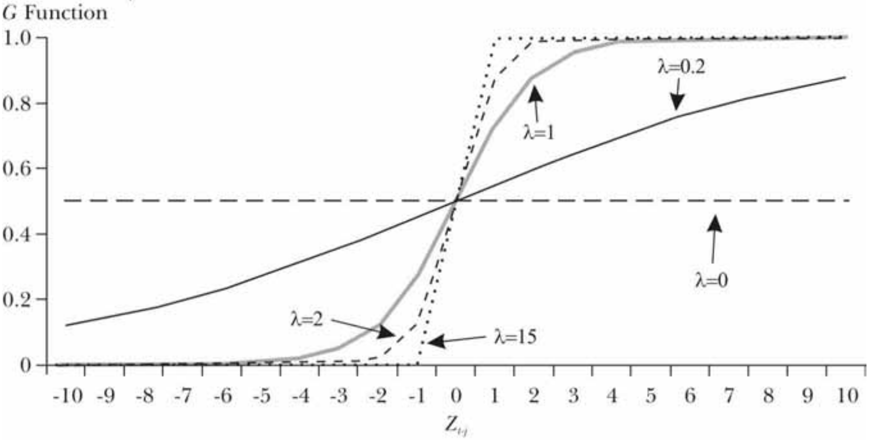
[12] The question of whether Peru, where a managed floating exchange rate regime officially exists, could be catalogued as a "phony floater" has been discussed at least in two papers (and remains as a non conclusive debate): Castro and Morón (2000) and Rossini (2001). The former presents evidence in favor of that hypothesis while the latter rejects it.

tested for a given state variable. We will use the logistic formulation for the transition function (or *G*-function) as expressed by equation (1).

$$G(z_{t-j};\gamma,\theta)=\left[1+e^{-\gamma\frac{(z_{t-j}-\theta)}{\sigma_z}}\right]^{-1} \quad \text{where } \gamma>0. \tag{1}$$

This function takes values from 0 to 1 depending on a given threshold represented by θ, a smoothing parameter γ and the value of a transition variable z in a given point of time (t-j), where σ_Z is the standard deviation of z_t. As z_{t-j} approaches to infinity, the *G*-function tends towards 1 whereas when the former approaches to minus infinity, the function tends to 0. This can be viewed in figure 1: for greater values of γ the *G*-function behaves more closely as a dummy variable that activates whenever $z_{t-j} > \theta$ (such as the curve for γ=15, where the transition describes an almost vertical line for z_{t-j} = 0).

FIGURE 1. THE SHAPE OF *G*-FUNCTION FOR THRESHOLD θ = 0 AND DIFFERENT VALUES OF γ



To understand how a non-linear VAR is built, we start by presenting its moving average representation as:

$$Y_t=[I-\Phi(L)]^{-1}C\varepsilon_t\ , \tag{2}$$

Where Y_t represents a k-vector of variables at point t in time and $[I-\Phi(L)]^{-1}$ is an array of parameters and lag operators. C is a k-by-k matrix that defines interrelations among the system's vector of disturbances ε_t (typically, C is defined as to be an identity matrix).

The Smooth Transition version for this VAR may incorporate the G-Function, to yield the following form:

$$Y_t = [1 - \Phi_1(L) - G(z_{t-j})\Phi_2(L)]^{-1} C\varepsilon_t \quad (3)$$

The simplest way to interpret equation (3) is to think of the extreme case of $\gamma = \infty$. One can observe that in such instances, Y_t will be represented by two different linear VARs, operating once G transits to one of its respective two possible values (i.e., 0 and 1, since G-function behaves more like a dummy). When γ takes smaller values, the states are no longer two but rather, work as a continuum that transit smoothly from the extreme situations in which $z_{t-j} = -\infty$ and $z_{t-j} = \infty$. It is also possible to extend (3) in order to include possible exogenous regressors.

IV. THE CORE LINEAR MODEL

We use a core linear model to identify the transmission of structural shocks through the economy. Later on, we add a non-linear structure to this model [i.e., we build a setup for (2) and then extend it to (3)]. The baseline Structural VAR (SVAR) model is built following Christiano et al. (1999), as the monetary policy's reaction function is identified by dividing the variables that can be contemporaneously affected by the policy tools. Thus, the SVAR is specified in the form of three recursive blocks: variables that are not contemporaneously affected by monetary policy, policy variables and variables that may be contemporaneously affected by the former block.

Regarding the policy block, it is assumed that, as has been recently surveyed by Woodford (2003), money aggregates can be treated as endogenous to the policy rate when this one is the instrument employed by monetary authorities to reach their objectives, as in the Peruvian case.

We further assume that the policy block is unable to affect contemporaneously both output and inflation. Moreover, we understand that output is the most exogenous variable of the VAR, as relevant information for production decisions may take several lags to be processed. As well, a second assumption regarding the non-policy block is that inflation has a certain inertial component but can contemporaneously react to output shocks. Finally, we presume that the real exchange rate could respond to all the previously mentioned variables, even the policy tools,[13] so it is the most endogenous variable of the system.

Consequently, the structural form of our procedure is as follows:

$$
(4) \quad
\begin{aligned}
R_t &= \phi_1 M_t + \phi_2 i_t + \phi_3 y_t + \phi_4 P_t + f_1(Y_{t-1}, X_t^*) + \varepsilon_t^R \\
M_t &= \phi_5 i_t + \phi_6 y_t + \phi_7 P_t + f_2(Y_{t-1}, X_t^*) + \varepsilon_t^M \\
i_t &= \phi_8 P_t + \phi_9 y_t + f_3(Y_{t-1}, X_t^*) + \varepsilon_t^i \\
P_t &= \phi_{10} y_t + f_4(Y_{t-1}, X_t^*) + \varepsilon_t^P \\
y_t &= f_5(Y_{t-1}, X_t^*) + \varepsilon_t^y
\end{aligned}
$$

In this formulation, R_t, M_t, i_t, P_t and y_t represent the real (bilateral) exchange rate, a money aggregate, the monetary policy reference rate, the CPI and the output gap, respectively. All variables are expressed as twelve-month log differences, except for the policy rate, which is expressed in a simple annual difference. As well, f_i represents a linear function composed by two sets of information (variables), Y_{t-1} and X_t^*. These sets represent information regarding to the endogenous and exogenous variables, respectively, from a given point in time up to periods *t*-1 and *t*, respectively again. Finally, ϕ_i symbolizes a given parameter and ε_t is a stochastic disturbance. The system of equations in (4) takes the form of (2) once it is expressed in its moving average formulation.

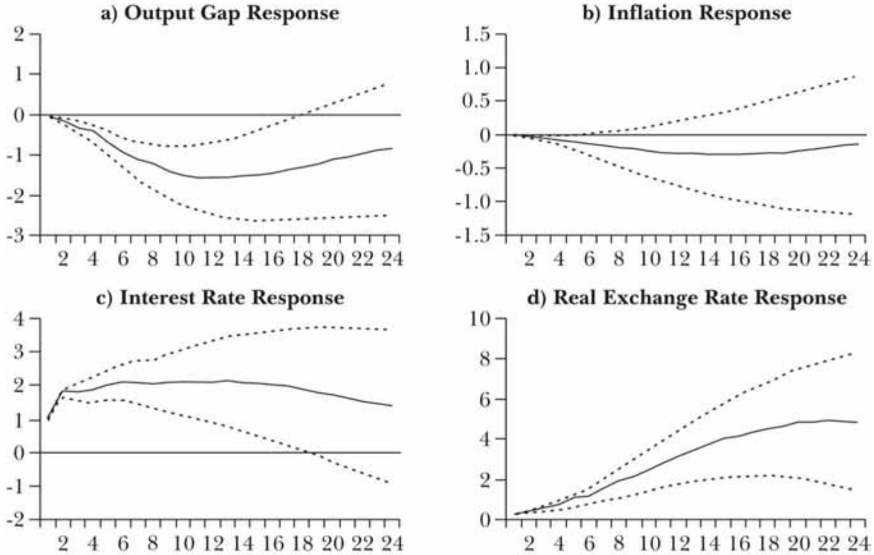
In the Smooth Transition version of this system, we let ϕ_i to take different values depending on a transition variable. We discuss this in the following section.

We estimated this specification using the usual ordinary least squares procedure. We tried over several tentative models using alternative variables.[14] The exogenous variables corresponding to X_t^* are reviewed in the Appendix. Lag structure and autocorrelation tests indicated the use of 4 lags in the estimation; in the case of the exogenous variables, only one lag is added to the contemporaneous value.

[13] As mentioned by Bravo and García (2002), who implement the same SVAR for the Chilean economy, the central bank may affect the real exchange rate through the existing connection between the nominal exchange rate, the policy rate and exchange market interventions.

[14] We discuss details on the employed data and the transformations that were necessary to be performed in the Appendix.

PANEL FIGURE 1. ACCUMULATED RESPONSES TO A MONETARY IMPULSE (1% INTEREST RATE INCREASE) IN THE LINEAR MODEL



NOTE: Dotted lines represent 95% Monte Carlo-confidence bands (based on 1,000 replications).

1. Linear impulse response functions

The accumulated impulse response functions for the linear system expressed by (4) can be observed in Panel Figures 1 and 2.[15]

Panel Figure 1 shows the responses to an increase of 1% in the policy rate. One can notice that the monetary policy operates in a traditional fashion causing a reduction in the output gap (Panel Figure 1.a) and inflation (Panel Figure 1.b). Instead, Panel Figure 1.c suggests the existence of an exchange rate puzzle since an increase in the interest rates causes a real depreciation in opposition to the appreciatory effect that would prevail in the short run (if prices were less elastic than the nominal exchange rate, as expected). We failed to solve this problem by introducing exogenous variables (in alternative estimations), which are typically suggested as a way to circumvent this type of puzzle (see Christiano et al., 1998). A similar puzzle was found in Winkelried (2004) and the author attributed this result to the high volatility

[15] We show accumulated responses in order to make comparisons more feasible along the paper.

and monthly frequency of the data,[16, 17] and in Parrado (2001) for the case of Chile, who argued that the managed exchange rate regime and the taxation of capital inflows could explain this phenomenon. An alternative explanation to this puzzle is that the extension of the data covers a period of a severe sudden stop, which was characterized by high interest rates along with depreciating real exchange rates. Therefore, we estimated an additional (non-reported) specification of the VAR controlling for the short-term external liabilities of Peruvian banks –a very proper variable to capture the capital flows' sudden stop experienced in Peru after the Russian crisis of 1998. However, we found no significant changes in the dynamics compared to those observed in the reported results.

The responses to real exchange rate shocks reported in Panel Figure 2 show some different dynamics than those expected in "single-currency" economies. In particular, real exchange rate depreciation, in contrast to the typical *J*-curve effect, only produces a short run significant fall in output.[18] This result is in line with the evidence presented by Carranza et al. (2003) and Bigio and Salas (2004). However, it is difficult to assure whether the real depreciation is triggering a balance sheet effect that lowers output in the short run or, rather, this is a consequence of the central bank's reaction –the raise in the policy rate shown in Panel Figure 2.c– or to a combination of both factors. Nonetheless, it is hard to believe that only monetary policy is working here since we have previous empirical evidence of a latent balance sheet effect in Peru (see section II) and, moreover, we find a positive pass-through rate in Panel 2.b. Again, the rapid significant responses are quite intriguing.

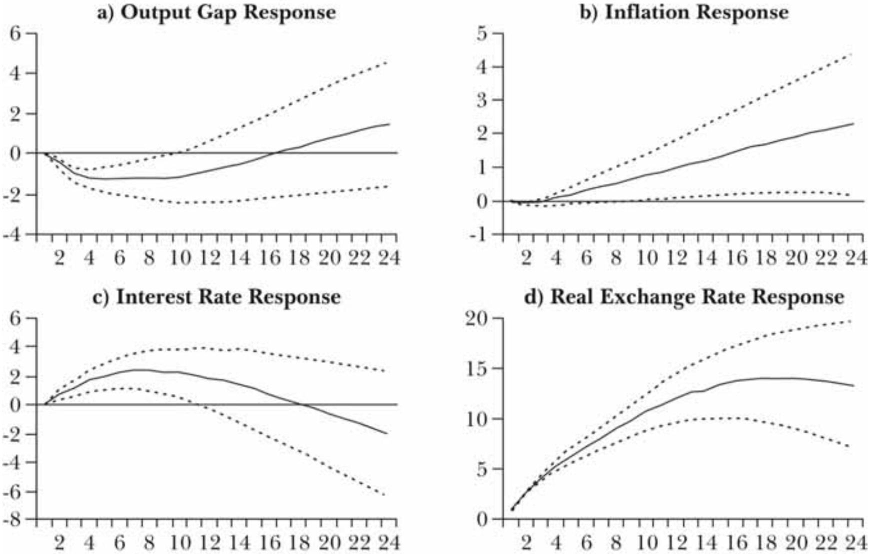
In the next section we present the asymmetric version of this model.

[16] This might also explain the fast significant responses observed in the impulse response functions. A similar pattern is found in previous exercises which used monthly Peruvian data (see, for example, Quispe, 2000; Bigio and Salas, 2004; and the same Winkelried, 2004).

[17] Accordingly, this problem may be solved in future extensions by employing data of higher frequency (e.g., quarterly data) –a solution not considered in our case due to the subsequent loss of degrees of freedom.

[18] An argument to explain the absence of a medium term competitiveness gain as a response to the shock is that the Peruvian economy does not substitute imports substantially with local production. On the contrary, many of its imports are industrial inputs so depreciations basically have a greater price than substitution effect.

PANEL FIGURE 2. ACCUMULATED RESPONSES TO A REAL EXCHANGE RATE IMPULSE (1% INCREASE) IN THE LINEAR MODEL



NOTE: Dotted lines represent 95% Monte Carlo-confidence bands (based on 1,000 replications).

V. THE STVAR

1. Testing the Presence of Asymmetries

One can expand the core linear model in (4) into a form such as (3) and thus we have the non-linear version of the model. Before presenting estimates for this model, we prove the presence of non-linearities by testing the null hypothesis Ho: $\gamma = 0$, where non-rejection would imply that that the system (3) is linear as in (2). In standard estimations, one could test any restriction in any of the VAR equations by building an F-test. The problem with this procedure is that since γ and θ are not previously known, direct χ^2 or F distributed tests are no longer valid. A solution proposed by Lukkonen et al. (1988) is to use a Taylor expansion that distributes χ^2 and has the additional advantage that it no longer requires an estimate for γ or θ.

