MONETARY POLICY RESPONSES TO AID SURGES IN AFRICA

Christopher Adam[*]
University of Oxford, UK

Stephen O'Connell
Swarthmore College, USA

Edward Buffie
Indiana University, USA

Catherine Pattillo
International Monetary Fund

UNU- WIDER Conference on

Aid: Principles, Policies and Performance

16-17 June 2006

This Draft: 22 May 2006

This paper draws on work undertaken by the authors for the Africa Department of the IMF in late 2005. We gratefully acknowledge the Department's generous support. All opinions expressed in this paper are, however, solely our own.

* Corresponding author: christopher.adam@economics.ox.ac.uk

1. Introduction

The last two decades have witnessed profound changes in the conduct of monetary policy in Sub-Saharan Africa. In the mid-1980s, African banking sectors were largely geared towards the financing of government and the extension of subsidized credit to favoured activities. To the extent that there was any discretion, monetary policy was conducted in an environment of substantial fiscal dominance, financial repression and, outside of the CFA countries, exchange controls. Although a number of countries remain in the grip of severe macroeconomic instability, there is, today, much less pressure on central banks on average to accommodate large domestic fiscal deficits. Central bank independence is now more meaningful, liberalized banking systems prevail in most countries, and exchange controls have been eliminated virtually everywhere on the continent.

Nonetheless, recent years have seen a growing number of African countries struggle with how best to deploy the available instruments of monetary policy in order to manage the macroeconomic volatility they face, while still maintaining a commitment to low and stable inflation. Recent work by the IMF (2005) and Foster and Killick (2006)[1] suggests that this struggle is nowhere more intense than in the macroeconomic management of volatile aid inflows, where concerns with the short-run management of aid inflows have threatened to overshadow broader considerations of the medium-term developmental rationale of aid. In extreme cases, these concerns may generate pressures for countries to reduce their reliance on aid flows, even when the medium-term returns to aid remain high and when donors are committing to substantially increase their aid budgets (Eifert and Gelb, 2005). In effect, for those countries not committed to a hard institutional peg, the monetary policy debate has shifted away from a narrow focus on price stabilization to embrace a broader but extremely operational set of questions. These include, for example: How aggressively should the authorities seek to manage the path of the nominal exchange rate, if at all? What is the role for using foreign reserve buffers to smooth the absorption of aid? Should aid-related liquidity growth be sterilized through bond sales? Moreover, how should these considerations be traded off against other concerns that legitimately compete for policymakers' attention, including concerns about external competitiveness and the development of nascent domestic financial sectors?

In this paper we seek to gain some purchase on these questions by using a stochastic simulation model to assess the properties of alternative monetary policy strategies, with the aim of identifying those strategies which provide for relatively smooth short-run absorption of aid surges, including avoiding excessive real appreciation. Calibrating this model to reflect key characteristics of *pre-stabilization* and *post-stabilization (*or *mature stablizer)* African economies, we show how strategies involving more or less active foreign exchange intervention and reserve buffering designed to smooth the path of domestic deficit financing serve best to influence short-run macroeconomic volatility.

[1] Both studies undertook case studies of aid surges in African countries. The IMF (2005) case studies were Ethiopia (2001-03), Ghana (2001-03), Mozambique (2000-02), Tanzania (2000-03) and Uganda (2001-03). Foster and Killick (2006) extended this list to include Mauritania (1999-2002) and Sierra Leone (2000-02).

Moreover, our results suggest that for pre-stabilization countries, a managed float, with little or no sterilization of increases in the monetary base, is the most attractive approach.

The remainder of the paper is structured as follows. In Section 2 we provide some motivation for the formal simulation analysis by establishing the main lines of our argument (borrowing freely the 'spend and absorb' terminology introduced in IMF(2005)) and presenting some stylized facts which will shape the calibration of the simulation model. Section 3 then describes the model in detail and Section 4 presents and discusses the simulation results. Section 5 concludes.

