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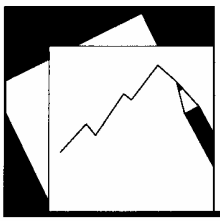

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'Inflation Targeting Lite' in Small Open Economies: The Case of Mauritius

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'Inflation Targeting Lite' in Small Open Economies: The Case of Mauritius

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Abstract

This paper develops a new macrofinance model for small open economies, allowing the investigation of Mauritius's experience with 'inflation targeting lite' as described in Stone (2003). It finds that this monetary policy regime has been associated with a general reduction in inflation, principally through a reduction in inflation expectations. The credibility the Bank of Mauritius has established with its 'inflation targeting lite' regime has allowed it to shift from an emphasis on exchange rate targeting towards inflation targeting. By estimating a model in which the yield curve is modeled explicitly we are able to obtain estimates of inflation expectations.

JEL Classification Numbers: E31, E43, E44, E52

Keywords: inflation targeting; small open economies; managed exchange rates

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I. INTRODUCTION

Like many other small open and emerging economies, Mauritius faces a number of monetary policy challenges. Although the Bank of Mauritius (BOM) has explicitly stated an annual inflation target since 1996, its monetary operations are complicated by the relatively shallow and unsophisticated nature of Mauritius's financial system, its history of sizable budget deficits, the thinness of its foreign exchange market, its limited integration into international capital markets, and its vulnerability to shocks. These challenges have meant that the BOM is unable to credibly choose a single nominal anchor, and although it is primarily concerned with inflation, it also intervenes in the foreign exchange market with a view to its external competitiveness and minimizing volatility.

Given its managed exchange rate float, Mauritius's monetary policy regime is most appropriately characterized as 'inflation targeting lite.' Stone (2003, p. 8) defines inflation targeting lite regimes as ones where the central bank "announce[s] a broad inflation objective but owing to [its] relative low credibility [it is] not able to maintain inflation as the foremost policy objective. Their relatively low credibility reflects their vulnerability to large economic shocks and financial instability and a weak institutional framework." It can be viewed as a transitional regime towards full-fledged inflation targeting. Stone (2003) identifies Mauritius as one of 19 emerging market countries that practice inflation targeting lite.

Along with solid economic growth, Mauritius has been able to achieve low and stable inflation after adopting inflation targeting lite (Sacerdoti et al., 2005). Inflation (year-on-year) fell from around 8 percent in mid-1996, when Mauritius introduced its current *inflation targeting lite* regime, to around 4 percent in the year to March 2004 (Figure 1).[2] Over the same period, output growth was high, averaging more than 5 percent per year. Therefore, Mauritius's inflation targeting lite regime has, so far, been associated with a decline in inflation. Nonetheless, as this decline was achieved during a period of relatively subdued inflation worldwide, a true test of its inflation targeting lite regime will come if global inflation picks up in the future.

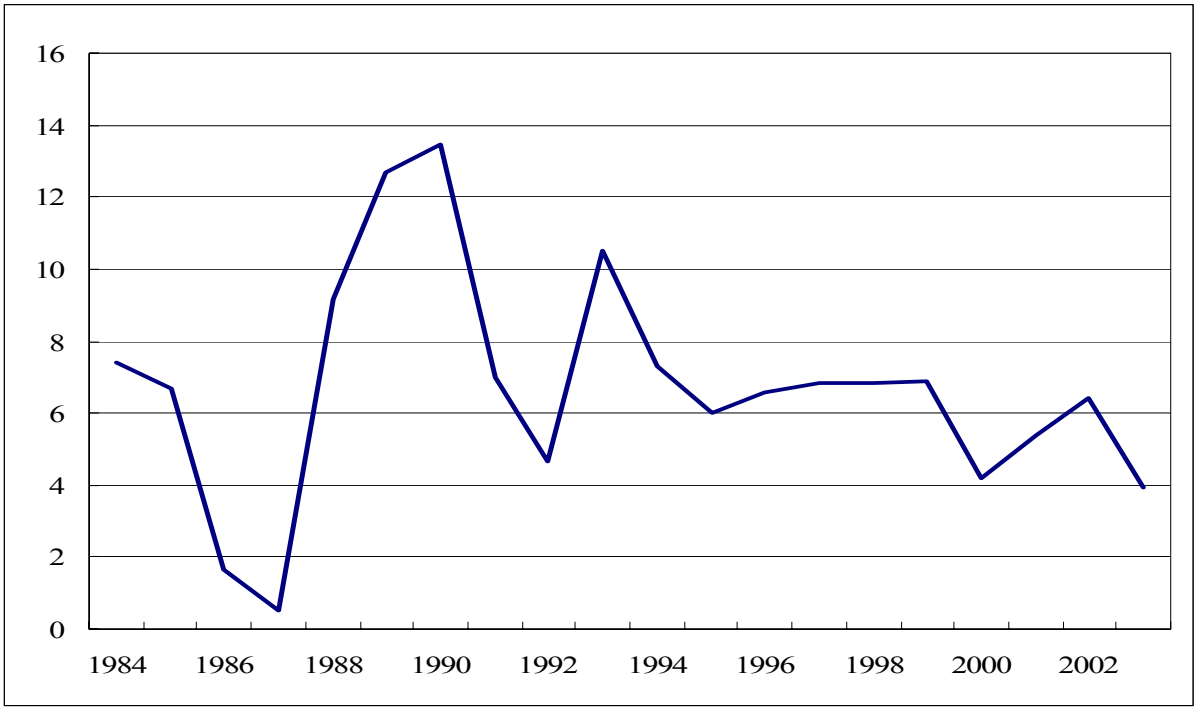
This paper investigates Mauritius's experience with inflation targeting lite, finding inflation targeting lite has been associated with a fall in inflation, principally through the successful reduction in expectations. A series of financial sector deregulation measures in the 1980s and 1990s set the stage for the BOM to pursue inflation targeting lite, through a de facto public commitment to low (CPI) inflation in the mid-1990s. While inflation targeting lite seems to have been generally successful, it took the BOM some time to earn the credibility required to anchor lower inflationary expectations. The increased credibility of the inflation targeting lite regime allows the BOM to shift from an emphasis on exchange rate targeting toward inflation targeting. Moreover, this shift appears to have been accomplished without significant costs in terms of lost credibility, higher inflation, or exchange rate instability. In

[2] An inflation rate of 3 to 5 percent sustained over time is generally accepted in Mauritius as low inflation.

Mauritius, interest rates have dropped even as monetary policy was refocused from the exchange rate constraint, indicating that monetary policy can be made more flexible.