The first order Taylor expansion of equation (3) takes the following form:

(5) $$Y_t = [1 - \Gamma_1(L) - z_{t-j}\Gamma_2(L)]^{-1} C\varepsilon_t ,$$

So that the null hypothesis $\gamma = 0$ becomes $\Gamma_2(L) = 0$. In order to contrast it, we use the well-known Likelihood-Ratio (*LR*) test.

We define $\Omega_\varepsilon^{linear}$ and $\Omega_\varepsilon^{non-linear}$ as the variance-covariance matrixes of the fitted errors extracted from the OLS estimation of (2) and (5) respectively. The subsequent *LR* test can be calculated under the following specification –which includes the modification proposed by Sims (1980) to take into account small-sample bias:

$$(6) \qquad LR = [T - (\rho k + n_X)](Ln\left|\Omega_\varepsilon^{linear}\right| - Ln\left|\Omega_\varepsilon^{non-linear}\right|) \sim \chi^2(\rho k^2)\,.$$

Here, T represents the sample size, ρ stands for the number of lags in the VAR, k is the number of endogenous variables, and n_X is the number of parameters of the exogenous variables estimated per equation. Notice that what is being tested is the significance of ρk^2 coefficients. We present the corresponding *p*-values for all the variables in our model in Table 1.[19]

TABLE 1. LIKELIHOOD-RATIO TEST FOR NON-LINEARITIES: *P*-VALUES

	Transition variable				
	y_t	P_t	i_t	M_t	R_t
Lag 1	0.36	0.05	0.00	0.49	0.00
Lag 2	0.00	0.02	0.00	0.00	0.00
Lag 3	0.07	0.02	0.00	0.11	0.00
Lag 4	0.00	0.00	0.00	0.13	0.00
Lag 5	0.18	0.00	0.00	0.24	0.00
Lag 6	0.01	0.00	0.00	0.51	0.00

As observed, the *LR* test reveals overall non-linearities when taking (at least one of the lags of) all the series in the system as transition variable. However, as mentioned before, in this study we are focusing on the role of the output gap as the state variable, since the economic theory provides strong arguments to consider its relevance for the type of asymmetries that we are interested in explore empirically here. The evidence in Table 1 is also helpful to pick a certain lag for the chosen transition variable: four of the six lags considered in the test proved to be statistically appropriate in the case of the output gap.[20]

[19] Equation by equation *F*-tests were also performed to contrast non-linearities. The results are available upon request.

[20] The final STVAR estimations were performed using the third lag of this se-

In the following section we present the procedure adopted in order to parameterize our estimation of the extension of (4) into (3).

2. Parameterization of the STVAR

In order to choose the correct parameters in (1), namely the threshold θ and the smoothing parameter γ, one could use a maximum likelihood technique with complete information or a non-linear least squares approach. These procedures have one possible problem that renders this estimation unfeasible: the presence of plenty of local maxima. This is because the model is highly sensitive to γ. As a matter of fact, the greater γ becomes, the larger the difference among states because they are conditioned to be more markedly distinct; in contrast, differences among distinct sign or size shocks will tend to dilute.

We take the same direction as in Weise (1999) who follows Leybournes et al. (1998) by performing a grid search for γ and θ. We do so by estimating *LR* tests that compare each non-linear model for a given pair of parameters γ and θ against the linear version. The 3-d plot that results from this search for the case where the output gap's third lag is treated as state variable is depicted in Figure 2. The range of search for θ is limited to the middle quintile of this series' distribution.[21]

In figure 2, we observe that significant non-linearities are particularly accentuated for values of θ equal or higher than zero, and for high values of γ. Hence, we parameterize θ very close to zero, since it is intuitively appealing,[22] and $\gamma=100$, a very high point that will emphasize the contrasts between one state (i.e., when $y_t > 0$) and the other ($y_t < 0$). This parameterization turns out to be very similar to the one used by Weise (1999) for US data.

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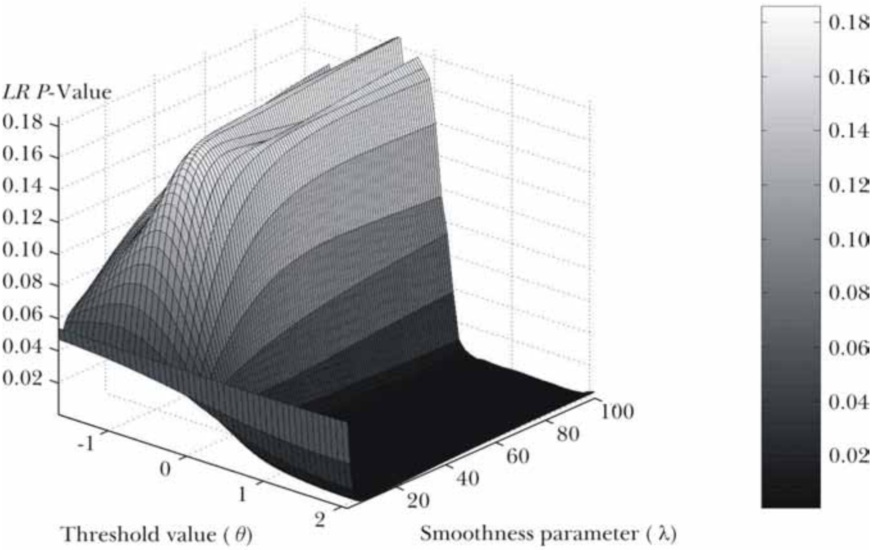
ries as the transition variable, since the asymmetric effects proved to be more clear in the impulse-responses analysis with such election.

[21] Because the data is highly concentrated in the middle of the distribution, when a grid search is performed over broader n-tiles, for high values of θ, the number of periods that lie within one of the states are too few to perform properly the test. This particular difficulty is stressed for a high smoothness parameter and provokes distortions in the *LR* tests.

[22] Given our specification of the output gap in the VAR –i.e., transformed as a twelve-month log difference– the intuition behind $\theta \cong 0$ is straightforward: the threshold is given by the point where the GDP annual growth rate equals the Potential GDP annual growth rate.

FIGURE 2. GRID SEARCH: *LR P*-VALUES FOR DIFFERENT THRESHOLDS AND SMOOTHNESS PARAMETERS GIVEN OUTPUT GAP (THIRD LAG) AS THE TRANSITION VARIABLE



The lag order of the non-linear VAR is 4. We choose this specification using as a guide the linear model. Weise (1999) also suggests the election of the same lag order used in the linear model for several other econometric reasons.

We now continue by commenting the results for the non-linear model estimation in the next section.

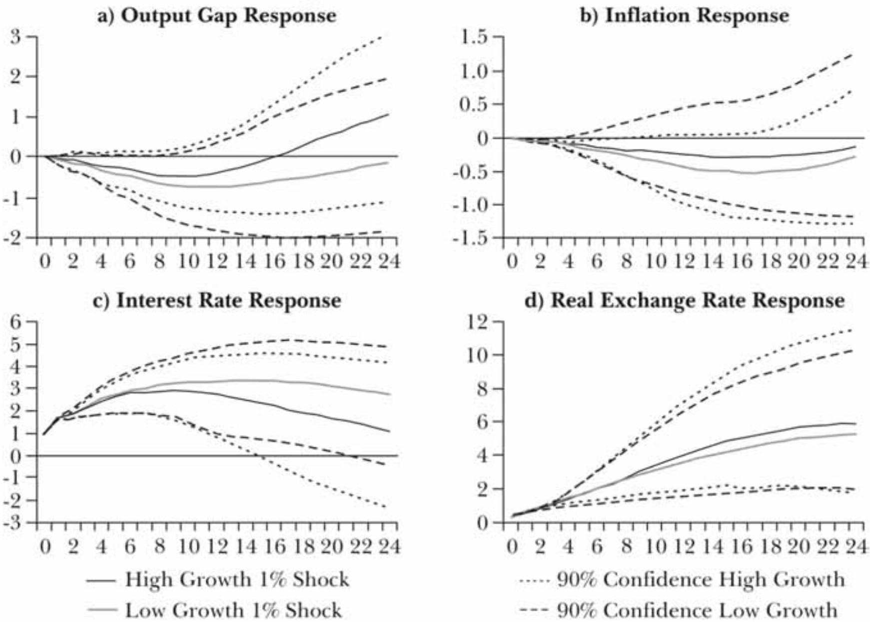
VI. RESULTS

1. Output dependant asymmetries of monetary shocks

The first main result of our study is found in Panel Figure 3 where we show the distinct non-linear impulse-response functions.[23] In panel (a) we find the accumulated response of the output

[23] These impulse-response functions are not constructed in the same fashion as in linear models. In the case of non-linear models, impulse response functions are highly dependant on their past history and on the position of the state variable at a given point in time. Taking expectations over the difference of a path characterized by a given shock and other where the shock is absent would not be the appropriate procedure since the dynamics of the function are not necessarily linear combination of shocks, but rather more complex construc-

PANEL FIGURE 3. ACCUMULATED RESPONSES TO A MONETARY IMPULSE (1% INTEREST RATE INCREASE) BY OUTPUT GAP STATE



(gap) to a 1% increase in the interbank rate depending on the position of the output gap's second lag. Dotted lines represent 90% confidence Generalized Impulse Response Functions (GIRF) bands both when the (annual growth rate of) output gap was greater than zero ("high growth") and for the opposite case ("low growth"). In particular, though not reported in the paper, non-accumulated responses show statistical significance between the third and eighth month after the shock. We can see that about a year ahead from the shock, the magnitude of the output gap response during high economic growth is, on average, two thirds of the response observed in downturn periods.[24] In contrast, the response of inflation is near the double in the former case [see panel (b)]. Moreover, the confidence bands depicted in the same graph suggest a more lasting effect during high growth periods. This feature may also explain why the policy shock proves to be

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tions. So, in contrast, we use the Generalized Impulse Response Function technique detailed in Koop et al. (1999).

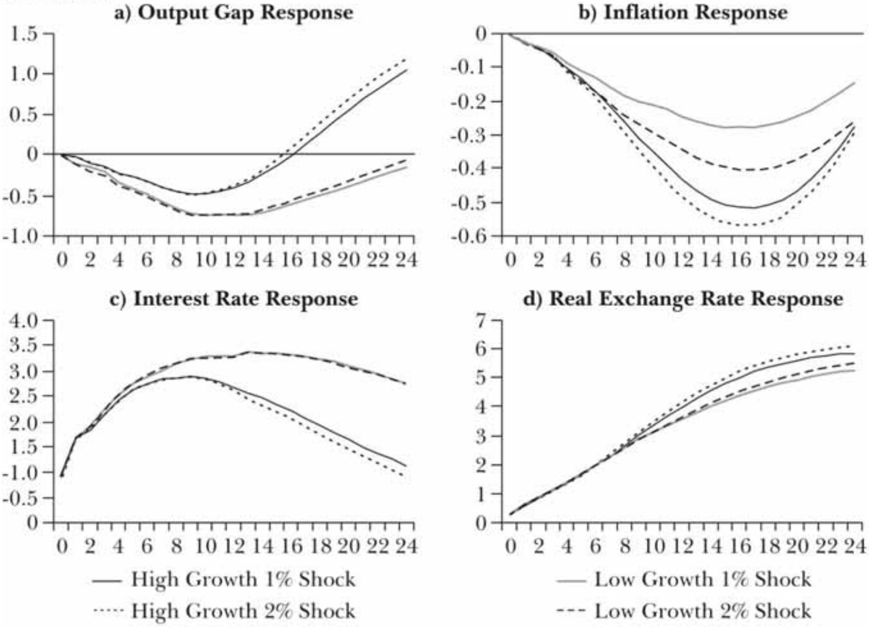
[24] Notice also that, in general, the magnitudes of responses are more realistic here than in the linear model. Compare, for instance, the responses for the output gap [i.e., panel figure 1 (a) *vs.* panel figure 3 (a)].

significantly more inertial during low growth episodes, as shown in panel (c). In general, these graphs prove the presence of asymmetries in terms of the response of some key variables of the economy to monetary policy shocks.

The evidence also suggests that monetary policy shocks over the aggregate demand probably dominate those related to an increase in marginal costs (see Castillo and Montoro, 2005). These findings suggest a convex supply curve as the one attributed by Weise (1999) to the US economy, in line with the Neo-Keynesian literature. The likely presence of a latent balance sheet effect seems not to affect the shape of asymmetries dependent on the output cycle. In the following subsections we show the effects once shocks of different size and sign are introduced.

The solid lines in Panel Figure 4 correspond to the expected impulse response functions, just as in Panel Figure 3, while the dashed lines represent the responses to 2% shocks in the policy rate during high and low output starting points. We divide the response of the 2% shock by two in order to observe if the impact is more than proportional. As one can observe in panel (a), we find

PANEL FIGURE 4. ACCUMULATED RESPONSES TO A MONETARY IMPULSE (1% INTEREST RATE INCREASE) BY OUTPUT GAP STATE FOR SHOCKS OF DIFFERENT SIZE

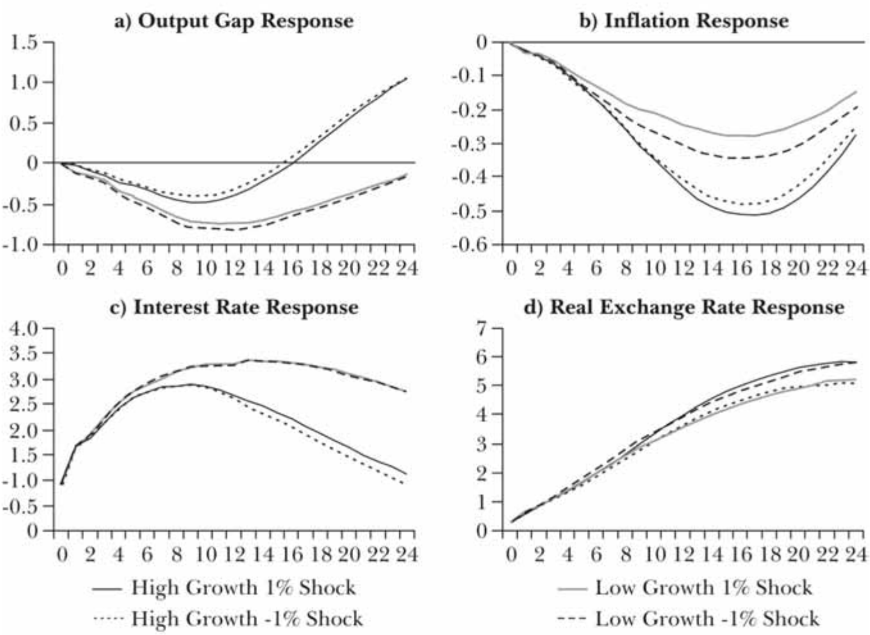


NOTE: The 2% shock responses are divided by 2.

that a double size shock seems to have no particular asymmetric effect in terms of the output gap. The opposite is found in terms of prices: more restrictive shocks generate an even greater restrictive response as one observes in panel (b), and this result is accentuated during low growth periods. Both graphs suggest that supply effects are more relevant in marginal terms the stronger the shocks become. This issue can be interpreted as support for Neo-Keynesian arguments that suggest that capital costs translate to the supply curve once shocks are strong enough as to compensate nominal rigidities such as menu costs; once adjustment costs overpass menu costs, relative prices are corrected and hence, the lesser is the marginal impact in terms of output. Since the share of capital costs is greater than labor costs in determining the firms' marginal costs, our findings are hardly surprising.