2. Basic Motivation and Stylized Facts

The conventional developmental rationale for aid suggests that it should ultimately be both fully spent and fully absorbed: fully spent in order to achieve the maximum expansion in the net supply of public goods and services, and fully absorbed to maximize the resource transfer from the rest of the world.[2] However, there are a number of circumstances in which a full and immediate spend-and-absorb response to aid surges may not be so desirable. These may include, for example, circumstances in which the country faces an inflation stabilization problem or an unsustainable stock of domestic debt, or where foreign exchange reserves fall short of their prudent level. Moreover, if there is a welfare rationale for smoothing the path of public spending over time the spending response to an aid surge depends on whether the surge is permanent or temporary and, if temporary, whether it constitutes a response to distress (e.g., a drought, in which case the flow of aid is matched to a temporary increase in the marginal return on government spending, and should be fully spent) or an inflow unrelated to the marginal product of expenditure. Experience suggests that aid has a large temporary component and that it typically provides little insurance against other sources of volatility in public spending (Bulir and Hamman, 2003, 2005). There is therefore a strong presumption, at least for post-stabilization economies, that a portion of any large aid surge should be held aside initially, rather than being immediately spent. The case for a partial spending response is even more powerful among pre-stabilization countries, where there is a high return to using some portion of the aid to reduce the present value of the government's domestic financing requirement.[3]

These considerations suggest that there is a wide range of circumstances in which the *ex ante* optimal response to a surge in aid, at least initially, does not entail the aid being fully spent and fully absorbed. Indeed, on the basis of their case study evidence, IMF (2005) and Foster and Killick (2006) suggest that a full spend-and-absorb response is the exception rather than the rule. Countries in their samples were more likely to either not spend and not absorb aid surges or to spend but simultaneously act to limit absorption out

---

[2] In the terminology of IMF (2005), an aid surge is *spent* to the degree that the fiscal deficit excluding aid increases in response to the aid (see equation (1) below); it is *absorbed* to the degree that the current account before grants increases (equation (2) below).

[3] Retiring privately domestic debt is one way of doing this, but we will focus on reducing the domestic credit requirement, i.e., reducing seigniorage relative to the no-aid counterfactual.

of concerns about nominal and real exchange rate appreciation. It is policy responses to these variations that constitute the focus of this paper.

Key accounting relationships

Before turning to our formal analysis, it is useful to write down the basic accounting identities that frame the subsequent discussion of policy choices. The first is the consolidated budget constraint of the public sector which we define as

(1) $\Delta H + \Delta B - \Delta NIR = DF =$ Fiscal Deficit - Net Budgetary Aid

where DF is domestic financing of the consolidated public sector deficit. Equation (1) states that the fiscal deficit net of aid is ultimately financed through some combination of seigniorage (defined here as growth in the monetary base ΔH), growth in domestic public sector debt (ΔB), and depletion of international reserves ($-\Delta NIR$).

The second is the balance of payments which takes the form

(2) $-\Delta NFA - \Delta NIR =$ CA Deficit (before grants) - Net Aid

where ΔNFA is the change in private net foreign assets, CA is the current account, and where overall net aid may include items that do not enter the fiscal accounts.

The right-hand side of (1) – the total change in public sector liabilities – is the province of fiscal policy, which determines the overall public sector deficit net of aid. Monetary policy may have important indirect effects on fiscal variables, as we will see; but in terms of policy instruments or intermediate targets, the domain of monetary policy is the *composition* of the left-hand side of (1), taking the right-hand side as given. Similarly, the current account net of aid is a general equilibrium phenomenon over which monetary policy has only indirect control. What monetary policy controls directly, subject to constraints on its reserve position, is the contribution of reserves to overall current account financing.

Thus, for any given domestic financing requirement, the monetary authority determines the relative contributions of seigniorage, net borrowing from the private sector, and reserve decumulation, via transactions with the private sector in foreign exchange and government securities. Its decision about international reserves determines the reserve contribution to current account financing.