Mauritius's institutional environment suggests that inflation targeting lite could be successful. Mauritius has a long tradition of strong independent public institutions, and although it has relatively high government debt (estimated at almost 60 percent of GDP in 2003/04), it has moderate (and declining) external debt.[3] The government has no history of extensively borrowing from the central bank and is actively reducing its budget deficit.[4] In addition, Mauritius has highly developed on-shore and young off-shore banking sectors, as well as a primary dealer's network to facilitate the trade in treasury bills. Although the central bank is not technically independent, the government has maintained "arms-length" transactions with the bank. Moreover, its central statistical office produces good and timely macroeconomic data. These factors are important prerequisites before the central bank can attempt any type of inflation targeting.

Figure 1. Annual CPI Inflation
(In percent)



[3] According to the 2003 reports of the World Economic Forum and Transparency International, Mauritius is among the top five African countries for quality of public institutions and perceptions of corruption.

[4] In fact, since 2002 the Bank of Mauritius (BOM) has been a net debtor of the government—that is, the government has maintained substantial (net) deposits with the BOM.

Mauritius's favorable experience with jointly managing an inflation target and its exchange rate could provide a useful example for other small open island economies. In attempts to provide credible nominal anchors, many small island economies have chosen hard pegs (through dollarization, monetary union, currency boards, and fixed pegs without bands). However, hard pegs can easily reduce an economy's flexibility in the face of real and external shocks, running the risk of overvaluation, and possibly resulting in balance of payments difficulties. Mauritius's experience provides a "practical" example of a small island economy that has controlled inflation while using inflation targeting lite as the monetary policy regime.

Mauritius's experience may also provide an empirical study of the monetary policy rule of an inflation targeting lite country. The paper explicitly estimates a monetary policy rule in which policy depends on the exchange rate, deviation of inflation from the target, and the output gap. This paper also attempts to contribute much-needed empirical evidence to compare with different recommendations of the theoretical literature on monetary policy rules of the open-economy inflation targeting (Ball, 1999; Svensson, 2000). By conducting monetary policy (indirectly) through the interest rate, at the same time as managing the exchange rate, the BOM could be thought to be effectively following Ball's (1999) recommendation that small open economies should conduct policy through some form of Monetary Condition Index (MCI), based on both the interest rate and the real exchange rate. Moreover, some studies have suggested that including the prices of tradables in an inflation target may lead to policy responses that generate large output volatility (Ball, 1999; Svensson, 2000; Dennis, 2001).[5] Mauritius's successful targeting of aggregate CPI inflation suggests that these concerns may be overstated. Not only is aggregate CPI inflation a more transparent target than "domestic" inflation, Mauritius's experience suggests that by focusing expectations, successful inflation targeting lite may be able to influence the pace and extent of pass-through, thereby limiting damage to the nontradables sector.[6]

The methodology used to investigate the monetary policy rule and inflationary expectations of the inflation targeting lite regime is based on a new open-economy macrofinance model that combines a no-arbitrage finance specification of the term structure with a standard open-economy empirical macroeconomic model. This allows the explicit modeling of the yield curve in a way that permits interactions between the macroeconomy and bond yields. While this paper's framework is similar to that of Hördahl, Tristani, and Vestin (2003) and Rudebusch and Wu (2003), it is the first to extend the framework to a small open economy.

The methodology has several strengths: (i) it exploits information on the maturity structure of interest rates, leading to a direct link between policy interest rates and the longer-term interest rates that influence real activity and inflation; (ii) it separates the effects of the level

[5] Subsequent, more micro-founded analysis, suggests similar considerations (Galí and Monacelli, 2003 and Parrado, 2004).

[6] Miskin (2004) also argues that successful inflation targeting can, through expectations formation, lessen the affect of exchange rate fluctuations on the economy.

and slope of the yield curve on activity and inflation; and (iii) it provides a direct link between inflationary expectations and the target inflation rate. This last aspect is especially useful, since it allows an investigation of the degree to which inflationary expectations have been anchored over the inflation targeting lite period.

This paper is organized as follows: Section II describes the development of inflation targeting lite in Mauritius, including the main components of its inflation targeting lite framework. Section III introduces the open economy macrofinance model; Section IV discusses the estimation of this model; while Section V describes the implicit behavior of inflationary expectations. Section VI discusses some steps needed to formalize the regime and concludes.

II. Development of Inflation Targeting Lite Framework

A. A Brief History of Mauritian Monetary Policy

This section briefly describes the history of monetary policy in Mauritius. The BOM was established as the central bank with the passage of the Bank of Mauritius Act in 1967. This enabled the BOM to act as the lender of last resort, as well as be the banker of the government. The powers of the BOM were further enhanced in 1971, when it was granted wide supervisory powers over banks, and given the authority to issue bank prudential regulations.

Prior to the 1990s, the BOM conducted monetary policy mainly through direct instruments, such as ceilings on commercial bank credit and administered interest rates. However, the financial reforms in the late 1980s brought some liberalization of exchange controls on both current and capital transactions.[7] The liberalization of capital controls and the establishment of an inter-bank foreign exchange market were completed in 1994. The basket-peg regime was replaced with a more flexible exchange regime, although limited intervention continued. Reflecting the emphasis of monetary policy on exchange rates during this period, annual inflation averaged close to 9 percent over the years between 1989 and 1993, and was also considerably volatile. Credit ceilings were also abolished in July 1993.

In line with the liberalization of the capital account and gradual floating of exchange rate, the BOM reconsidered its monetary operations and objectives in the 1990s. The managed float of the exchange rate that was adopted in 1994 required the BOM to choose a new monetary policy regime to control inflation. Annual inflation had averaged close to 10 percent over the years 1989 to 1993, with considerable variability. Thus, there was a need for monetary policy to achieve lower inflation and to maintain competitiveness at the same time. However, a full-fledged inflation targeting was not feasible owing to the needs to intervene the foreign exchange market and the lack of a well developed financial sector. As a result, in 1996 the

[7] Mauritius accepted the obligations of Article VIII of the Articles of Agreement of the International Monetary Fund in 1993.

BOM introduced "an informal inflation targeting regime," which is essentially the inflation targeting lite regime.

This financial liberalization has allowed Mauritius to develop a relatively large and comprehensive domestic financial system and a growing offshore sector. The domestic banking system is sound and profitable. The basic financial sector infrastructure, such as payment, securities trading and settlement systems, is modern and efficient. There is also a primary dealers network to facilitate the trade in government securities. However, the foreign exchange market is very thin and its secondary government bond market is relatively illiquid and underdeveloped. In addition, development of the corporate capital market has lagged behind that of the banking sector.

B. Inflation Targeting Lite Framework

According to Stone (2003), inflation targeting lite regimes typically share some common features: (1) multiple monetary policy objectives; (2) mixed operating targets and instruments including short-term interest rates, exchange rate, reserve money or aggregate money; (3) exchange rate intervention; (4) opaque monetary policy formulation (depending on the weights given to each objective and the transmission channels); (5) the constrained transparency of monetary policy operations; and (6) emphasis on financial stability.