Panel Figure 5 compares negative and positive shocks.[25] Again, we find no marked asymmetries in output responses but they do

PANEL FIGURE 5. ACCUMULATED RESPONSES TO A MONETARY IMPULSE (1% INTEREST RATE INCREASE) BY OUTPUT GAP FOR SHOCKS OF DIFFERENT SIGN



NOTE: The -1% shock responses are multiplied by -1.

[25] The impulse response function for expansionary shocks was pre multiplied by -1 in order to be comparable with the positive shocks.

appear more clearly in the case of inflation. For low growth periods, an expansionary shock (i.e. a reduction of 1% in the policy rate) shows to have greater than proportional effects in terms of prices and output when compared to restrictive shocks. Conversely, for high growth periods, expansionary shocks have less effect in both output and prices. Hence, this panel figure suggests something quite appealing: the fact that monetary policy has more power to contract when the economy is in expansion and has more power to expand in low growth periods. One reason for the former case is the existence of capacity constraints that will restrict the expansionary power of monetary impulses. We also may conclude that wage rigidities are not of principal relevance as one might think since restrictive shocks have less impact on output precisely when wage rigidities are more damaging, during low growth periods,[26] compared to positive impulses during the same phase.

For the US, Weise (1999) found no sign asymmetries for 1.5% monetary shocks (in any direction), though when shocks are raised to a double, the evidence indicates that output and prices are more responsive to negative shocks, while only prices are responsive to expansionary shocks in low growth periods.

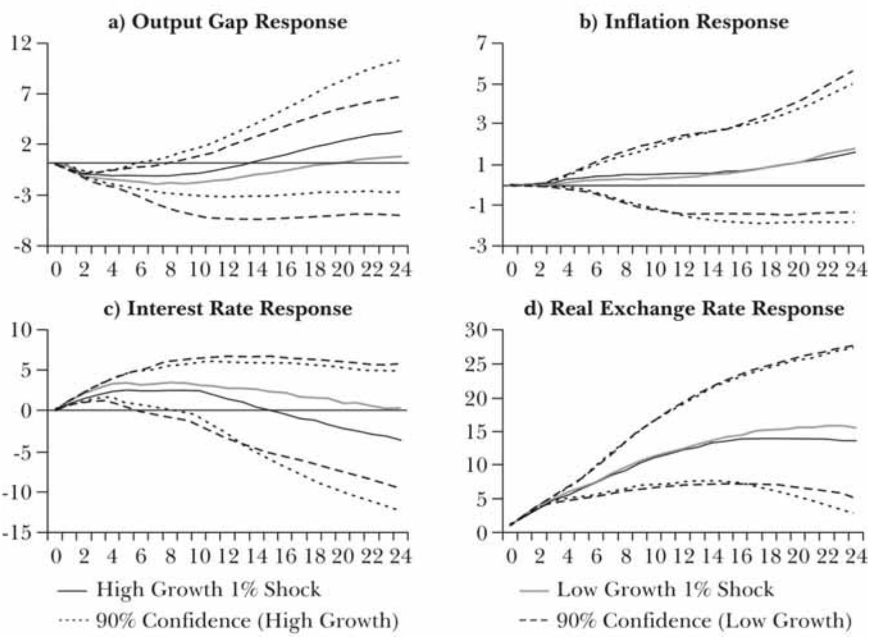
2. Output dependant asymmetries of real exchange rate shocks

As mentioned in section II, for economies that do not suffer from dollarization one should expect a real exchange rate depreciation to have positive effects on output, some periods after a slight contraction –the so called "*J*-curve" shaped effect. For a dollarized economy such as Peru, this may not always be the case as one observes in Panel Figure 6.a. As in the linear model, it is not clear that the quick negative responses of the output gap surge as a consequence of a balance sheet effect that hits the economy or by the response of the policy interest rates to this shock. We believe both effects to be present; moreover, considering previous empirical research based on firm-level analysis where the balance sheet effect was found to exist in the Peruvian economy (see section II). Under such circumstances, monetary authorities would have incentives to raise interest rates for two reasons: to counteract the pass-through of the exchange rate to prices and to avoid the balance sheet effect. Furthermore, given that monetary policy is said to work with several lags, if output is

[26] See for example Jackman and Sutton (1982).

affected almost immediately after the real exchange rate shock, as our results reveal, it is likely that only the balance sheet effect is working in the very short run.

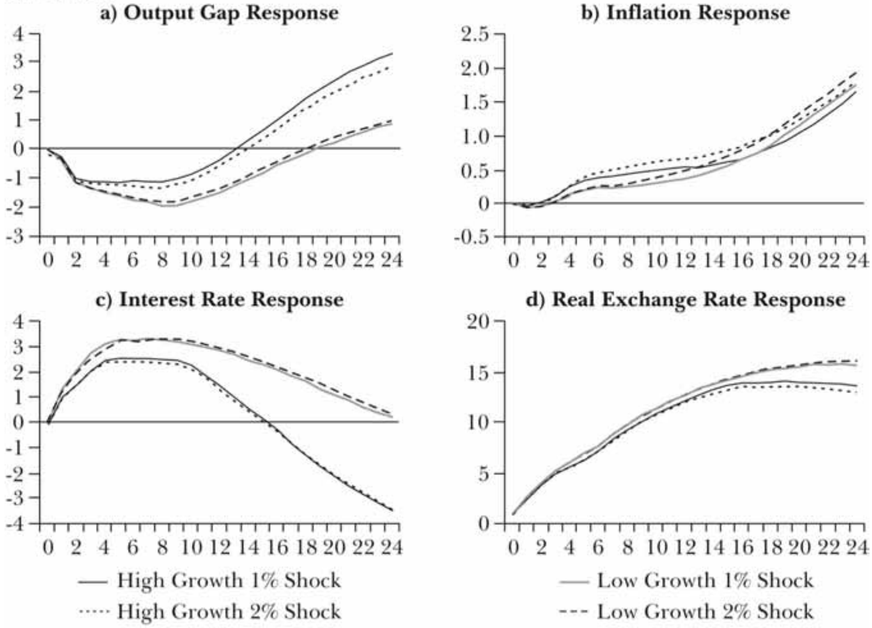
PANEL FIGURE 6. ACCUMULATED RESPONSES TO A REAL EXCHANGE RATE IMPULSE (1% INCREASE) BY OUTPUT GAP STATE



Panel (a) presents additional evidence, in particular, that the negative effect in terms of the output gap is greater and lasts significantly more when the economy is a low growth context. As a matter of fact, Panel (c) shows a more aggressive response by monetary authorities when in low growth thus suggesting greater fear for abrupt depreciations during these periods. This last point makes sense taking into account that firms are stand in a more fragile position when the economy in not growing enough. Turning back to the effects on output, it is hence not clear whether the greater impact of the real exchange depreciation on low growth periods is a consequence of the asymmetric response of the monetary authorities worried for a greater balance sheet effect, or by a more damaging balance sheet effect itself. Panel (a) also shows the apparent absence of a significant long-run positive output response.

Panel (b) shows a superior pass-through rate when the economy is in a high growth period [this is more clear when observing Panel (b) in Panel Figure 7]. It is again not obvious if this is because of some overheating in the economy or because the response of monetary authorities during these periods is less emphatic. In any case, the results are consistent with Winkelried (2003), who reports an always positive pass-through rate both in periods of economic growth and downturns. The strong dynamics regarding the evolution of the real exchange rate respond to a highly persistent autoregressive process.

PANEL FIGURE 7. ACCUMULATED RESPONSES TO A REAL EXCHANGE RATE IMPULSE (1% INCREASE) BY OUTPUT GAP STATE FOR SHOCKS OF DIFFERENT SIZE

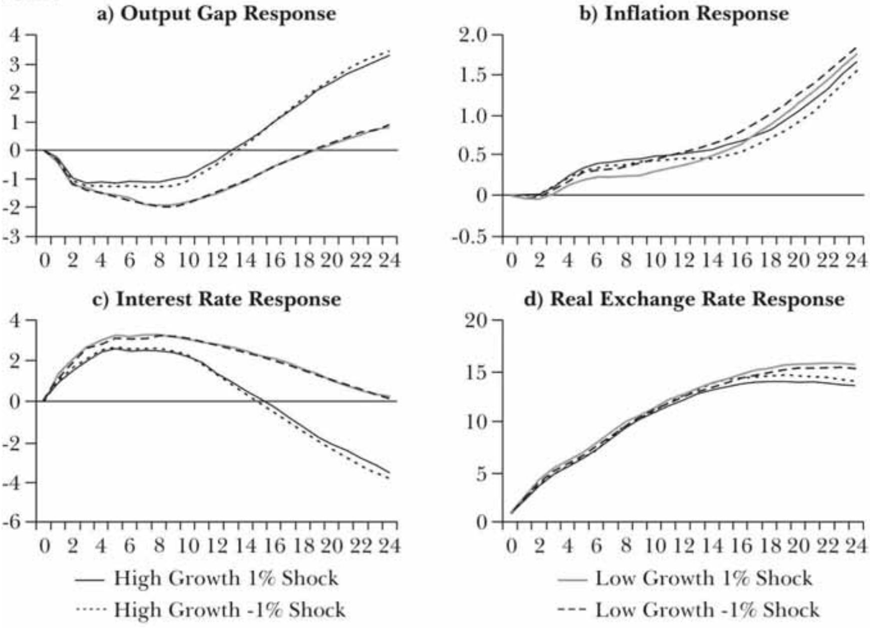


NOTE: The 2% shocks responses are divided by 2.

When comparing 2% shocks against 1% shocks (Panel Figure 7), we find that double sized shocks have almost the same effect in terms of output during low growth periods but their effect is more than proportional when we have high economic growth. Another relevant idea suggested by panel (a) is that the balance sheet effect appears regardless of the size of the exchange rate shock. On the other hand, as expected, the effect in terms of the pass-through rate is more than proportional in both cases as was also found by Winkelried (2003).

Panel Figure 8 shows that negative against positive shocks have relatively symmetric effects in all variables of the system except for prices where we find that negative shocks have a lesser than proportional effect when in high growth. The opposite differences occur in low growth periods. An interesting general conclusion derived from this evidence is that the balance sheet effect not only would operate in a single direction, this is, contracting the output gap after devaluation episodes, as the "classic" approach to the balance sheet effect sustains, but also having a expansionary impact after a positive shock in the real exchange rate.

PANEL FIGURE 8. ACCUMULATED RESPONSES TO A REAL EXCHANGE RATE IMPULSE (1% INCREASE) BY OUTPUT GAP STATE FOR SHOCKS OF DIFFERENT SIGN



NOTE: The -1% shocks responses are multiplied by -1.

VII. CONCLUDING REMARKS

Several conclusions underlie this study, providing answers to the main questions that were posed in the initial section of the paper. We summarize them below.

- Asymmetries regarding the position of the output gap are found to be present in the Peruvian economy. In particular, increases in the monetary policy reference rate have a greater relative impact on output than inflation during low growth periods and the opposite is found for high growth periods. Thus, asymmetries relative to interest rate shocks work in a similar manner as they do in the US; the presence of a latent balance sheet effect appears not to have originated substantial differences in terms of the way in which monetary policy works in a highly dollarized economy. For both types of economies the general picture suggests a convex aggregate supply curve.

• Larger interest rate shocks show that they are marginally more powerful to affect prices rather than output. We interpret this result as evidence of menu costs that become less relevant once shocks are of greater magnitude and/or of output capacity constraints.

• When comparing negative against positive interest rate shocks we find that interest reductions render a more powerful effect that tends to increase in low growth episodes, but the exact opposite asymmetries are found during high growth periods. Hence, monetary policy in Peru is more powerful to force output towards its long-term trend than to take it apart from it.

• In terms of real exchange rate shocks, we find evidence that suggests that depreciations have only negative significant effects in terms of output. Increases in the policy interest rate tend to follow sudden depreciations. Conditional on an initial low growth, the impact on output of this shock is proportional but the monetary policy is asymmetrically more restrictive as compared to high growth periods. We find a rationale for this response in the fact that the balance sheet effect is more harmful during low growth periods. Consequently, we infer that the Central Bank is more fearful of the balance sheet effect during economic downturns. On the other hand, we suggest that the shape of the output response to real exchange rate shocks could also be related to the fact that depreciations generate greater price than substitution effects and to a high correlation with credit-crunch episodes. Finally, inflation response proves to be always positive but larger during the positive side of the business cycle.

• In terms of shocks of different sign and magnitude, the real exchange rate generates no important asymmetries except for the pass-through rate, which is larger the greater the shock. Thus, the balance sheet effect would generate output expansions in the events of real exchange rate appreciations. On the other hand, monetary authority's reaction has behaved asymmetrically in terms of the business cycle, but not in response to different sign and magnitude of real exchange rate shocks. This result enters in contradiction with recent optimal monetary policy literature's suggestions (see section II).

Finally, we expect to motivate further research on non-linearities. Contributions such as this paper seem to suggest that this sort of response patterns in key variables for macroeconomic policy analysis are a fact that deserve to be studied more in detail.

To conclude, it is important to point out several limitations of this paper. As usual with VAR models, there are many alternative ways of identification that may imply different impulse-response results. In spite of having adopted a largely used identification scheme –which is based on a simplified structural representation of a small open economy–, our choice is certainly subject to potential criticisms. In particular, even though the finding of a puzzling response of the real exchange rate after the interest rate shock can have some economic explanations, as mentioned in the text, a different identification procedure might support or discard this outcome. Within a different model framework, the potential balance sheet effect could also be tested by changing the source of the shock –e.g., simulating a more underlying shock, such as to the international interest rate, instead of using the real exchange rate shock–. We leave these topics for future research.