Some further evidence

Despite sharing some common structural features, such as relatively underdeveloped domestic financial sectors and limited integration with world capital markets, the set of feasible policy choices confronting individual African countries will be shaped largely by their location along two key dimensions, the first being their recent inflation experience and the second the prevalence of concerns about fiscal dominance. Figure 1 locates the non-CFA countries in Africa along these two axes. The vertical axis divides countries with low recent inflation from those with moderate or high inflation, using a 3-year backward average of observed inflation. We use a 15 percent threshold to separate 'low inflation' from 'high inflation' countries. The horizontal axis distributes countries according to a measure of the degree of latent fiscal dominance. Ideally, we would use a measure of the expected future seigniorage requirements to measure fiscal dominance, but since this is not observable we use as a proxy the frequency with which the domestic financing requirement has exceeded a threshold of 3.5 percent of GDP.[4]

The most striking distinction in Figure 1 is between *pre-stabilization* countries in the north-east quadrant, those with chronic moderate to high inflation, like Ghana, the Democratic Republic of Congo (until very recently), and Uganda (until the early 1990s), and the *mature stabilizers* in the south-west quadrant, with established track records of fiscal discipline and low inflation, like Tanzania and Uganda since the early 1990s. These groups are likely to differ dramatically in the importance attached to inflation stabilization and to institutional reform in the design of monetary and fiscal policy. Pre-stabilization countries face the challenge of establishing credible fiscal discipline, while mature stabilizers face the more modest challenge of maintaining it. Hence, in pre-stabilization countries, there is a strong presumption that a portion of any major aid inflow will be used to support a reduction in inflation. Aid will therefore not be fully spent; instead, the fiscal deficit after grants will be allowed to fall so that the domestic financing requirement is reduced. Reducing expected inflation will be part and parcel of the aid-assisted macroeconomic program. Among the mature stabilizers, in contrast, a major aid inflow may or may not end up substituting for domestic deficit financing. There is no intrinsic need to reduce seigniorage, because inflation is reliably anchored by ongoing fiscal discipline. The path of domestic financing will therefore be more likely to reflect other considerations, including the government's perception of the permanence of aid and its preferences regarding the relative importance of smoothing government spending and domestic financing.

This distinction emerges very clearly from Table 1 which reports the average propensity to spend for various country groupings, reveals a consistent pattern. Across SSA countries as a whole spending out of aid has averaged about 75 cents on the dollar. For low-inflation economies and those classified by the IMF as mature stabilizers, the propensity to spend is marginally higher while for those countries still grappling with chronically high inflation, a much larger proportion of aid is used to substitute for domestic financing, and particularly so out of positive aid flows.

The south-east quadrant of Figure 1 consists of *low institutional credibility* countries, where expected inflation is currently low, but fiscal discipline is sufficiently weak that there is a substantial *ex ante* risk of high future inflation. These countries share a credibility problem, but not an inflation-stabilization one, with the pre-stabilization countries. Behaviorally, however, their optimal response to aid may look similar. For example, if the roots of fiscal indiscipline lie in a weak mechanism for the evaluation of

[4] This is not the same thing as a seigniorage threshold, but given the costs of internal debt, a higher probability that the domestic financing requirement will exceed a threshold in the near future implies a higher probability that future demands for inflationary finance, whether implicit or explicit, will prove decisive.

public spending projects, then strengthening this mechanism may mean delaying the spending response to an aid inflow, so that projects are undertaken only after they have cleared a demanding efficiency hurdle. This is likely to mean that, again, aid will not be fully spent, at least initially. In the background, the objective is not to reduce monetary finance and expected inflation *per se*, but to extend a tentative track record for modest inflation and to buttress credibility by strengthening institutional commitments to fiscal discipline.

The northwest quadrant of Figure 1 is not likely to be densely populated, given the relatively low inflation inertia in SSA and the likelihood, under low fiscal dominance, of a prudent fiscal and monetary response to shocks, although transitory food supply shocks, for example, can have a major influence on year-to-year inflation. Some degree of monetary accommodation of inflationary shocks is therefore likely to be in operation in this quadrant, as when a major drought or currency devaluation is allowed to pass through to core inflation over a horizon of a few years. Our analysis will largely omit this case, given its limited empirical relevance by comparison with the other three quadrants.

Table 2 provides some further details on the country groupings included in this taxonomy which we use in calibrating our simulations in Section 4. Three central features emerge from Table 1. The first is that while average inflation rates are very similar between the *Low Institutional Credibility* and *Mature Stabilizer* groups actual fiscal deficits and the domestic debt burden are substantially higher in the former group. Second, the recipients of very large aid flows – as measured by recipient GDP – are clustered amongst the *Pre-stabilization* and *Low Credibility* groups, rather than amongst the *Mature Stabilizers.* Finally, there appears to be little systematic difference in the degree of dollarization across the country groupings, at least as measured by the dollarization of banking sector liabilities.[5]

With these distinctions in mind, we now describe the features of a stochastic simulation model calibrated to the structural features outlined in this section.