In line with Stone's definition, Mauritius's inflation targeting lite regime essentially has these elements: (1) multiple purposes of monetary policy with increasing commitment to price stability as one of two primary goals of monetary policy; (2) the public announcement of an annual target for aggregate (consumer price) inflation; (3) a flexible monetary policy that includes exchange rate management; (4) an integrated operational strategy in which many variables, including foreign exchange intervention, are used to set the monetary policy instruments, while maintaining the managed float of the exchange rate regime; and (5) relatively transparent monetary policy operations.

Despite the announcement of an annual inflation target, Mauritius's recent monetary policy cannot be considered fully fledged inflation targeting. Such a regime requires a clear mandate to the central bank to achieve price stability, together with an institutional framework in which all other monetary policy objectives are subordinated to inflation targeting and in which the central bank is held accountable for reaching the target and for having to explain the reasons for any deviations between outcomes and targets. This requires that high-frequency inflation reports be prepared, and appropriate analytical models elaborated, for inflation forecasting and for highlighting the channels between policy instruments and inflation. Nevertheless, it does encompass some of the main elements required for formal inflation targeting (Mishkin, 2004).

Multiple purposes of monetary policy with increasing focus on price stability

The goals of the BOM have evolved over the past decades. The Bank of Mauritius Act 1966 laid down the purpose of the BOM as to "safeguard the internal and external value of the currency of Mauritius and its internal convertibility" and to "direct its policy towards achieving monetary conditions conducive to strengthening the economic activity and

prosperity of Mauritius." The 1988 amendment of this Act granted the BOM the responsibility for the formulation and execution of monetary policy consistent with price stability. The new Bank of Mauritius Act introduced in 2004 should further the strengthen BOM's price stability objective, by stating "[t]he primary object of the Bank shall be to maintain price stability …"

However, the BOM also remains concerned about economic growth and competitiveness of the economy. It means that the BOM targets exchange rate under its managed floating regime as well as its inflation target. For example, the BOM's 2001 Annual Report stated that "the basic thrust of monetary policy continued to be directed toward the achievement of low inflation and a stable exchange rate" (statement from the Governor, page 6), while 2002 Annual Report states that the exchange rate will "reflect the macroeconomic fundamentals of the country" (statement of the Governor, page 7).

Even though price stability was not established as the BOM's sole primary objective, the BOM has increasingly focused on this objective, and has declared its commitment to achieving this goal since 1996. In a number of speeches, the governor of the BOM has made it clear that price stability is the primary goal of the BOM.

Public announcement of aggregate inflation targets

The BOM began announcing an aggregate inflation target in its 1996/97 (June–July) annual report. The BOM pursued a very gradual approach to lowering its inflation objectives. It began with targets of over 8 percent for 1996/97, and gradually lowered them to 4 percent—see Table 1. This gradualist strategy allowed the BOM to establish solid credibility in managing inflation by allowing the public to observe the achievement of a sequence of realistic targets. In addition, the BOM incorporate inflation forecasting when setting its annual inflation target. For example, the government introduced a value-added tax (VAT) in September 7, 1998, which would have the one-off effect on inflation. In response, the BOM increased its target from 6 percent in 1997/98 to 8 percent in 1998/99, so that it accommodated the strong inflation expectation at that time, thereby preserving its credibility. As shown in Table 1, the BOM has been able to meet the preannounced inflation objective in all years except in 2001/02, when unanticipated increases in VAT and a cyclone resulted in the target being missed.

Table 1. CPI Inflation Targets and Outcomes

	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Target inflation	8.0	6.0	8.0	6.0	5.0-5.5	6.0	6.0	4.0
Actual inflation	7.9	5.4	7.9	5.3	4.4	6.3	5.1	4.0

However, if the target is not far enough in the future for policy to have much impact, then the "target" is more a forecast than a target. The target is not formulated in the framework of a medium-term trajectory that takes into account the lags between policy changes and inflation

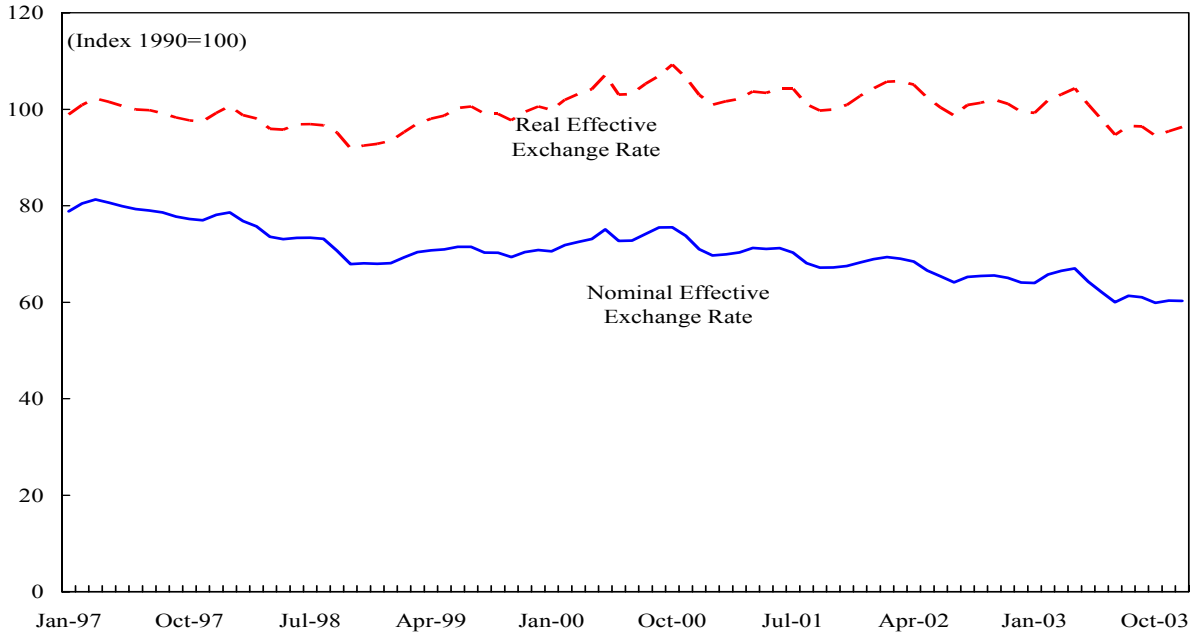
(only a forward-looking 12-month target is announced), and analytical framework specifying the channels between monetary policy instruments and inflation is not yet available. The BOM, however, plan to further refine their inflation-forecasting methodology, together with the analysis of the transmission mechanism between monetary policy and inflation in the period ahead.

Monetary policy rules including real exchange rate target

A managed floating exchange regime might be appropriate for Mauritius. Given the special features of the small island economies, it is critical for Mauritius to maintain external competitiveness and therefore the current account sustainability through adopting a flexible exchange rate regime. Given a thin foreign exchange market, however, a fully floating regime would likely lead to overshooting fuelling inflation and financial stability.