Appendix

The data

The data used in the estimations has monthly frequency. It starts in January 1994 and ends in July 2004. The endogenous series (detailed below) were transformed to annual differences[27, 28] to

[27] Alternative estimations based on first differences transformations were also performed, but as some series seemed not be stationary, we preferred the annual differences specification of the variables.

[28] To be more precise, all variables are expressed in annual percentage

achieve stationarity, which was tested with Augmented Dickey-Fuller, Phillips-Perron and KPSS unit root tests. In the case of the series that, according to the Zivot and Andrews test, presented structural breaks, we followed Weise (1999) –who mentions the existing risk of rejecting linearity in the benchmark VAR because of time-dependent structural breaks in the data– and proceeded to model these breaks in a simple regression equation and then captured the residual series.

The Output Gap (y_t): Log level of seasonally adjusted GDP real index (Source: Central Reserve Bank of Peru) and its permanent component, which was estimated by employing the Hodrick-Prescott filter with the traditional 14400 smoothing parameter for monthly data.

Prices (P_t): Log level consumer price index (Source: Central Reserve Bank of Peru), "corrected" for a trend break in February 2002.

Monetary Policy Interest Rate (i_t): Approximately until 2002, when the Inflation Targeting regime was introduced in Peru, the Interbank Rate (Source: Central Reserve Bank of Peru) –which is now the dominant instrument of monetary policy– was determined by market forces, so we had to reconstruct a "smoothed" policy rate in a similar fashion as in Winkelried (2004): we regressed the interbank rate against operative indicators of monetary policy, such as the official discount rate and the banks' current account balance in the Central Bank (we also tried an alternative specification which included the average reserve surplus or deficit as a percentage of liabilities subject to reserve requirement, with no significant improvements in the estimation). For the period 1994-2002, the fitted series from this regression was used as the policy interest rate; from then on, we just used the observed interbank rate. Of course, this procedure also allows us to overcome the problem that the interest rate was not the monetary policy tool in the period 1994-2001.

Monetary Aggregate (M_t): Log level of seasonally adjusted M_0 (Source: Central Reserve Bank of Peru), "corrected" for a mean break in March 1996.

changes, since after taking twelve-month differences to the log levels we multiplied the resulting series by 100. Of course, we did not follow the same procedure for the interest rate, since this series is originally expressed in percentage terms; in particular, we took no logarithms nor did we perform the multiplication by 100 for the case of this variable.

Real Exchange Rate (R_t): Log level of the real bilateral exchange rate between Peru and the US (based on nominal *nuevo sol* per dollar exchange rate). (Source: Central Reserve Bank of Peru.)

Exogenous variables (X_t^*): At first, we specified alternative VARs with several series that were candidates to be included as exogenous variables, according to previous similar empirical work for other economies (e.g., oil price, US real GDP and inflation rate, commodity price index, among others). However, in the final model we just included the Fed Funds rate (in first difference) for simplicity, because the inclusion of other variables seemed not to offer any important qualitative differences to the results. (The sources of the alternative series employed in the exogenous variables block were the IFS database and Economagic.com.)

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The bank lending channel in Venezuela: evidence from bank level data

1. INTRODUCTION

It is known that the degree of financial markets participation has important implications for the monetary transmission. Recent evidence suggests that the traditional lending channel is not very strong in Venezuela.[1] Changes in the real interest rate do not seem to induce significant responses of aggregate demand, in-

[1] See Arreaza, Ayala and Fernández (2002), Mendoza (2003), and Arreaza, Blanco and Dorta (2004).

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vestment or consumption, curtailing the ability of the central bank to affect inflation through this channel. One of the reasons underlying the lack of importance of the interest channel in Venezuela may perhaps be the limited scope for intermediation through domestic financial markets that prevails in the economy. While the interest rate channel operates through changes in the demand for loans, it seems important to investigate whether there are relevant supply-side effects in the credit market that can further affect monetary transmission.

In fact, much attention has been devoted lately to the effects of monetary policy on bank lending in the presence of financial market imperfections. The traditional interest rate channel relies on the crucial assumption that there are no frictions in the credit market. Thus, following a tightening of monetary policy the liquidity of the financial system and the market interest rate adjust accordingly, triggering an increase in the cost of capital that reduces investment, consumption and thereby aggregate demand. But in the presence of asymmetric information or moral hazard, distributional effects associated to the supply of bank loans may intensify the impact of monetary policy.

The literature distinguishes two mechanisms for monetary policy to affect loan supply in the presence of information problems: the broad credit channel or balance sheet channel and the lending channel (Cecchetti, 1995, Bernanke and Gertler, 1995). The balance sheet channel is based on asymmetric information and moral hazard problems between lenders (financial institutions) and borrowers (consumers or firms), so that the external finance premium of the latter depends on their net worth as reflected in their balance sheet. A policy-induced deterioration in the balance sheet of potential borrowers[2] will limit their access to external finance by reducing their creditworthiness and increasing their risk premium. Without perfect substitutes for bank loans as a source of external funding, this leads to a reduction of investment and consumption beyond the entailed by the increase in the cost of capital. This may imply that socially efficient projects of some borrowers may not be funded.

The bank-lending channel, on the other hand, studies the effects of information frictions between banks and the providers of their funds. Essentially, if monetary policy tightens, asymmetric information problems may make it difficult for some banks to

[2] This deterioration is due either to the increase in the real value of nominally denominated debt or the reduction of future cash flows.

protect their credit lines because of a limited access to non-deposit sources of funds. For instance, offsetting a deposit reduction with alternative sources of funds may be harder for small and illiquid banks than for large, liquid or more capitalized banks (Kashyap and Stein, 2000). Information problems may be of particular importance in emerging economies where capital markets are not well developed, and firms and consumers have limited sources of external funding.

When assessing the presence of the lending channel, recent studies have looked at time-series variations in cross-sectional data from banks' balance sheets. Assuming that demand for loans is homogeneous across banks, the testable implication of this theory is that the effect of monetary policy on loan supply varies across banks, depending on their characteristics. That is, monetary policy will have a distributional effect in addition to the traditional demand effects. Recent findings suggest that these asymmetries may be relevant in many countries. For instance, Kashyap and Stein (2000) find evidence that supports the presence of a lending channel in the US. Favero, Giavazzi and Flabbi (1999), and Ehrmann et al. (2001) find that bank lending contracts in the Euro area following a contractionary monetary policy. Vasquez (2001) finds the lending channel to be present in a number of developing economies.

In this paper we investigate the presence of the lending channel in Venezuela using bank level data, which has not been done before. Previous findings that support the presence of the bank-lending channel in Venezuela employed aggregate data, which is not appropriate (Cecchetti, 1995). The testable implication of the lending channel is distributional, that is, monetary policy will have different effects across agents, and this cannot be gauged with aggregate data, making previous evidence hardly conclusive. Following Ehrmann et al. (2001) and Hernando and Martínez-Pagés (2001), we employ monthly bank level data to determine whether bank characteristics such as size, liquidity, and specialization (household loans or commercial and corporate loans) affect the ability of banks to protect their credit lines from policy-induced reductions in bank deposits. In this study we do not find strong evidence to support the presence of a bank-lending channel in Venezuela.

The paper is structured as follows. The second section contains stylized facts about the recent evolution of the financial sector in Venezuela. The third section develops the econometric model and reports the results, and the final section contains our conclusions.

2. STYLIZED FACTS

Since the capital market is rather small, the financial sector in Venezuela is bank dominated. Banks have a predominant role as financial intermediators in Venezuela. The banking sector holds about 75% of domestic financial assets, while capital markets only have a 20% share and insurance companies 5%.[3]

Starting in 1989, the banking sector has experienced dramatic changes. Financial liberalization started in 1989, and foreign banks were allowed to operate in the country in 1992, which increased competition among domestic banks. But liberalization was done without proper banking surveillance or enforcement of prudential regulations, so that lack of transparency in banking operations and book-entry practices, plus a low degree of capitalization prevailed. Some banking institutions thus became very vulnerable, and did not stand in good shape after the 1992-93 recession (Ayala et al., 2002). Then, a significant number of banks went under during the severe banking crisis in 1994-1995.[4]

TABLE 1. OWNERHIP STRUCTURE OF THE FINANCIAL SECTOR IN VENEZUELA, 2002

Institutions	*Private*	*State owned*	*Total*
Universal Banks	17	0	17
Commercial Banks	17	1	18
Banks with Special Regulations	0	5	5
Investment Banks	8	1	9
Mortgage Banks	3	0	3
Financial Leasing Companies	2	1	3
Savings Banks	5	0	5
Mutual Funds	4	0	4
Total	*56*	*8*	*64*

SOURCES: Ayala, Fernández and Mirabal (2002). Data: Sudeban (Superintendencia de Bancos).

After the banking crises a more comprehensive and stricter Law of Banking Surveillance and Supervision was passed in 1997. Under this new regulation and in order to reduce costs and im-

[3] Source: Central Bank of Venezuela, Department of Financial Market Analysis, for 2001.

[4] For a detailed description of the banking crisis see Krivoy (2002).

prove capitalization, a process of mergers and consolidation between institutions developed, reducing the number of banks and increasing potential gains from economies of scale. In spite of a higher concentration, there is still no strong evidence of collusion within the banking sector.[5] As shown in Tables 1 and 2, most banks now operate as universal or commercial banks. In 1993, before the crisis there were 167 banks, whereas by the end of 2002 there were only 55, 35 of which were commercial and universal banks. Our analysis centers in universal and commercial banks, since these banks carry the bulk of the intermediation between deposits from the public and loans, and account for 98% of the financial assets of the whole system (Fernández, 2004).

TABLE 2. EVOLUTION OF THE FINANCIAL INSTITUTIONS IN VENEZUELA,[a] 1993-2002

Year	*Universal Banks*	*Commercial Banks*	*Investment Banks*	*Mortgage Banks*	*Financial Leasing Co.*	*Savings Banks*	*Total*
1993	0	46	47	17	36	21	167
1994	0	40	25	8	22	21	116
1995	0	39	20	9	18	21	107
1996	2	37	18	7	16	21	101
1997	12	29	15	5	12	21	94
1998	14	26	13	5	9	17	84
1999	15	26	11	4	5	17	78
2000	14	24	12	4	5	12	71
2001	18	22	10	3	4	5	62
2002	17	18	9	3	3	5	55

SOURCES: Ayala, Fernández and Mirabal (2002). Data: Department of Financial System Analysis, Central Bank of Venezuela.

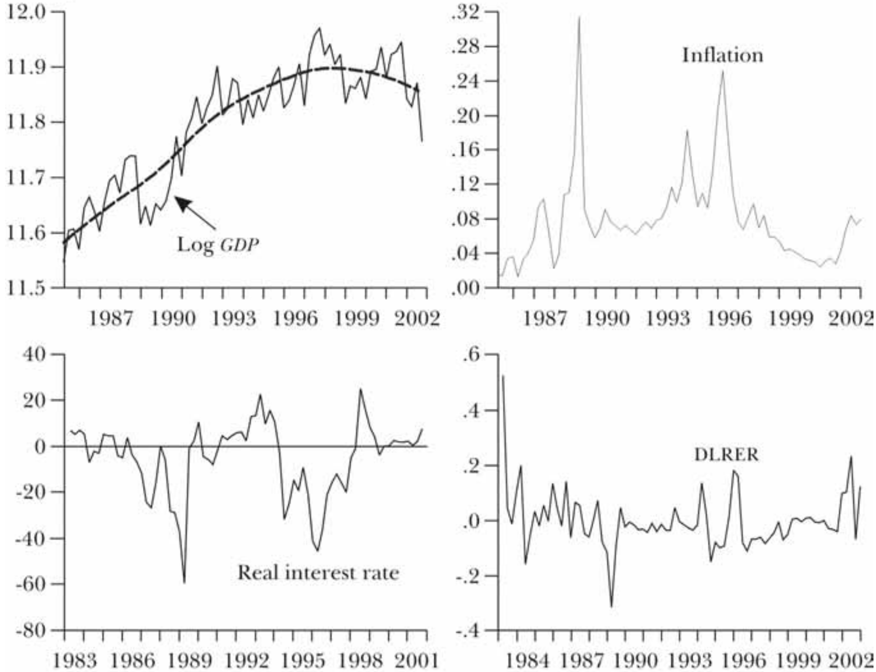
[a] Excludes Mutual Funds and Special Regulation Banks.

But if regulation has improved after the banking crisis, financial depth has not recovered as expected. Poor economic performance throughout the period may be underlying this fact. Figure 1 depicts the dynamics of quarterly *GDP* and inflation during the past 20 years.

GDP exhibited an increasing trend until 1998. Then it started to decline, exhibiting large fluctuations around the trend. The liberalization program in 1989, the banking crisis in the midnine-

[5] See Zambrano, Vera and Faust (2001), Arreaza, Fernández and Mirabal (2001), and Fernández (2004).

FIGURE 1. OUTPUT, INFLATION, REAL INTEREST RATE AND REAL EXCHANGE RATE, 1983-2003



SOURCES: Central Bank of Venezuela. Own calculations.

ties and the political events in 2002-03 marked 3 periods of recession. The average growth of *GDP* between 1983 and 2003 has been less than 1%, with a standard deviation on 5%, a high degree of volatility even by Latin American standards. Inflation has been highly volatile as well, with an average annual rate near 40%, and a standard deviation of 25%.[6] The real exchange rate and the real interest rate exhibited a large volatility during the period, with standard deviations of 10% and 16% respectively. It is worth noticing that the real interest rate was negative throughout most of the period.

Such poor macroeconomic performance, high degree of volatility and the presence of real negative deposit rates during the

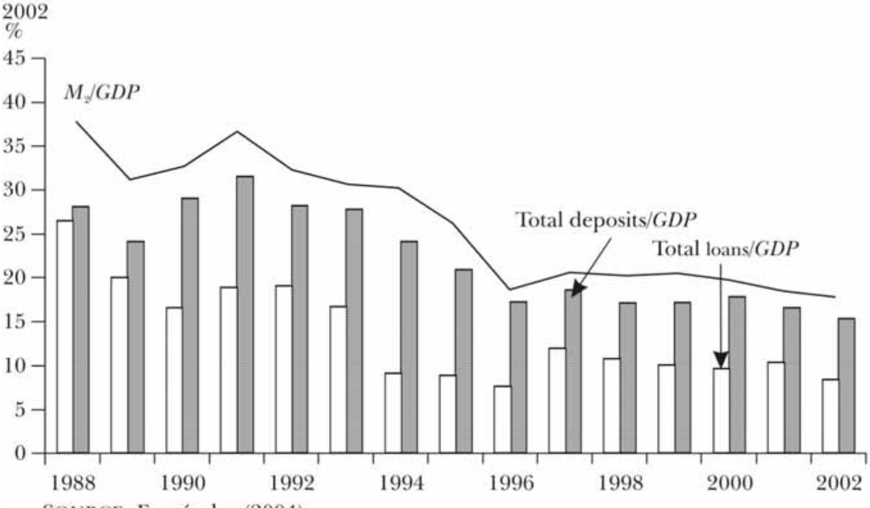
[6] Inflation dynamics are very similar to the nominal exchange rate ones, with peaks in 1989 and 1996 that coincide with large devaluations of the nominal exchange rate that followed the end of capital control regimes. Between 1996 and 2002, inflation rates declined with the adoption of exchange rate bands, and then the trend picked up again when the bands were abandoned in 2002.

last decades may well then explain the low degree of monetization of the Venezuelan economy.[7] The demand for domestic financial assets by residents has secularly declined in favor of assets in foreign currency held in the international financial system.[8] As opposed to other Latin American countries, domestic banks in Venezuela are not allowed to carry deposits in foreign currency. This dynamics had led not only to a reduction in total deposits, but to a change in their composition, since the fraction of demand deposits has increased relative to time deposits. By 2003, for instance, demand deposits represented around 55% of total deposits (Fernández, 2004).

Figure 2 displays the ratios of M_2, total deposits and total credits to *GDP*.

The M_2/GDP ratio has declined from 40% in 1988 to 18% by 2002.

FIGURE 2. DISPLAYS THE RATIOS OF M_2, TOTAL LOANS, DEPOSITS AND M_2, 1988-2002



SOURCE: Fernández (2004).

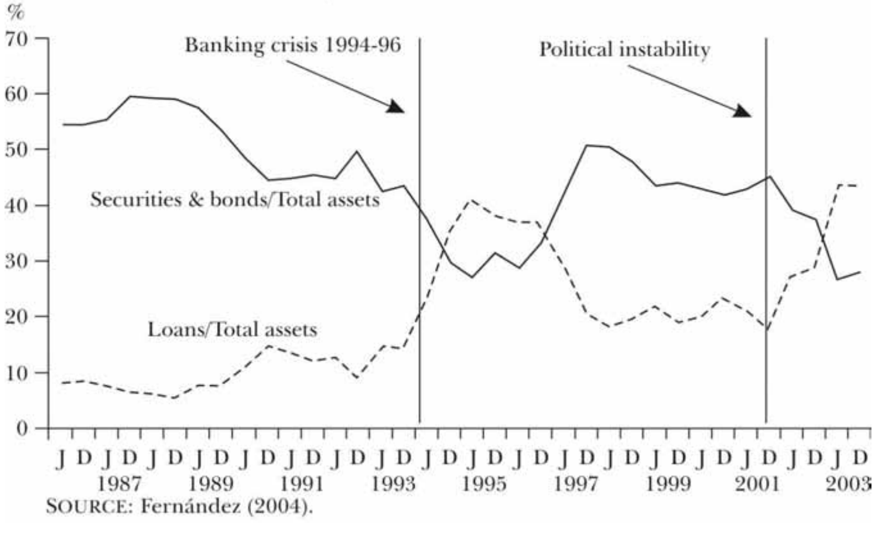
[7] Recent papers explore the reasons behind capital flight and currency substitution in emerging economies. The gradual substitution of domestic deposits for foreign currency denominated assets may result from recurring episodes macroeconomic instability and high inflation Savastano (1996), or from agents' portfolio decisions to hedge against inflation and foreign exchange risk that is not compensated by the deposit rate spread (Levy Yeyati and Ize, 2003).

[8] Using data from the BIS and Sudeban (Superintendencia de Bancos), Ayala, Mirabal and Fernández (2002) and Fernández (2004) estimate that domestic agents hold a fraction of at least 55% of their financial assets in the international banking system.

The amount of total deposits to *GDP* in the banking sector has dropped considerably in the same fashion: from 30% in 1988 to 15% in 2002. There is a clear declining trend of this ratio until the end of the banking crisis in 1996, but the amount of deposits did not regain its pre-crisis levels after 1997. The ratio of total loans to *GDP*, in spite of improving after the crisis, is still very low, amounting to less than 10% by 2002, which is less than the pre-crisis level. Such a low degree of financial depth is remarkable, even for Latin America standards, and it severely curtails the scope for financial intermediation.[9]

Looking at the supply side of the credit market, we notice that the composition of banks' portfolios has also changed during the period. The share of securities and government bonds in bank's portfolios has increased since the nineties and particularly after 2000, coinciding with the growth of domestic currency denominated debt. These dynamics are depicted in Figure 3.

FIGURE 3. UNIVERSAL AND COMMERCIAL BANK'S PORTFOLIO, 199-2003 (Loans/Assets *vs.* Securities+Bonds/assets)



SOURCE: Fernández (2004).

In the late eighties, banks allocated nearly 60% of their portfolios to loans and just a small fraction to securities and bonds. In the nineties the share of loans decreased progressively, reaching a minimum of less than 30% during the banking crisis, and then it went back to pre-crisis levels around 1997. Starting in 2001, when

[9] The credit/*GDP* ratio is around 70% in Chile, for instance.

the economy started to show signs of recession,[10] the share of loans started to decrease again. By 2003, the amount of resources allocated to loans is smaller to the one allocated to securities and bonds. The decline of loans coincided with the growth of domestic currency denominated public debt, which has increased thricefold between 1999 and 2003. Aggregate loan supply is then affected by portfolio adjustments in response to domestic risks faced by the banking sector. What we would like to investigate next is whether these adjustments are frictionless across banks, or if there are asymmetric information problems within the financial sector able to generate relevant distributional effects that further affect intermediation.

FIGURE 4. ASSET COMPOSITION OF BANKS BY SIZE GROUPS, 1997-2002

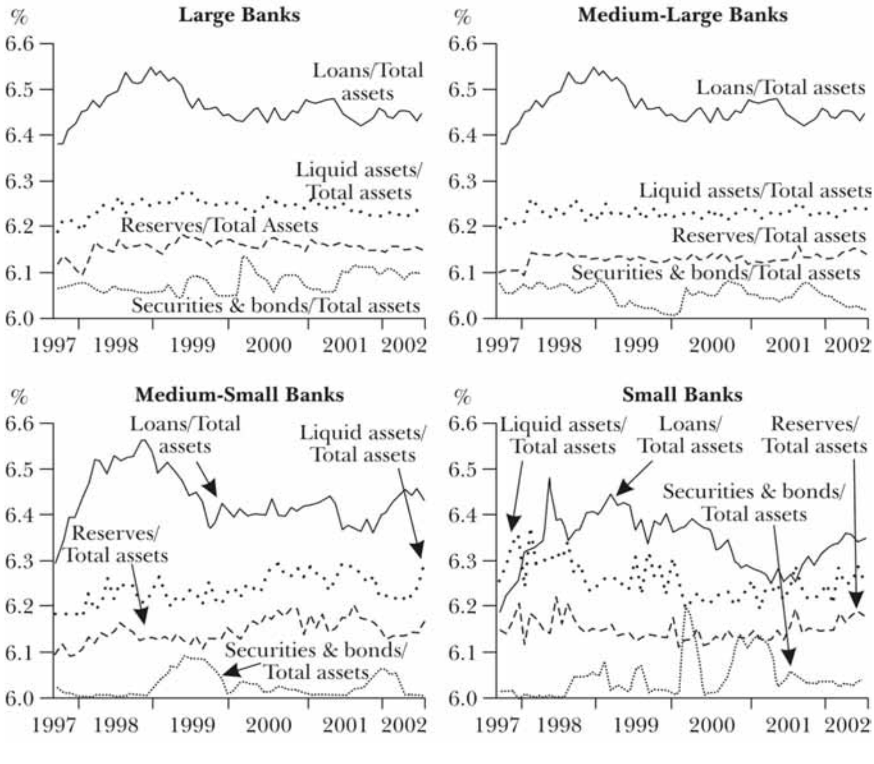


Figure 4 depicts the asset composition of banks classified into four groups, according to the share of assets held by of each bank

[10] *GDP* decreased by 8.9% in 2002 and by 7.6% in 2003.

of the total assets of the banking system.[11] The figure displays the shares of total loans, reserves, liquid assets and securities and bonds to total assets. We can pin down some facts by simply looking at these pictures. First, a common feature across groups is the increase in loans after the banking crisis and a subsequent decline, which may be seen as systemic effects (e.g. macroeconomic conditions and monetary policy). But on the other hand, small banks tend to have a smaller share of their assets allocated to loans and their behavior also seems more volatile. This may be an indication of the existence of some cross-sectional differences in the response of bank loans to monetary policy, but in order to test for the presence of the lending channel we need to resort to an econometric analysis to control for loan demand and systemic effects.

3. ECONOMETRIC APPROACH

To address the question of whether asymmetric information problems between banks affect the ability of some banks to protect their credit lines from policy-induced reductions in deposits, we will follow the approach in Hernando and Matínez-Pagés (2001) and Ehrmann et al. (2001). The idea behind these papers is to determine if monetary policy-induced changes in banks' insured deposits translate into changes in their supply of loans, depending on banks' characteristics, such as size, liquidity or capitalization, controlling for loan-demand effects. These characteristics may be taken as proxies of informational asymmetries. For instance, in case of a tight monetary policy, asymmetric information problems may make it difficult for small and illiquid banks to offset the reduction of insured deposits by frictionlessly raising alternative sources of funds to isolate their credit lines.

We employ balance sheet data of 20 universal and commercial banks between 1997 and 2001. We use this period in order to avoid the possible structural changes. In the aftermath of the banking crisis in 1996 banks were required to change book-entry procedures and a new banking regulation was passed in 1997. Thus, we do not want to use data prior to 1997. The substitution of the currency bands for a free float in February 2002, and the

[11] Group 1 (Large banks): greater than 5%; Group 2 (Medium-large banks): between 1% and 4.99%; Group 3 (Medium-small banks): between 0.50% and 0.99%; and Group 4 (Small banks): less than 0.5%.

subsequent substitution of the free float for capital controls in 2003 implied changes in the way monetary policy was conducted that would possibly affect our analysis.

We include in our panel only those banks that capture deposits from the public and issue corporate, commercial (small businesses) and consumption loans. We excluded small banks that only participate in the reserve market, and branches of foreign banks that closed operations during the period. Mergers were treated by considering the data of the merged institutions as the data of the largest bank, and reconstructing the data backwards as the sum of the two banks before the merge, so no new bank appears.

Since monetary policy tends to affect economic variables with lags, a dynamic panel specification is more appropriate for our purposes than a static panel.[12] Our baseline equation is thus the following:

$$(1)\quad \Delta CR_{i,t} = \alpha_i + \sum_{j=1}^{l} \rho_j \Delta CR_{t-j} + \sum_{j=1}^{J} \beta_{1j} \Delta GDP_{t-j} + \sum_{j=1}^{J} \beta_{2j} \Delta ER_{t-j} + \sum_{j=1}^{J} \beta_{3j} \Delta R_{t-j} + \sum_{j=1}^{J} \beta_j^n \Delta R_{t-j} W^n{}_{i,t-1} + \delta W_{i,t-1} + \sum_{j=1}^{11} \beta_{5j} D_j + u_{it}$$

Where *CR* is total loans, *GDP* is monthly output, *ER* is the real exchange rate, *R* is the indicator of monetary policy, W^n stands for bank characteristics (liquidity and size), and *D* are seasonal dummies.[13] Liquidity is measured as the ratio of liquid assets to total assets, and size is measured as the fraction of assets held by each bank with respect to total assets of the banking sector. All variables are in logs, except interest rates and seasonal dummies. All the bank specific data enters with lags in the equation to avoid endogeneity problems.

We included macroeconomic variables such as *GDP* and the real exchange rate in the equation to control for demand side effects. Since we are dealing with monthly data, this allowed US to analyze the accumulated effect of monetary policy on loans after 6, 9 and 12 months.

We investigate whether the long-run response of credit to monetary policy shocks differs depending on bank characteristics, which play as indicators of informational asymmetries. Long-run

[12] Preliminary results using a static panel version of Equation 1 do not suggest the presence of the lending channel in Venezuela.

[13] *GDP* quarterly data is transformed into monthly data using an algorithm based on variations of a monthly production index. The real exchange rate is simply proxied by CPI_{US}*nominal exchange rate/$CPI_{domestic}$.

coefficients are computed as the sum of the coefficients of the lags of the regressors, divided by one minus the sum of the coefficients of the dependent variable, $\sum_{j=1}^{J} \beta_j^n \Big/ \left(1 - \sum_{j=1}^{l} \rho_j\right)$. If the bank-lending channel holds, the long-run interaction coefficients between policy variables and bank characteristics should be positive and significant.

Pinning down a variable that indicates the stance of monetary policy in Venezuela over a long period of time is not a clear-cut task. During the period of analysis, the exchange rate bands conditioned the control exerted by the central bank over monetary aggregates and domestic interest rates.[14] But as opposed to fixed exchange rate regimes, even under perfect capital mobility currency bands allow certain control over domestic interest rates. Deviations of the exchange rate from the central parity generate expectations of currency depreciation[15] that affect domestic interest rates, allowing the central bank certain control on the latter (Svenson, 1994). This, of course, depends on the credibility of the bands. Pineda, Toledo and Zavarce (2001) analyze the behavior of the exchange rate between during the currency bands regime and find that the exchange rate was consistently below the central parity, and that the volatility of the exchange rate was much lower than the bandwidth. They find that the credibility of the announced band depended mostly on the level of international reserves, and that the central bank seemed to operate within a narrow unannounced 'mini-band', which was in fact credible. It is within that credible 'mini-band' that the central bank had certain independence for monetary policy.

In this paper we opted for two variables as indicators of the stance of monetary policy: a policy interest rate and bank reserves, although we focus more on interest rates.[16] There are ca-

[14] Under a fixed exchange rate regime, the equilibrium domestic interest rates is equal to international interest rates, plus a foreign exchange rate risk premium, given that the expected domestic currency depreciation rate should be equal to zero (UIP condition). Any attempt by the central bank to shift interest rates from equilibrium will imply capital movements that will force the central bank to shift domestic rates back to equilibrium.