As a result, the monetary policy rule has continued to be accompanied by an exchange rate objective, with a view to maintaining the rupee broadly stable in real terms on a trade weighted basis. This is in line with Ball's rule (1999). Indeed, over the last eight years the nominal effective exchange rate depreciated steadily, while the real effective exchange rate remained broadly stable (Figure 2).[8] It seems that the BOM promoted the gradual depreciation of the nominal exchange rate to compensate for the positive inflation differential with partner countries.

Figure 2. Nominal and Real Effective Exchange Rates



[8] Although the effective exchange rate shown in Figure 2 seems roughly constant, the bilateral exchange rates have been allowed to vary.

An integrated operational strategy

Since no single instrument can be very effective in implementing monetary policy, an integrated approach is adopted. As in many emerging market countries, Mauritius's secondary government bond market is relatively illiquid and underdeveloped. Therefore, the BOM cannot easily target short-term interest rates directly through open market operations in this market. As an alternative, the BOM has used a mix of integrated policy instruments to *target short-term interest rates indirectly*, including through the primary government bond market. Underlying its choice of settings for these instruments is the BOM's detailed and information-inclusive reserve money program. The BOM publicly announced the existence of its reserve money program for liquidity management and forecasting purposes in 1996. The main objective of this is to maintain the monetary base on a path consistent with the BOM's inflation target, and the Central Statistical Office's economic growth forecast. However, as the BOM has found it difficult to achieve its reserve money target, it has never announced its reserve money and associated M2 targets.

Open market operations

The BOM has increasingly relied on short-term interest rates as its operational target, despite maintaining the reserve money target as a complementary operational target. In the primary government bond market, treasury (or, more recently, the BOM) bills of 3-, 6-, 12- and 24-month maturities are sold at weekly auctions.[9] This has tended to produce fairly stable yield curves, with the resulting price discovery likely to be relatively efficient. These auctions have been used to implement the reserve money program.

- The BOM varies its sales of treasury and BOM bills in the *primary market auction* in order to influence the level of liquid reserves held by commercial banks. While the amount of treasury bills sold at the weekly auction is guided by the reserve money program, the interest rates resulting from these auctions have been used as an indicator of the stance of monetary policy.

- *Repurchase transactions* (repo) and reverse repo operations have also been used periodically since 1999 for fine tuning, complementing the primary auction of treasury bills.

- The BOM's *secondary market* cell (a portfolio of treasury bills) is occasionally employed in secondary market trading, allowing market participants to adjust their liquidity between the weekly primary auctions.

The signaling role of interest rates

As the lender of last resort, the BOM provides a *Lombard facility* where banks can borrow overnight to meet reserve requirements. The BOM mainly uses the Lombard rate to signal

[9] The Development Loan Stock with maturities up to 15 years are issued annually, while five-year bonds are issued quarterly. From July 2003, the BOM began to issue its own bills.

the stance of monetary policy, since the market generally seems to have adjusted its rates in line with movements in the Lombard rate in the past. However, with the money market rate currently much lower than the Lombard rate, this facility has not been used extensively in recent times.

Foreign exchange intervention

The BOM maintains some intervention in the foreign exchange market. The purpose of such interventions may be either to target certain real effective exchange level or to minimize the excessive volatility of exchange rate in the events of large foreign exchange turnover.

The BOM keeps what foreign exchange market interventions it makes consistent with its inflation target by integrating these interventions with its open market operations decisions through its reserve money program. Although the BOM claims to be limiting its foreign exchange interventions to principally smoothing volatility, it seems to have continued (even one-sided) intervention until recently—see Table 2. However, Table 2 shows the general decline of foreign exchange market intervention over the period. It may imply that the BOM increased policy flexibility by shifting from an emphasis on the exchange rate toward inflation targeting. Moreover, fewer, and more symmetric, interventions may have further strengthened the BOM's credibility in anchoring aggregate inflation expectations. Nevertheless, given its very thin foreign exchange market, some intervention may remain necessary to smooth excessive volatility of exchange rate.

Table 2. Bank of Mauritius Foreign Exchange Market Intervention, 1996/97–2003/04

(In millions of U.S. dollars).

	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Sale	392.1	252.4	126.6	94.0	118.3	19.0	0	0
Purchase	38.9	37.0	11.0	15.7	0	21.1	189.0	68.0

Source: Bank of Mauritius Annual Reports.

Transparent monetary policy operations

The transparent operation of monetary policy has benefited from frequent consultations between the BOM and commercial banks, as well as public statements by its Governor. Commercial banks seem generally satisfied with their frequent dialogue with the BOM. The BOM also maintains an informative website, publishes a comprehensive annual report and a comprehensive monthly statistical monetary bulletin, and has a relatively open policy towards the media. The introduction of the Lombard facility, and the framework for repurchase and reverse repurchase transactions, were designed to increase transparency further. Nonetheless, additional transparency—of the sort outlined in the final section—would be required before the regime could be formalized.

III. AN OPEN-ECONOMY MACROFINANCE MODEL

This section develops the open economy macrofinance model used to investigate Mauritius's monetary policy framework as described above. To do this, a macrofinance model—similar to that of Hördahl, Tristani, and Vestin (2003), and Rudebusch and Wu (2003))—is combined with an empirical open economy model—in the spirit of Svensson, 2000. This model integrates open economy macroeconomic and financial models, combining an affine model of the term structure (which imposes no-arbitrage constraints), with an open economy, new Keynesian model of the economy, where monetary policy is represented by a simple interest rate rule. By using the yield curve to extract information about inflation expectations, new information can be brought to bear on the performance of inflation targeting lite.

Explicitly modeling the yield curve implicitly places interest rates at the center of monetary policy operations. As discussed above, the BOM indirectly targets (operationally) the short-term interest rate through its monetary policy operations (which also influence the slope of the yield curve), and the inflationary expectations of participants in the primary bond market. Consequently, we take the short term interest rate as the policy variable, and following Rudebusch and Wu (2003), we assume that behavior of this rate may be captured by two latent term structure factors, L_t and S_t, in

$$i_t = \delta_0 + L_t + S_t . \qquad (1)$$

One of these factors, S_t, represents the slope of the yield curve (i.e., the spread between the long- and short-term interest rates), while the other, L_t, represents the level of the yield curve.[10] Rudebusch and Wu (2003) present powerful evidence—that at least for the U.S.—movements in the factor representing the level of the yield curve, L_t, mirrors movements in inflationary expectations (across both long- and short-horizons).[11] Consequently, we will use movements in L_t as a proxy for the movement of inflationary expectations, meaning that given (1) fluctuations in S_t should reflect fluctuations due to the monetary policy choices of the central bank. Also given (1), fluctuations in S_t maybe interpreted as movements in the real interest rate. Finally, the specification of longer-term yields is determined assuming that

[10] The first factor underlying the yield curve is typically constant across maturities, and consequently is interpreted as reflecting the general "level" of the yield curve. The second factor varies across maturities (but constant across investment grades), and consequently is often interpreted as reflecting the "slope" of the yield curve.