[15] The currency depreciations expectations depend on the band realignment expectations plus and the expected depreciation relative to the central parity or within the band.

[16] This policy rate is a combination of the central bank CD rate and the TEM rate (Títulos de Estabilización Macroeconómica) used in Dorta and Guerra

veats with both measures though. Bank reserves may be reflecting demand side changes that we may not be able to control for. Additionally, interest rates have not been actively and consistently used as monetary policy instruments in Venezuela. Traditionally, the central bank has based its financial programming on monetary aggregates. It is only after 2002 when the central bank started to shift attention from using monetary aggregates as instruments of monetary policy to using interest rates of interest rates. Nevertheless, even in periods where aggregates were the main instrument of monetary policy, the central bank still cared about the level of the interest rates. In fact, the central bank adjusted quantities of open market operations with TEMs and DPNs, when interest rates exceeded certain ranges (Guerra and Dorta, 2003). Therefore, it seems that interest rates may be used as well as an indicator of the stance of monetary policy in Venezuela.

In the presence of individual fixed effects, direct OLS estimation of Equation 1 leads to inconsistent and inefficient estimates. In order to eliminate the fixed effects, the data could be transformed by first differences or orthogonal deviations to eliminate fixed effects. But since the lagged values of the transformed data will be correlated with the transformed error term, an instrumental variable method must be employed.[17] Thus, to ensure consistency and efficiency of our estimates e use the Arellano and Bond (1991) GMM approach for dynamic panels, with orthogonal deviations of the bank specific data to remove individual effects, and allowing for White period robust standard errors. We use the Sargan test to check for the validity of our instruments, i.e. that they are not correlated with the transformed residuals and check for autocorrelation.

Tables 3 though 7 report the estimates of the long-run coefficients of the explanatory variables in Equation 1 for J=6, J=9 and J=12. In Tables 3, 4, 5 and 6 we use TEMs rates as a monetary policy indicator. The first column Tables 3-5 reports estimates of Equation 1 using two bank characteristics, size and liquidity, while the second and third columns shows results considering one characteristic at a time. In Table 6 we analyze the case of a double interaction between size and liquidity with monetary policy. The underlying idea of this double interaction is that the

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(2003). TEMs were central bank-issued instruments since DPNs (domestic public debt bonds) were insufficient for the volume of open market operations.

[17] See Baltagi (1995).

effect of a tight monetary policy should be larger for small and illiquid banks than for large and liquid banks (Kashyap and Stein, 2000).

The effects of the interest rate on total loans are always negative and almost always significant. Output growth has a positive and significant effect on loans and a depreciation of the real exchange rate seems to have a negative impact on loans, which may

TABLE 3. LONG-RUN MULTIPLIERS, 6 LAGS

	1. Size and Liquidity		*2. Liquidity*		*3. Size*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Size	0.0050	0.0084			0.0071	0.0079
Liquidity	0.0098	0.0095	0.0072	0.0113		
Policy Indicator (PI)	-0.0046*	0.0026	-0.0039	0.0032	-0.0019**	0.0009
Real GDP growth	1.7150***	0.4330	2.0485***	0.3567	2.2900***	0.4137
Real Exchange rate	-1.4114***	0.2978	-1.8642***	0.2824	-1.7205***	0.3142
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	0.397	0.528	2.525	0.112	0.015	0.902
2	1.888	0.389	2.594	0.273	0.375	0.945
6	10.981	0.089	9.715	0.137	9.861	0.131
12	17.644	0.129	16.053	0.189	16.257	0.180
Sargan Test	413.667	0.9898	514.936	0.9888	492.628	0.9193

Monetary Policy Indicator: TEMs rate. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 1025. Number of banks:20

NOTE: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 1 of bank characteristics multiplied by the policy indicator, seasonal dummies.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 4 of bank characteristics multiplied by the policy indicator, seasonal dummies.

TABLE 4. LONG-RUN MULTIPLIERS, 9 LAGS

	1. Size and Liquidity		*2. Liquidity*		*3. Size*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Size	0.0190	0.0154			0.0234*	0.0121
Liquidity	0.0226	0.0163	0.0093	0.0129		
Policy Indicator (PI)	-0.0124***	0.0048	-0.0071*	0.0042	-0.0047***	0.0016
Real GDP growth	1.0333	0.7101	1.1626	0.7305	1.4684**	0.6491
Real Exchange rate	-1.8054***	0.5870	-1.8064***	0.4619	-1.4788***	0.5053
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	1.207	0.272	0.341	0.559	1.103	0.293
2	3.151	0.207	0.358	0.836	1.642	0.440
6	11.699	0.069	10.159	0.118	9.870	0.130
12	19.049	0.088	18.657	0.0977	17.448	0.133
Sargan Test	402.908	0.973	419.197	0.889	482.118	0.941

Monetary Policy Indicator: TEMs rate. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 971. Number of banks:20

NOTE: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 1 of bank characteristics multiplied by the policy indicator, seasonal dummies.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 4 of bank characteristics multiplied by the policy indicator, seasonal dummies.

be the consequence of balance sheet effects derived from devaluations.[18]

[18] According to the Mundell-Fleming model, depreciations should have an expansionary effect on output, since domestic goods become more competitive relative to foreign goods. But when firms' revenues are denominated in domestic currency while their debt or inputs are denominated in foreign currency, de-

TABLE 5. LONG-RUN MULTIPLIERS, 12 LAGS

	1. Size and Liquidity		*2. Liquidity*		*3. Size*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Size	0.0209	0.0197			0.0314*	0.0188
Liquidity	0.0307	0.0243	0.0085	0.0191		
Policy Indicator (PI)	-0.0097	0.0127	-0.0026	0.0120	-0.0029	0.0053
Real GDP growth	-0.9741	1.4631	-0.3842	1.4437	-0.4851	1.4417
Real Exchange rate	-0.9085	2.4200	-1.2812	2.8272	-1.4309	1.8926
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	1.366	0.242	0.927	0.335	0.430	0.512
2	2.469	0.291	1.008	0.604	0.660	0.719
6	11.703	0.069	11.013	0.088	8.340	0.214
12	18.771	0.094	19.535	0.076	13.929	0.305
Sargan Test	366.260	0.916	441.660	0.864	442.971	0.873

Monetary Policy Indicator: TEMs rate. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 914. Number of banks:20

NOTE: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 1 of bank characteristics multiplied by the policy indicator, seasonal dummies.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 4 of bank characteristics multiplied by the policy indicator, seasonal dummies.

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valuations have a deleterious effect on firms' balance sheets, which limits their ability to borrow and invest, leading to output drops (Krugman, 1999). More recently, Galindo, Panizza and Schiantarelli (2003) find evidence supporting the presence of balance sheet effects in Latin American economies, which may be consistent with our finding here.

None of the variables are significant after 9 months, which is not at odds with previous findings suggesting that the impact of monetary policy on output through the interest rate and exchange rate channels vanishes after 3 quarters.[19] These results seem to be robust across different specifications.

TABLE 6. LONG-RUN MULTIPLIERS. DOUBLE INTERACTION BET. SIZE AND LIQUIDITY

	1. 6 Lags		*2. 9 Lags*		*3. 12 Lags*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Size*Liquidity	0.0226	0.0170	0.0460*	0.0272	0.0473	0.0488
Policy Indicator (PI)	-0.0020**	0.0288	-0.0046***	0.0015	-0.0035	0.0049
Real GDP growth	2.3220***	0.4113	1.4811**	0.6568	0.6959	1.4554
Real Exchange rate	-1.6902***	0.2957	-1.4207***	0.5111	-1.7883	1.7556
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	0.026	0.871	1.117	0.290	0.2929	0.588
2	3.186	0.203	3.420	0.181	1.771	0.412
6	12.916	0.044	12.222	0.047	9.816	0.133
12	19.613	0.075	19.671	0.074	16.332	0.176
Sargan Test	444.846	0.9213	436.528	0.9552	399.216	0.7142

Monetary Policy Indicator: TEMs rate. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 1025, 971, 920. Number of banks: 20

NOTE: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 1 of bank characteristics multiplied by the policy indicator, seasonal dummies.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 4 of bank characteristics multiplied by the policy indicator, seasonal dummies.

[19] See Arreaza, Blanco and Dorta (2003).

When we study the interaction between the policy variable and the bank characteristics, liquidity is never significant, while size appears to be significant sometimes but at 10% level. The double interaction between size and liquidity with the policy variable is only marginally significant for $J=9$ at a 10% level.[20] Table 7 displays

TABLE 7. LONG-RUN MULTIPLIERS

	1. 6 Lags		*2. 9 Lags*		*3. 12 Lags*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Size	-0.000001	0.00001	-0.000001	0.000001	-0.0000021*	0.0000013
Liquidity	-0.000007	0.000007	0.000001	0.000001	-0.000006	0.000012
Policy Indicator (PI)	-0.000002	0.000002	0.0000003	0.000003	-0.000001	0.000005
Real GDP growth	2.3042***	0.4669	2.1476***	0.7037	0.0332	4.2282
Real Exchange rate	-1.1976**	0.5084	-0.2371	0.8336	-0.6373	3.9349
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	0.611	0.434	1.286	0.257	0.857	0.354
2	2.814	0.245	2.855	0.240	1.396	0.498
6	12.382	0.054	11.242	0.081	10.924	0.091
12	19.634	0.074	16.857	0.155	14.900	0.109
Sargan Test	442.871	0.9168	431.484	0.9369	434.423	0.7953

Monetary Policy Indicator: Reserves. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 1025, 971, 920. Number of banks:20

NOTE: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 1 of bank characteristics multiplied by the policy indicator, seasonal dummies.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, lag 1 of the bank characteristics, lag 4 of bank characteristics multiplied by the policy indicator, seasonal dummies.

[20] The p-value was = 0.0961.

TABLE 8. LONG-RUN MULTIPLIERS. TYPE OF BANK

	1. 6 Lags		*2. 9 Lags*		*3. 12 Lags*	
	Coeff.	*S. Error*	*Coeff.*	*S. Error*	*Coeff.*	*S. Error*
Bank Characteristic:						
Dummy1	-0.0015	0.0014	-0.0020	0.0018	-0.0041*	0.0023
Policy Indicator (PI)	-0.0016*	0.0009	-0.0019	0.0014	-0.0024	0.0029
Real GDP growth	0.9238***	0.2823	1.5635***	0.5272	0.8463	0.9816
Real Exchange rate	-1.5889***	0.3113h	-0.5939	0.4419	-1.3650	1.1030
	Test	*p-value*	*Test*	*p-value*	*Test*	*p-value*
Residual Correlation						
1	0.718	0.397	1.102	0.294	0.091	0.763
2	1.778	0.411	1.331	0.514	0.204	0.903
6	11.070	0.086	9.694	0.138	9.367	0.154
12	16.806	0.157	16.554	0.167	16.888	0.154
Sargan Test	509.994	0.9501	490.094	0.9653	450.028	0.9104

Monetary Policy Indicator: TEMs rate. Dependent Variable: first difference of the log of total loans

Panel GMM estimation. 2SLS instrument weighting matrix. White period standard errors

Number of observations: 1025, 971, 920. Number of banks:20

Note: */**/*** significance at 10%, 5%, 1% level.

Regressors: 3 lags of the dependent variable, macroeconomic variables and policy indicator, Dummy1 multiplied by lags of the policy indicator, seasonal dummies. Dummy1= 1 if the bank is household loan oriented, and 0 otherwise.

Instruments: levels of the dependent variable (lag 4 up to 12), macroeconomic variables and policy indicator, Dummy1 multiplied by the policy indicator, seasonal dummies.

the results when we use changes in bank reserves as an indicator of the stance monetary policy. Results do not vary much from the previous ones, except that changes in bank reserves do not appear to be significant, and may not be a good policy indicator.[21]

[21] Using changes in net domestic credit of the central bank instead of total reserves generates similar results.

Hence, assuming we are properly controlling for demand effects, we do not find strong evidence of a differential response to monetary policy across banks to support the presence of a bank-lending channel in Venezuela.

These results may have some problems though. There may be other bank characteristics correlated with bank size, such as the bank specialization on household or commercial loans, which may be more relevant to explain different effects of monetary policy across banks. We therefore ran an additional set of regressions adding a dummy variable that takes the value of and 1 if the bank specializes on household loans, and 0 if the bank more oriented to commercial and corporate loans.[22] We interacted this dummy with the policy variable and again, the results do not suggest that this characteristic is a source of distributional effects of monetary policy. We report the results of this exercise in Table 8.

4. FINAL COMMENTS

In this paper we empirically tested the presence of the bank-lending channel in Venezuela. Bank characteristics such as size, liquidity and specialization were taken as proxies for sources of informational asymmetries within the domestic financial sector. If relevant, such asymmetries should imply that monetary policy has distributional effects. As long as a policy tightening leads to a reduction in deposits that some banks may not be able to offset, loan supply will fall accordingly. Results in this paper do not suggest that these bank characteristics (size, liquidity or loan specialization) are sources of cross-sectional differences in the response of loan supply to changes in monetary policy.

We believe these findings are relevant to improve our understanding of the effects of monetary policy in Venezuela. But if informational frictions are not relevant within the banking sector, they may still be important between banks and potential borrow-

[22] Household loans oriented banks are those which allocate a fraction of over 50% of their loan portfolio to consumption loans. This is obviously a very imperfect measure, but it is still informative about bank specialization. From the bank's balance sheet data it is not possible to perfectly discriminate between household loans and commercial loans. Credit cards and vehicle loans are just a rough measure of what can be considered as household loans, which is what we actually used for the purpose of this classification. Therefore, results of this particular exercise should be taken with certain reserve.

ers. In such case, balance sheet effects could be affecting intermediation and thus the effects of monetary policy. Unfortunately, information at a firm level on their sources of financing is not available, hindering a thorough study about the presence and importance of balance sheet effects. Nevertheless, other paths could be explored to understand why intermediation has such limited scope in Venezuela. For instance, the impact on intermediation of the recent growth of off-balance operations by banks (trust funds and offshore transactions) has not been studied yet, and should become a matter of future investigation.