[11] More specifically, this interpretation of L_t means that it represents general movements in inflationary expectations across horizons. Rudebusch and Wu (2003) also assume that fluctuations in the inflationary expectations are more volatile than those in the *equilibrium* real interest rate, which seems reasonable for Mauritius.

they satisfy an affine no-arbitrage formulation.[12] Therefore, bond yields at all maturities are ultimately pinned down by the behavior of L_t and S_t.

A relatively standard new-Keynesian representation of aggregate demand in an open economy is of the form:[13]

$$y_t = \mu_y E_t y_{t+1} + (1-\mu_y)\left[\beta_{y1} y_{t-1} + \beta_{y2} y_{t-2}\right] + \beta_{qy} q_{t-1} - \beta_r (i_{t-1} - L_{t-1}) + \varepsilon_{yt} \qquad (2)$$

where y_t is output gap, $E_t y_{t+1}$ is the expected output gap at time t, q_t is real exchange rate, i_t is the short-term interest rate, and $\varepsilon_{yt} \sim N(0, \sigma_y)$ represents real demand shocks. As mentioned above, L_t represents the inflation rate expected by private agents. These expectations play a very important role in the context of Mauritius's annual centralized wage determination system, since they provide a focal point for the behavior of wage- and price-setters.[14] A fall in the real interest rate ($i_t - L_t$), and a depreciation of the real exchange rate also lead to an expansion in output with a lag, the latter through its effects on net exports. The parameter μ_y measures the relative importance of the expected future output gap.

Agents are assumed to gradually modify their views about inflationary expectations, as represented by L_t, with actual inflation according to

$$L_t = \rho_L L_{t-1} + (1-\rho_L)\pi_t + \varepsilon_{Lt}, \qquad (3)$$

where ρ_L is the relative weight between the past inflation expectation to the actual inflation, and $\varepsilon_{Lt} \sim N(0, \sigma_L)$ represents other nonsystematic influences on expectations formation.

The open economy supply equation (Phillips curve) is given by

$$\pi_t = \mu_\pi L_t + (1-\mu_\pi)\left[\alpha_{\pi 1}\pi_{t-1} + \alpha_{\pi 2}\pi_{t-2}\right] + \alpha_q q_{t-1} + \alpha_y y_{t-1} + \varepsilon_{\pi t}.^{15} \qquad (4)$$

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[12] The affine no-arbitrage term structure model is presented in Appendix I. We also assume that the price of the risk associated with the factors underlying the term structure may be represented as $\Lambda_t = \lambda_0 + \lambda_1 \begin{bmatrix} L_t \\ S_t \end{bmatrix}$. Since we use demeaned data in the following empirical exercise, we can, without loss of generality, normalize δ_0 and λ_0 to zero.

[13] Micro-founded small open economy models produce a similar expression for the output gap (Galí and Monacelli, 2003; Parrado, 2004).

[14] Under Mauritius's centralized tripartite wage setting mechanism, there is automatic across-the-board wage indexation for any inflation above 5 percent in a year.

[15] Again, micro-founded small open economy models produce a similar Phillips' curve, although for domestic inflation (Galí and Monacelli, 2003; Parrado, 2004).

In this specification, current inflation, π_t, reflects a weighted average of the public's forward looking expectation of the inflation rate, which we equate with L_t, with backward looking expectations represented by two lags of inflation. A key parameter in (4) is μ_π, which measures the relative importance of forward- versus backward-looking pricing behavior. The output gap, as well as changes in competitiveness, are also assumed to influence inflation. The innovation, $\varepsilon_{\pi t} \sim N(0, \sigma_\pi)$, represents stochastic cost-push factors.

Provided that the real interest parity condition holds, real effective exchange rate dynamics may be written as[16]

$$q_t = E_t q_{t+1} - (i_t - E_t \pi_{t+1}) + \varepsilon_{qt}. \tag{5}$$

The current real exchange rate is determined by the expected future real exchange rate, $E_t q_{t+1}$, and the ex ante real interest rate $(i_t - E_t \pi_{t+1})$. Assuming some inertia in the formation of real exchange rate expectations, we assume that the real exchange rate is given by

$$q_t = E_t q_{t+1} + \beta_{q1} q_{t-1} + \beta_{q2} q_{t-2} - \beta_{qS} (i_t - L_t) + \varepsilon_{qt}, \tag{6}$$

where β_{q1} and β_{q2} reflect transitional dynamics.

The BOM's monetary policy rule is assumed to be similar to that recommended by Ball (1999) for small open economies. It includes the output gap y_t, inflation expectation (as captured by L_t), the deviation between actual inflation and inflation expectation $(\pi_t - L_t)$, the real exchange rate q_t, as well as a desire to smooth the real interest rate:

$$i_t = L_t + \rho_S (i_{t-1} - L_{t-1}) + (1 - \rho_S)\left[\gamma_q q_t + \gamma_\pi (\pi_t - L_t) + \gamma_y y_t\right] + u_{St} \tag{7}$$

$$u_{St} = \rho_u u_{S,t-1} + \varepsilon_{S,t}. \tag{8}$$

Equation (7) has the nominal policy interest rate centered about inflationary expectations, and captures the various possible monetary policy objectives of the BOM: to stabilize the real economy; to maintain an appropriate real exchange rate; and to close the gap between actual inflation and its inflation target. It also allows for some persistence in the setting of this rate. Using (1), equation (7) may be easily expressed in terms of the slope factor S_t as

$$S_t = \rho_S S_{t-1} + (1 - \rho_S)\left[\gamma_q q_t + \gamma_\pi (\pi_t - L_t) + \gamma_y y_t\right] + u_{St}. \tag{9}$$

[16] This is similar to equation 2.11 in Svensson (2000).

The parameter estimates of equation (9) should reveal the relative importance of each of these objectives to the BOM. In addition, the dynamics of S_t allow for both partial adjustment, and (through (8)) serially correlated unanticipated monetary policy shocks. If $\rho_S = 0$, the dynamics of S_t arise from monetary policy partial adjustment. Conversely, if $\rho_S \neq 0$, the BOM's monetary policy choice exhibits persistence, and occurs in gradual adjustments. Finally, before moving on to estimate the model, we reformulate (2) and (6) to remove i_t from the system. By using (1) and (2) we can obtain (2')

$$y_t = \mu_y E_t y_{t+1} + (1-\mu_y)\left[\beta_{y1} y_{t-1} + \beta_{y2} y_{t-2}\right] - \beta_r S_{t-1} + \varepsilon_{yt}, \qquad (2')$$

and using (6) and (1) we can obtain (6')

$$q_t = E_t q_{t+1} + \beta_{q1} q_{t-1} + \beta_{q2} q_{t-2} - \beta_{qS} S_t + \varepsilon_{qt}. \qquad (6')$$

The dynamic structure of the transition for the state of the economy is determined by equations (2'), (3), (4), (6'), (8) and (9). The state space of the combined rational expectations open economy macrofinance model is outlined in Appendix I.