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Commercial banks' demand for excess liquid assets

1. INTRODUCTION

Liquid assets of commercial banks are those assets that are generally thought to have low risk (for example government securities) and a short maturity horizon (Garber and Weisbrod, 1992). In most countries, the monetary authority sets prudential floors on the amount of liquid assets a bank should hold. These minimum reserve requirements have been in place in Barbados since the Central Bank of Barbados began operations in 1973. At this time, commercial banks were only required to hold 2% of their deposits in cash or in non-interest bearing accounts at the Central Bank and 1% in Government securities. Subsequent to its introduction, the Central Bank utilised the reserve requirement to pursue its monetary and prudential objectives (Blackman, 1997). The reserve requirement reached a maximum of about 33% in 1991 when Barbados was in the troughs of one of its deepest reces-

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sions. Since then the rate has been gradually reduced as the Bank endeavoured to liberalise the financial market, and at the end of 2004 was 17% of domestic deposits.[1]

Commercial banks tend to hold reserves above the minimum required amount –referred to as excess liquid assets– for a number of reasons. Alger and Alger (1999) identifies four broad categories of theories that explain why commercial banks hold reserves: *1)* portfolio management; *2)* precautionary motives, and; *3)* market imperfections. This body of mostly theoretical literature predicts that the amount of liquid assets should increase when the opportunity cost of holding reserves declines and the uncertainty regarding the return on assets and the likelihood of a liquidity shock rises.

While liquid assets allow commercial banks to maintain profitability and reduce the risk associated with its asset portfolio, the monetary authority also carefully monitors trends in liquidity. Within the Central Bank of Barbados, a report is prepared on developments in domestic and external liquidity every two weeks and a meeting of personnel from various departments within the Bank (primarily research, banking, bank supervision and exchange control) is held to discuss key developments. These meetings and reports assist the Central Bank to track overall financial sector vulnerability, asses the potential of the banking system to provide new credit and monitor the effects of monetary and fiscal policy changes.

To illustrate the role of excess reserves a simplified commercial bank balance sheet is provided in Table 1. On the asset side of the balance sheet are cash and cash equivalents (deposits at the central bank), investments in government securities and loans (the only long-term asset in this example). Liabilities, on the other hand, are composed of demand deposits that can be withdrawn without incurring a penalty, time and savings deposits and borrowings from the head office. A tighter monetary policy stance by government –an increase in the required reserve ratio– results in an expansion in the holdings of either cash or government securities that can only be satisfied by the commercial bank reducing the amount of loans it provides.

Given its importance in the monetary transmission process, a number of recent studies have attempted to model the empirical determinants of commercial bank excess reserves. The most re-

[1] See Williams (2004) for an assessment of the potential impact of financial liberalisation on businesses in Barbados.

cent of these, Agénor, Aizerman and Hoffmaister (2004) examine the extent to which the fall in credit in crisis-stricken East Asian countries during the 1990s was as a result of a reduction in demand or an increased incidence of credit rationing. The authors report that the required reserves tend to have a negative impact on the holdings of excess reserves while the volatility of cash holdings and interest rates were inversely related to the holdings of excess reserves. Cyclical changes and the volatility of the cycle, however, did not significantly influence excess reserves. Using a panel of Mexican commercial banks, Alger and Alger (1999) report similar results but also find that banks with relatively more demand deposits hold less liquid assets and that small banks usually to rely more on liquid assets to meet severe liquidity shocks relative to large banks. The authors attribute these results to large banks being able to maintain a more diversified depositor portfolio and better access to liabilities to meet liquidity needs. González Eiras (2004), using a similar model but different objectives, estimate a difference-in-difference model to evaluate the impact of the announcement of a lender of last resort facility on banks' liquid asset holdings. The results of the study indicate as a result of the facility, liquid assets holdings fell by almost 7%.

This paper adds to this growing body of literature by providing an empirical assessment of excess reserve dynamics in Barbados. Barbados is an interesting case study because, unlike most of the countries examined in the literature, it maintains controls on capital account transactions. As a result, any build-up in excess liquidity or reduction in liquidity cannot be easily offset by accessing the external financial market. The remainder of this paper is structured as follows: Section 2 presents a survey of the trends in the holdings of excess liquid assets in Barbados; An empirical model of the demand for excess reserves is introduced in Section 3 and Section 4 gives the estimated model results and an assessment of whether the build-up in excess liquid assets between 2000 and 2004 in Barbados was due to supply- or demand-side factors. Section 5 summarises the main findings of the paper and presents some policy recommendations.

2. TRENDS IN THE HOLDINGS OF LIQUID ASSETS BY COMMERCIAL BANKS

Both the monetary and fiscal authorities have a vested interest in liquidity developments. The fiscal authorities are concerned about excess liquid assets since it represents resources that could be used to finance possible growth-enhancing ventures. The central bank, on the other hand, monitors liquidity developments to ensure that the financial system is able to cope with shocks and to evaluate the likely effectiveness of policy changes.

Table 1 provides macroeconomic indicators for Barbados between 1975 and 2004. The first panel plots the ratio of excess reserves to demand deposits. It shows that excess reserves have fluctuated widely around an average of about 9% of domestic deposits between 1975 and 2004. Excess reserves consist primarily of excess holdings of government securities: during the period holdings of excess securities was on average 7% of domestic deposits while holdings of excess cash was only 2%. Excess cash holdings exceeded those of excess securities only twice during the review. The first time this occurred was in 1975 when the government securities market was still quite thin and in 2002 when the government recorded a fiscal deficit (on- and off-budget) of almost 10% of gross domestic product.

TABLE 1. SIMPLIFIED COMMERCIAL BANK BALANCE SHEET

Assets (uses of funds)	*Liabilities (sources of funds)*
Cash	Demand Deposits
Securities	Time and Savings Deposits
Loans	Borrowing from Head Office

If one compares the income to trend income ratio –an indicator of the business cycle– and the excess reserves panel one can identify that reserves seem to be highly pro-cyclical. During the two major oil-induced recessions in Barbados (1981-1982 and 1990-1992) excess reserves fell to their lowest levels on record. At the end of 1991, excess liquid assets were actually negative as the nation struggled under the pressure of an international and domestic liquidity crisis. As a result, balance of payments support was sought from the International Monetary Fund that culminated in a 1992 Staff-Monitored programme. The programme, along with a general rebound in the world economy, resulted in eight consecutive years (up until 2000) of growth in real gross domestic product, modest external current account balances and a rebound in domestic and international liquidity.

Unlike the previous two recessions, excess liquidity of the banking system actually rose significantly during the 2001 downturn, as the Government engaged in a major counter-cyclical spending programme to reflate the economy after the September 11th attacks. The programme was financed by a US$150 million bond issue on the internal capital market and $52 million from the partial divestment of the Barbados National Bank –subsequently sold to Republic Bank of Trinidad and Tobago in 2003– and the Insurance Corporation of Barbados. This monetary expansion along with a slowdown in credit resulted in excess reserves of commercial banks rising to about 23%, the highest ratio on record and in addition to required reserves of 24%.

The expansion in excess liquidity during the 1990s also reflected a programme of both domestic and external liberalisation. In terms of domestic liberalisation, the monetary authorities have also attempted to utilise more indirect monetary policy tools. In light of the very high levels of liquidity in the financial system in recent years, it is no longer necessary to have a securities requirement in order to guarantee the purchase of government securities. The securities reserve requirements has therefore fallen from as high as 25% in 1991/92 to its present level of 12%, and the cash reserve ratio was lowered from 8% to 5% over the same period. The Bank has also moved away from setting the weighted average loan rate –since this could result in commercial banks holding more reserves– and now only controls the minimum deposit rate. Williams (2004) states that controls over the minimum deposit are maintained for two reasons: *1)* the level of concentration within the commercial banking industry and; *2)* to control the financing costs of businesses.

The Central Bank has also eliminated much of the control it previously held over foreign exchange transactions. Commercial banks in Barbados are now allowed to approve, without reference to the Central Bank: applications to transfer funds from Barbados to CARICOM countries in respect of all current transactions with the exception of certain specified transactions to which special limits or restrictions apply; investments in corporate securities in the form of equities cross-listed and cross-traded on the stock exchanges in CARICOM may, without limit, but approved by the Barbados Stock Exchange, and; approve all investment transactions in private unlisted equities in CARICOM countries. In addition, commercial banks and other entities in the financial sector can invest monies overseas under a so-called "second-tier" reserve programme. This allows the institutions access to investment opportunities abroad on the condition that the funds can be repatriated if the monetary authorities require them.

3. ECONOMETRIC MODEL

This section of the study specifies a demand function for excess liquid reserves (er) of commercial banks. From the literature, the main factors that explain a bank's demand for reserves can be linked to its customer characteristics, macroeconomic environment, monetary policies and fiscal strategies. A bank needs to hold liquid assets to meet the cash requirements of its customers (captured by fluctuations in the cash-to-deposit ratio, C/D). In most financial systems around the world, if the institution does not have the resources to satisfy its customers' demand, then it either has to borrow on the inter-bank market or the central bank, both of which incur an interest penalty. Agénor, Aizenman and Hoffmaister (2004) show that ith a sufficiently high penalty rate, liquidity shocks, which increase consumers' demand for cash, can encourage a bank to hold more liquid assets.

The current macroeconomic situation, in terms of both the level of economic activity (given by the deviation of income from trend, Y/Y^T) and income volatility, also has an important impact on the demand for liquid reserves of commercial banks. A cyclical downturn, for example, lowers banks' expected transactions demand for money, on the part of consumers, and therefore lead to decreased holdings of excess liquid assets. In contrast, a rise in economic volatility, since it is usually accompanied by liquidity shocks, can lead to greater holdings of excess reserves.

The actions of the monetary authorities influence the demand for liquid assets primarily through statutory changes. The variables employed to capture monetary policy in this paper are the reserve requirement (rr), the discount rate (r^d) and the treasury-bill rate (r^{tb}). An increase in required reserves should, holding all other factors constant, reduce the demand for liquid assets, since this increases the revenue foregone from holding these low or zero interest-bearing assets. The interest rate variables are expected to have similar but opposite effects on the demand for excess liquid assets. For example, an increase in the penalty rate on borrowing from the central bank increases the costs of a liquidity shortfall and should increase the demand for excess reserves, while an increase in the treasury bill rate increases the opportunity cost of holding liquidity assets and should result in lower holdings of excess reserves by commercial banks.

Changes in the fiscal policy stance of government can also have a significant influence on the liquidity of commercial banks. During downturns in the business cycle, the classic Keynesian policy recommendation is to boost government spending, which then raises overall aggregate demand by a multiple (commonly referred to as the Keynesian multiplier) of the increase in expenditure. Government spending, however, can only be raised by issuing debt, increasing taxes or creating money (given by the change in the net domestic assets of the central bank, nda). Since, raising taxes are implemented with a significant lag, the most popular means of financing the increased spending is through money creation or borrowing from overseas. Both actions, however, result in greater deposits in the banking system and by extension a rise in bank reserves.

The estimated demand equation of excess liquid assets is therefore given by the following autoregressive specification, which allows for a gradual adjustment to the desired level of excess reserves:

$$\begin{aligned} ln\left(\frac{er}{dd}\right) &= A_1\, ln\left(\frac{er}{dd}\right) + A_2\, ln\left(\frac{rr}{dd}\right) + A_3\, ln\left(CV_{C/D}\right) + A_4\, ln\left(\frac{Y}{Y^T}\right) \\ &+ A_5\, ln\left(CV_{\frac{Y}{Y^T}}\right) + A_6\, ln\left(r^d\right) + A_7\, ln\left(nda\right) + \varepsilon \end{aligned} \tag{1}$$

where ε is an error term which is assumed to have normal properties and $a_j(L)$ are lag polynomials, with:

$$A_1 = a_{11}L + \ldots + a_{1p}L^p \text{ and}$$
$$A_j = 1 + a_{j1}L + \ldots + a_{jp}L^p$$

for $j \geq 2$ and L is the lag operator. The model is estimated using ordinary least squares using the econometric package PCGIVE 10.4 within OX 10.4 (see Doornik, 2001; Hendry and Doornik, 2001). A similar equation is also estimated for the holdings of excess cash and excess securities, with the only change being that total required reserves is replaced by the cash reserve and required securities reserve ratio. The Kwiatkowski, et al. (1992) test indicates that all the variables are stationary in levels.[2]

[2] The test statistics are 0.171 for ER_{t-1}, 0.110 for RR, 0.142 for CD, 0.098

4. RESULTS

4.1 Model evaluation

Table 2 presents the coefficient estimates and various specification tests of the model results. The equations are able to explain more than 82% of the variation in the holdings of excess reserves, excess cash and excess securities over the estimation period. In addition, the *LM* test for autocorrelation accepts the null hypothesis of no autocorrelation for all three regressions at the 5% level of testing. To further evaluate the robustness of the model results the bank rate is substituted for the treasury bill rate and the income to trend income variable is generated using the Hodrick-Prescott filter rather than a linear trend. These changes did not significantly influence the main conclusions of the paper. It is possible that during significant domestic and external shocks the behaviour of the banking industry could change. Testing for parameter constancy is therefore important since it indicates whether the model can be an effective tool to draw broad policy conclusions as well as the behaviour of excess liquid assets during different periods. As a result, the author employs the Hansen (1992) test for the constancy of the regression coefficients to evaluate the three estimated equations. In all three regressions, the Hansen test accepted the null of parameter constancy over the estimation period. Instability tests were also computed for each variable but these were all small suggesting that the parameters did not change significantly during the estimation period.

4.2 Regression results

Given that the previous section indicates that the models provide a fairly robust representation of excess reserve dynamics, this section analyses the estimated coefficients. The table gives the sum of the lagged coefficients (since the individual coefficients are difficult to interpret) with the standard errors calculated using the delta method.[3] The coefficients therefore show the long run

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for Y/Y_T, 0.033 for CV_{Y/Y_T}, 0.144 for r and 0.137 for NDA compared to the 1% critical value of 0.216.

[3] The delta method calculates the standard error of a group of coefficients by using the variance and covariance of the coefficients:

$$var(\sum_i \theta_i) = \sum_i var(\theta_i) + \sum_i \sum_j cov(\theta_i \theta_j) .$$

effects of a change in the explanatory variables on the demand for excess reserves.

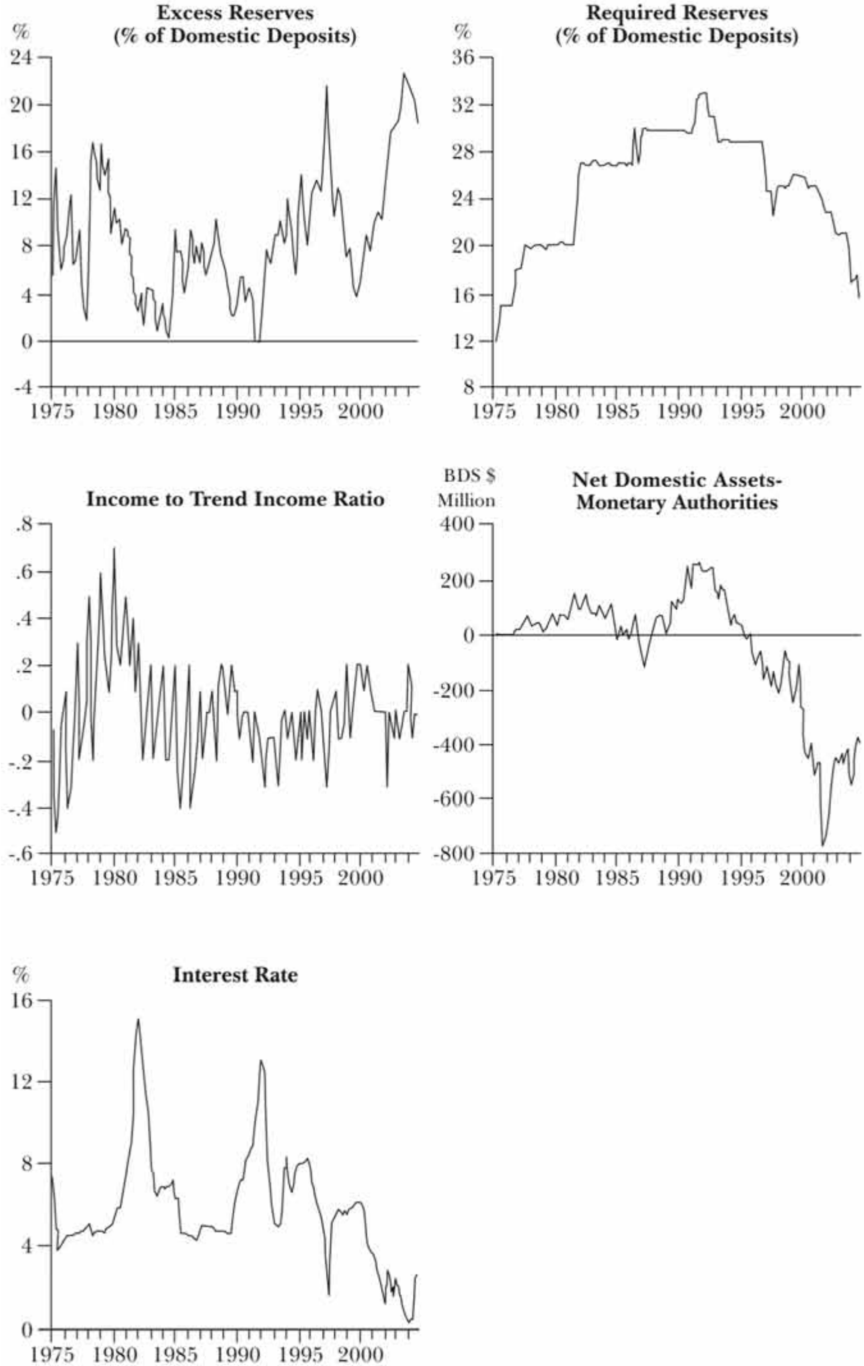
All the coefficients are generally inline with *a priori* expectations. The relatively large coefficient on the lagged excess reserve term suggests some persistence in the excess reserves of commercial banks. Similar to Agénor, Aizerman and Hoffmaister (2004),

TABLE 2. DETERMINANTS OF EXCESS LIQUID ASSETS

	ER	*EC*	*ES*
Constant	4.280	-1.902	2.325
	(2.392)	(0.937)	(1.821)
ER_{t-1}	0.813	0.651	0.874
	(0.069)	(0.073)	(0.064)
RR	-0.085	0.165	-0.063
	(0.390)	(0.452)	(0.361)
CD	-0.002	-0.001	-0.005
	(0.000)	(0.000)	(0.002)
Y/Y_T	-0.024	-	-0.021
	(0.009)		(0.005)
CV_{Y/Y_T}	-0.001	-0.001	-0.001
	(0.000)	(0.000)	(0.001)
r	-0.107	0.121	-0.135
	(0.062)	(0.048)	(0.068)
NDA	-0.001	-0.004	0.001
	(0.000)	(0.001)	(0.001)
See	2.197	0.946	1.869
R^2	0.856	0.854	0.822
Autocorrelation *LM* Test	6.150	5.021	1.535
(χ^2_5)	[0.292]	[0.413]	[0.909]
Hansen Parameter Instability	2.843	3.792	5.080

NOTE: The dependent variable is the ratio of excess reserves to domestic deposits (ER). The regressors ER_{t-1} , RR , CD , Y/Y_T , CV_{Y/Y_T} , r and NDA are the lag of excess reserves, required reserves (as a ratio to domestic deposits), the coefficient of variation of the ratio of cash to deposits, income to trend income ratio, coefficient of variation of the income to trend income ratio, the treasury bill rate and net domestic assets of the banking system. The estimates in the table correspond to the sum of the coefficients of the lag polynomials for $p = 4$, and their standard errors (calculated using the delta method) are provided in parenthesis below the coefficients and p-values are given in square brackets.

FIGURE 1. MACROECONOMIC INDICATORS, 1975-2000



the required reserve variable and the volatility of the cash to deposit ratios are negatively related to the holdings of excess cash reserves. However, the coefficient on the required reserve variable was insignificant suggesting that a change in the required reserve ratio does not significantly influence the demand for excess reserves. This suggests that commercial banks have some target level of excess reserves over and beyond what is required by the monetary authorities.

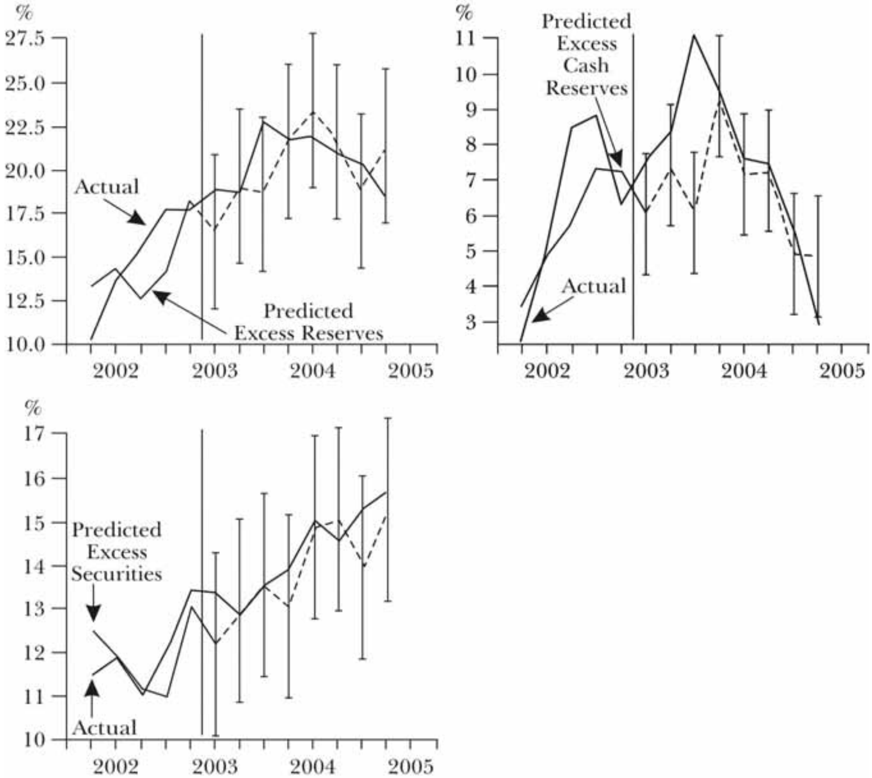
The coefficient estimates also indicate that excess reserves tend to be inversely related to the business cycle, suggesting that commercial banks tend to error on the side of caution by holding relatively more excess reserves during downturns. While this might lead to lower risk, in terms of the number of defaults in the industry, it can also deepen the recession as the reduction in the provision of credit lowers investment and the ability of the economy to rebound from the cyclical downturn. The volatility of income is incorrectly signed and has a relatively minor effect on the holdings of excess reserves, probably reflective of the small level income volatility in Barbados (see Figure 1). As expected, a rise in interest rates, which represents the opportunity cost of holding excess reserves is negatively and significantly related to the interest rate, while money creation by government leads to a rise in the holdings of excess reserves.

To assess the behaviour of the models to replicate the dynamics of excess reserves in Barbados, Figure 2 presents the out of sample one-step ahead forecasts for excess reserves, excess cash and excess securities holdings. The forecasts are generated by estimating the models using data up to December 2002 to predict values of excess reserves for the following period (March 2003). For the following period (June 2003), the forecasted value for March 2003 is replaced by the actual value and the forecast for June 2003 is generated. This process is replicated for the following periods up to December 2004. The figure shows that all three models are able to reasonably track the dynamics of excess reserve changes.

4.3 Was the 2000-2003 expansion in excess reserves due to supply or demand factors?

The second part of this study uses the models estimated in the previous section to establish whether the build-up in liquidity between 2000 and 2004 was due to supply- or demand-side factors. The first step in this process was to obtain dynamic forecasts for

FIGURE 2. ACTUAL AND PREDICTED EXCESS RESERVE ASSETS, 2002-06

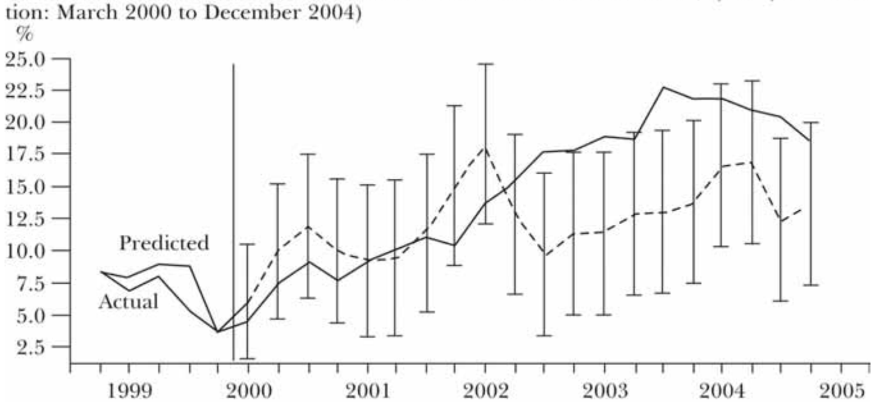


excess reserves. Dynamic forecast, in contrast to the previous section, are obtained by using previous forecasts of excess reserves in period k to generate forecasts for period $k+1$. For example, the forecast for the first quarter of 2000 are obtained by taking the actual values of excess reserves in the fourth quarter of 1999 and previous quarters and the actual values of the other regressors in the first quarter of 2001 and their lagged values. Subsequent forecasts are obtained by taking the forecasted value of excess reserves and for previous quarters and the actual values of the other regressors.

In the second step, the build-up in excess liquidity is said to be supply-side induced if the actual values for excess reserves fall outside of the predicted error bands (two standard errors), since if banks are unwilling to lend because of a perceived increase in the risk of default, the forecast errors from the regression model should be relatively large and positive. In contrast, if banks were unable to lend, probably due to reduced credit demand (resulting from an anticipation by firms of future weak demand or lower profits) the forecast errors would be relatively small, suggesting an involuntary accumulation of reserves.

Figure 3 shows the behaviour of the observed excess reserves and the dynamic forecasts between 2000 and 2004 together with error bands (two standard errors). The figure shows that most of the build-up in excess reserves up to the first quarter of 2002 and most of 2004 are in line with the model projections, suggesting that the accumulation of excess reserves during this period can be attributed to a slowdown in overall aggregate demand rather than increased conservatism by commercial banks. In 2003, however, the actual values diverge significantly from actual values –falling well outside of the error bars. The persistent build-up in liquidity during this period appears therefore to have been supply-side phenomenon –increased conservatism by commercial banks.

FIGURE 3. ACTUAL AND PREDICTED EXCESS RESERVE ASSETS (Dynamyc Simulation: March 2000 to December 2004)



5. CONCLUSIONS

This paper has three main goals: *1)* discuss the trends in excess liquidity between 1975 and 2004; *2)* identify the key determinants of excess demand during the period, and; *3)* provide an assessment of whether the recent accumulation in liquid assets was due to supply- or demand-side factors. The discussion of excess liquidity trends suggests that the variation in excess reserves during this period was highly pro-cyclical: expanding during a boom and contracting during downturns in the business cycle. The paper then estimates a model of the demand for excess reserves using quarterly data between 1975 and 2004. These results show that excess reserves are highly persistent –dependent on previous values of excess reserves– shocks to the currency to deposit ratio, the business cycle, the interest rate and money creation.

The model is then employed to generate dynamic projections for excess reserves between 2000 and 2004 to identify whether the build-up in reserves during the review period can be attributed to supply- or demand-side factors. The assumption is that if the actual values fall outside of the error bands, this would suggest that the expansion in liquidity was due to supply-side factors. The paper finds that most of the expansion in excess liquidity up to the second quarter of 2002 and most of 2004 were principally due to demand-side factors. During 2003, however, most of the expansion in liquidity seemed to have occurred on account of supply-side factors.

The finding that commercial banks' perceptions of risk during 2003 were somewhat higher than what was consistent with macroeconomic fundamentals seems to suggest that there exist some degree of information asymmetries. At present, the only agency that produces a quarterly press release is the Central Bank of Barbados. The Government's Statistical Department –which some have argued is understaffed and unequipped– does not widely disseminate most of the data it produces to the public and does not have a presence on the web. Similarly, the Ministry of Finance and Economic Affairs does not have a web presence and only produces forecasts of Government activity for one year. This paper recommends that greater resources should be devoted to the collection and dissemination of macroeconomic indicators on a timely, frequent and consistent basis in order to reduce information asymmetries in the financial system and wider economy.

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6. A Word or a PDF file containing the paper should be e-mailed to rodrigo_gomez@cemla.org and demaria@cemla.org by January 15, 2007.

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Superintendencia del Sistema Financiero (El Salvador)
Superintendencia de Bancos (Guatemala)
Comisión Nacional de Bancos y Seguros (Honduras)
Superintendencia de Bancos (Panama)
Banco Centroamericano de Integración Económica
Banco Latinoamericano de Exportaciones, S. A.
Deutscher Genossenschafts- und Raiffeisenverband e.V. (German Cooperative and Raiffeisen Confederation)
Fondo Latinoamericano de Reservas