IV. MODEL ESTIMATION

The above macrofinance model is estimated by maximum likelihood for the inflation targeting lite period—July 1996 to March 2004. Monthly data on government bond yields (for 3-, 6-, and 12-month maturities) provided by the BOM, annualized CPI inflation from the IMF's *International Financial Statistics*, and the real exchange rate from the IMF's Information Notice System are used to estimate the model. Due to the unavailability of less than annual GDP (or even unemployment) data, we use detrended, seasonally adjusted, real monthly credit to the private sector (deflated by the CPI) as a proxy for the output gap.[17]

Appendix II presents the parameter estimates of the open economy macrofinance model. First, consider the dynamics of the latent factors. The factor representing inflationary expectations, L_t, is extremely persistent with ρ_L estimated at 0.9921. With inflation expectations so persistent, they are extremely difficult to change, with actual inflation carrying a very small weight in inflation expectation formation. In short, once the BOM establishes a good or bad reputation, it lasts a long time.

[17] Since the constant term in latent factor models cannot typically be identified, we work with de-meaned data. Also, as we are estimating two latent factors from three bond maturities, we assume that six-month bond yields are measured with error. This assumption is critical for the identification of the two latent factors. For a given set of parameter estimates and independent variables, the maturities measured without error define two (deterministic) linear equations in two unknowns, which can then be solved for the latent factors.

The BOM's estimated monetary policy rule is

$$S_t = 0.989 S_{t-1} + 0.011\left[0.6474 q_t + 0.9301 \pi_t + 0.0096 y_t\right] + u_{St}$$

$$u_{S,t} = 1.17 \exp(-5) u_{S,t-1} + \varepsilon_{S,t}$$

With the estimated $\rho_S = 0.989$, S_t is also highly persistent. This seems reasonable in terms of the considerable inertia seen in the BOM's (stated) monetary policy setting. However, this also implies that the BOM has relatively weak control over the short-term interest rate ($(1-\rho_S) = 0.011$), although this could be an artifact of the *indirect* nature of the BOM's interest rate targeting, and the relatively crude proxy we were forced to use for the output gap. Unanticipated monetary shocks, u_{St}, on the other hand, are uncorrelated (as ρ_u = 1.17exp(-5)). The relative importance of the inflationary deviations, the output gap, and the real exchange rate are revealed by the estimates of γ_π, γ_q and γ_y, and are 0.9301, 0.6474 and 0.0096, respectively. These estimates suggest that possibly two monetary policy objectives influence policy, which is consistent with an inflation targeting lite regime. Unfortunately, though, all of these parameters are very imprecisely estimated (possibly because ρ_S is so large), with none actually being significant.

The estimated parameters of the aggregate supply (Phillips curve) equation suggest that current inflation depends primarily on inflationary expectations ($\mu_\pi = 0.87414$).[18] This indicates the importance of framing expectations throughout the setting of monetary policy, and suggests that central bank credibility is crucial. Surprisingly, all other explanatory variables, including real exchange rate and output gap, are much less important than expectations, and are insignificant. However, the weak impact of the real exchange rate may reflect the past reliance on (inflexible) administered prices for several imported goods, as well as the crude proxy of the monthly output gap. The preeminent role of inflationary expectations in Mauritius is relatively unsurprising, though, given the important role these expectations can play in the centralized wage-setting process.[19]

The estimated parameters describing the aggregate demand equation suggest that, at least at a monthly frequency, there is a negligible weight on forward-looking output expectations ($\mu_y = 0.0663$). The very low estimate for β_{qy} implies a very weak impact of real exchange rate changes on output. This could reflect the relatively flat nature of the real exchange rate over the inflation targeting lite period.

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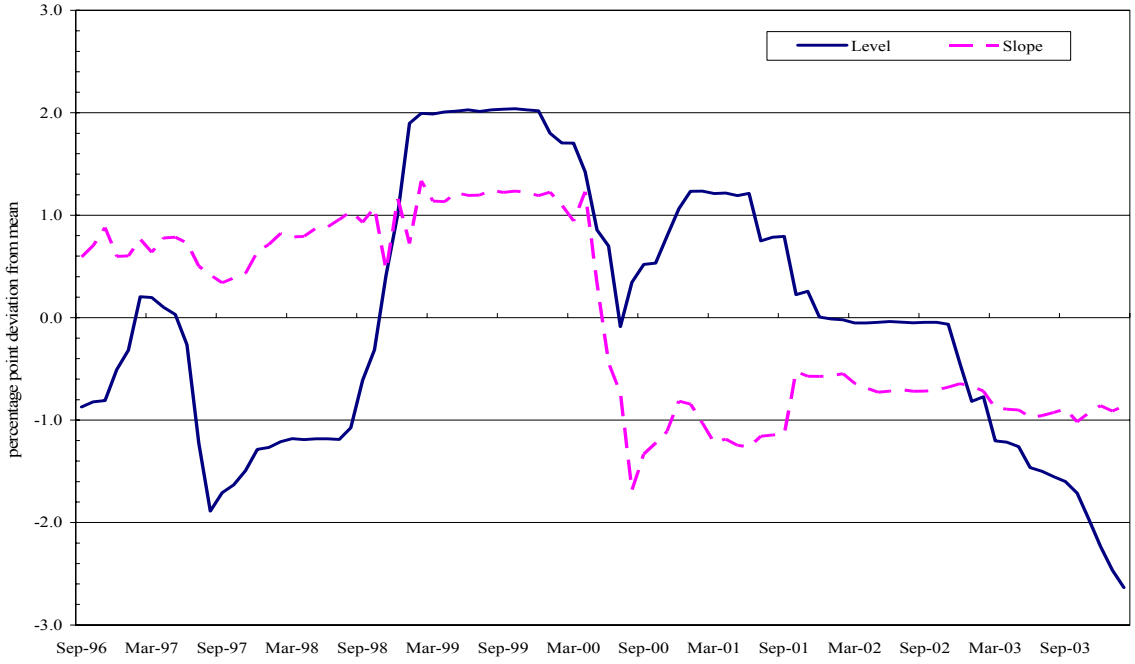
[18] Celasun, Gelos, and Prati (2004) also find very large weights (sometimes larger than unity) when they estimate equations similar to (4) for a number of emerging markets.

[19] For a fuller discussion of Mauritius's labor market institutions, and its unemployment challenge, see Porter (2004).

V. THE DYNAMICS OF INFLATION EXPECTATIONS

Figure 3 presents the latent factor that represents the level of the yield curve, L_t, as well as the slope, S_t. Two observations are immediate: (i) as measured by the level of the yield curve, inflationary expectations in Mauritius are time-varying; and (ii) the average level (and fluctuation) of expected inflation have declined significantly, especially since late-2000. This suggests that the BOM has earned credibility for its inflation targeting lite performance.

Figure 3. The Level and Slope of the Yield Curve



However, as measured by expectations, the implementation of inflation targeting lite has not been even. Inflationary expectations increased rapidly in mid-1998 (following a couple of years of relatively large foreign exchange interventions), before subsequently falling in 2000. The continuously steady depreciation of exchange rate over the whole period is one major factor to prevent inflationary expectations from declining rapidly until 2000. The rapid decline from 2000 could, in part, reflect the gradual reduction in foreign exchange interventions, but also follows a significant move by the BOM against inflationary pressures.[20] It also coincides with the introduction of the Lombard facility, which the BOM

[20] In 1999, the BOM deliberately introduced a tight monetary policy to head off inflationary pressures during the recovery in 1998/99. Despite slow growth in 1999/00, the Lombard rate was raised to 12.0 percent, and to 12.5 percent in late-September and November 2000, respectively. The tighter stance was kept in place until May 2001, when the BOM began a series of easings, lowering the Lombard rate from 12.5 percent to 9.5 percent as of January 2004.

introduced to improve transparency and its ability to signal the stance of monetary policy. The behavior of the slope suggests that aside from one (or, possibly, two) episodes, the spread between short- and long-term securities has remained relatively flat. Its sudden decline during 2000 may reflect lower (real) returns available in more advanced economies, and, possibly, a revision of growth prospects, given uncertainty about the future of trade preferences.

VI. CONCLUSION

Mauritius's inflation targeting lite regime has been associated with a fall in inflation, and—as seen in Figure 3—an impressive fall in inflation expectations. That is, inflation targeting lite appears to have been able to moderate inflationary expectations, and resulted in a steady reduction in actual inflation. These expectations are particularly important in the case of Mauritius, since they can provide a focal point during the centralized wage bargaining process, thereby affecting inflation far into the future.

Mauritius's experience to date suggests the potential value of inflation targeting lite. It does not make a pure commitment to an inflation target due to the need to maintain a managed float, but nevertheless has achieved low inflation because of gradually improving credibility. By focusing on the aggregate CPI inflation expectation, the BOM has also anchored actual inflation, without generating excessive output volatility. Mauritius's experience suggests that, if applied consistently and credibly, inflation targeting lite can be a feasible policy alternative to a hard peg for small island economies.[21]

However, Mauritius's experience can be taken only so far. First, its experience comes against a backdrop of relatively subdued inflation worldwide. It remains to be seen how Mauritius's inflation targeting lite regime will fare if global inflation rises significantly, although a formalization of the current regime may limit any erosion of the gains already achieved. Second, it shows that even in a country with solid institutions, a lack of fiscal dominance, and low external debt, it can take a long time before the central bank has earned sufficient credibility to anchor expectations for low inflation.

[21] Indeed, Mishkin (2004, p. 25) concludes that in the context of inflation targeting "... there is a rational for central banks in emerging market countries to smooth exchange rates," provided they do not go too far.

APPENDIX I

State space representation

The dynamic system, (2'), (3), (4), (6'), (8) and (9), can then be given the following state space representation $\Gamma_0 Y_t = \Gamma_1 Y_{t-1} + \Psi \varepsilon_t + \Pi \eta_t$, where the x^{th} of η_t is $\eta_{xt} = x_t - E_{t-1}x_t$, or the expectational forecasting error, and where

$Y_t = \left[\pi_t \;\; \pi_{t-1} \;\; q_t \;\; q_{t-1} \;\; y_t \;\; y_{t-1} \;\; L_t \;\; S_t \;\; u_{St} \;\; E_t y_{y+1} \;\; E_t q_{y+1}\right]'$, $\varepsilon_t = \left[\varepsilon_{\pi t} \;\; \varepsilon_{qt} \;\; \varepsilon_{yt} \;\; \varepsilon_{Lt} \;\; \varepsilon_{St}\right]'$ and

$$\Gamma_0 = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & -\mu_\pi & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & \beta_{qS} & 0 & 0 & -1 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & -\mu_y & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
\rho_L - 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
(\rho_S - 1)\gamma_\pi & 0 & (\rho_S - 1)\gamma_q & 0 & (\rho_S - 1)\gamma_y & 0 & (1-\rho_S)\gamma_\pi & 1 & -1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}$$

$$\Gamma_1 = \begin{bmatrix}
(1-\mu_\pi)\alpha_{\pi 1} & (1-\mu_\pi)\alpha_{\pi 2} & \alpha_q & 0 & \alpha_y & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \beta_{q1} & \beta_{q2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \beta_{qy} & 0 & (1-\mu_y)\beta_{y1} & (1-\mu_y)\beta_{y2} & 0 & -\beta_r & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \rho_L & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & \rho_S & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \rho_u & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}$$

$$\Psi = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0
\end{bmatrix}, \text{ and } \Pi = \begin{bmatrix}
0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1
\end{bmatrix}.$$

Using the Sims (2001) algorithm for linear rational expectations models, the system can be transformed into the form $Y_t = \Gamma Y_{t-1} + \Omega\varepsilon_t$, with the state vector of the system following the law of motion $F_t = \rho F_{t-1} + \Sigma\varepsilon_t$, where the state is $F_t = \left[\pi_t \;\; \pi_{t-1} \;\; q_t \;\; q_{t-1} \;\; y_t \;\; y_{t-1} \;\; L_t \;\; S_t \;\; u_{St}\right]'$.

No arbitrage conditions

For an economy where the state evolves according to $F_t = \rho F_{t-1} + \Sigma\varepsilon_t$, and the price of the risk associated with the factors underlying the term structure is represented by $\hat{\Lambda}_t = \hat{\lambda}_0 + \hat{\lambda}_1 F_t$, Rudebusch and Wu (2003) derive a recursive structure for an affine no-arbitrage bond-pricing model. With the very short-term interest rate, i_t, expressed as a linear function of the state of the economy, $i_t^1 = -\overline{A}_1 - \overline{B}_1' F_t$, they show that the yield on other maturities ($i_t^j = -\overline{A}_j - \overline{B}_j' F_t$) must satisfy following recursive patterns for *j*>1:

$$\overline{A}_j = \overline{A}_{j-1} - \overline{B}_{j-1}'\Sigma\hat{\lambda}_0 + \frac{1}{2}\overline{B}_{j-1}'\Sigma\Sigma'\overline{B}_{j-1} + \overline{A}_1, \text{ and}$$

$$\overline{B}_j = \overline{B}_{j-1}'\left(\rho - \Sigma\hat{\lambda}_1\right) + \overline{B}_1'.$$

Likelihood function of the macro finance model

As described in the paper, the authors use data on inflation, private sector credit, and the real exchange rate, as well as the yields on 3-, 6-, and 12- month treasury securities. We stack the observed values in a vector $z_t = \left[\pi_t \;\; q_t \;\; y_t \;\; i_t^3 \;\; i_t^6 \;\; i_t^{12}\right]'$. Since we are estimating two latent factors from three yields, we must assume that one yield is measured with error. Following common practice, we assume the yield associated with the middle maturity—6 months—is measured with error (and distributed $N(0,\sigma_6)$). Assuming that conditional on the first *t-1* observations, the *t*th observation is Gaussian, then $z_t = \Gamma^z F_{t-1} + \Omega^z \xi_t$, where

$$\Gamma^z = \begin{bmatrix} \rho_{1,.} \\ \rho_{3,.} \\ \rho_{5,.} \\ B\rho \end{bmatrix}, \Omega^z = \begin{bmatrix} \Sigma_{1,.} & 0 \\ \Sigma_{3,.} & 0 \\ \Sigma_{5,.} & 0 \\ B\Sigma & B^m \end{bmatrix}, B^m = \begin{bmatrix} 0 \\ \sigma_6 \\ 0 \end{bmatrix}, \text{ and } \xi_t = \begin{bmatrix} \varepsilon_t \\ \varepsilon_t^m \end{bmatrix}, \text{ where } \varepsilon_t^m \text{ is the measurement error}$$

and where $B = \left[B_3 \;\; B_6 \;\; B_{12}\right]'$, $A_j = -\overline{A}_j / j$, and $B_j = -\overline{B}_j / j$. The log of the conditional density of the *t*th observation is

$$llh_t = -\frac{1}{2}\left[\ln(2\pi) + \ln\left(\det\left(\Omega^z\Omega^{z'}\right)\right) + \left(z_t - \Gamma^z F_{t-1}\right)'\left(\Omega^z\Omega^{z'}\right)^{-1}\left(z_t - \Gamma^z F_{t-1}\right)\right],$$

with the conditional log likelihood being $L_{z_T,\ldots,z_2|z_1}\left(z_T,\ldots,z_2 \mid z_1;\theta\right) = \sum_2^T llh_t$. Standard errors are computed using the outer product of gradients estimator.

APPENDIX II

Mauritius: Parameter Estimates of the Macrofinance Open Economy Model[1]

Aggregate demand curve

μ_y = 0.0663 [0.4243] β_{y1} = 0.0632 [0.0000] β_{y2} = 0.9368 [0.0000]

β_{qy} = -0.0003 [0.9992] β_r = -0.0085 [0.3687]

Aggregate supply curve

μ_π = 0.87414 [0.2054] $\alpha_{\pi 1}$ = -0.0123 [0.9941] $\alpha_{\pi 2}$ = 0.5791 [0.9110]

α_q = -0.2509 [0.9969] α_y = -0.076 [0.9976]

Inflation dynamics

ρ_L = 0.9921 [3.3exp(-57)]

Real exchange rate dynamics

β_{q1} = 0.9447 [0.6841] β_{q2} = 0.9885 [0.0018] β_{qS} = 0.0038 [0.7554]

Monetary policy reaction function

ρ_S = 0.9890 [5.1exp(-25)] γ_q = 0.6474 [0.9985] γ_π = 0.9301 [0.8678]

γ_y = 0.0096 [0.9999] ρ_u = 1.17exp(-5) [1.0000]

Risk pricing matrix

λ_1^{LL} = -0.1338 [0.6173] λ_1^{LS} =0.5793 [0.1659]

λ_1^{SL} = -1.06exp(-5) [0.9999] λ_1^{SS} = -0.0014 [0.9976]

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[1] P-values are in square brackets.

Standard deviations

σ_L = 0.2950 [0.0120] σ_S = 0.2631 [0.0505]

σ_π = 5.3179 [1.9exp(-16)] σ_q = 0.0607 [0.1399] σ_y = 0.0222 [4.6exp(-14)]

Standard deviation of measurement error for the 6-month bond yield

σ_6 = 0.1956 [1exp(-20)]

REFERENCES

Ball, Laurence, 1998, "Policy Rules for Open Economies," Research Discussion Paper 9806 (Sydney: Reserve Bank of Australia).

Celasun, Oya, Gaston Gelos, and Alessandro Prati, 2004, "Obstacles to Disinflation: What Is the Role of Fiscal Expectations?" IMF Working Paper 04/111 (Washington: International Monetary Fund).

Dennis, Richard, 2001, "Monetary Policy and Exchange Rates in Small Open Economies," Federal Reserve Bank of San Francisco Economic Letter 2003-16, May, (San Francisco: Federal Reserve Bank of San Francisco).

Galí, Jordi, and Tommaso Monachelli, 2004, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy" (unpublished; Barcelona: Universitat Pompeu Fabra).

Hördahl, Peter, Oreste Tristani, and David Vestin, 2003, "A Joint Econometric Model of Macroeconomic and Term Structure Dynamics" (unpublished; Frankfurt: European Central Bank).

Mishkin, Frederic S., 2004, "Can Inflation Targeting Work in Emerging Market Countries?" paper presented at an IMF conference in honor of Guillermo A. Calvo, Washington, D.C., April.

Parrado, Eric, 2004, "Inflation Targeting and Exchange Rate Rules in an Open Economy," IMF Working Paper 04/21 (Washington: International Monetary Fund).

Porter, Nathan, 2004, "Wage Compression, Employment Restrictions and Unemployment: The Case of Mauritius," IMF Working Paper 04/205 (Washington: International Monetary Fund).

Rudebusch, Glenn, and Tao Wu, 2003, "A Macro-Finance Model of the Term Structure, Monetary Policy, and the Economy," Federal Reserve Bank of San Francisco Working Paper 2003-17, September, (San Francisco: Federal Reserve Bank of San Francisco).

Sacerdoti, Emilio, Gamal El-Masry, Padamja Khandelwal, and Yudong Yao, 2005, *Mauritius: Challenges of Sustained Growth* (Washington: International Monetary Fund).

Sims, Christopher A., 2001, "Solving Linear Rational Expectations Models," *Computational Economics*, Vol. 20, pp. 1–20.

Stone, Mark, 2003, "Inflation Targeting Lite," IMF Working Paper 03/12 (Washington: International Monetary Fund).

Svensson, Lars E.O., 2000, "Open Economy Inflation Targeting," *Journal of International Economics*, Vol. 50, pp. 155–183.

Truman E., 2003, *Inflation Targeting and the International Financial System: Challenges and Opportunities* (Washington: Institute for International Economics.)