3. The Model

Basic Design
We work with a simple optimizing two-sector dependent economy model with currency substitution in which both domestic and foreign currencies delivery liquidity services.[6] The representative private agent consumes traded imports and non-traded final goods and accumulates financial wealth in the form of three assets: domestic currency, foreign currency and government bonds. There are no banks in this model so that money is base money (i.e. the money multiplier is fixed at unity) and foreign currency balances are held in non-interest-bearing forms. Capital mobility is imperfect: government bonds, which

[5] This is of course a partial indicator of the degree of dollarization, since foreign currency balances and offshore deposits are likely to play as important a role in domestic portfolios as domestic foreign currency deposits. But we currently have no solid basis for measuring the full extent of dollarization and no reason to suspect major differences across our groups.
[6] This model shares a similar structure with that developed in Buffie (2003) and Buffie *et al* (2004).

are indexed to the consumer prices, are non-traded while the private agent has no access to foreign bonds. Nonetheless, the private capital account is open so that the private agent can accumulate or decumulate foreign currency through transactions with the central bank or current account surpluses.

The supply side of the economy is simple, reflecting our focus on the short-run. The economy produces exported and non-tradable goods using sector-specific capital, an intermediate import (oil) and labour, which is intersectorally mobile. The aggregate capital stock is fixed and there is no investment. We allow for two adjustment mechanisms on the supply side. In the first, we assume flexible prices and wages, so that full employment prevails and the relative supply of exported and non-traded goods is governed by the real exchange rate for exports. We assume a relatively low elasticity of substitution in production, which implies that shocks to sectoral supplies and demands have a relatively strong effect on the real exchange rate. The second adjustment mechanism assumes that non-traded goods prices are sticky so that the output of non-traded goods is demand-determined in the short run. In this case, macroeconomic adjustment can then take place off the production frontier, via booms or recessions in the nontraded goods sector.[7]

Macroeconomic policy choices are defined through a set of linear rules for government and the central bank. Taking the tax structure as given, fiscal policy consists purely of the spending response to the aid shock. On the monetary side, two independent rules define how the instruments of indirect monetary control – transactions in foreign exchange and government securities with the private sector – are deployed.

Finally, the model is closed by defining a stochastic process for the external shocks. In this case we limit the sources of external volatility to stochastic shocks in the net aid inflow and to the world price of export commodities.[8]

The formal structure
The representative household maximizes an expected utility function of the form

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{C_s^{1-\tau^{-1}}}{1-\tau^{-1}} + \frac{hL_s^{1-\tau^{-1}}}{1-\tau^{-1}} \right),$$

where τ is the inter-temporal elasticity of substitution, $\beta \equiv (1+\rho)^{-1}$ is the discount factor, and the consumption and liquidity aggregates C and L are CES functions of the underlying goods and currencies:

---

[7] In the sticky-price version, we assume that labour is sector-specific, so that value-added in the exportables sector is fixed, aside from supply shocks.

[8] This two-shock structure is nested within a higher dimension structure in which we allow for the stochastic determination of non-tradable output (via rainfall volatility) and for volatility in intermediate input prices ('oil shocks'). Given the specific focus on managing aid shocks we suppress these other sources of volatility in this paper.

$$C_t \equiv \left(k_N C_{Nt}^{\frac{\alpha-1}{\alpha}} + k_I c_{It}^{\frac{\alpha-1}{\alpha}} \right)^{\frac{\alpha}{\alpha-1}} \qquad L_t \equiv \left\{ k_M \left(\frac{M_t}{P_t} \right)^{\frac{\sigma-1}{\sigma}} + k_F \left(\frac{E_t f_t}{P_t} \right)^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}.$$

Here C_{Nt} and c_{It} are consumption of non-traded and imported goods, M_t and f_t are end-of-period holdings of domestic and foreign currency, E_t is the nominal exchange rate, and P is a consumption-based price index.[9]

Along with domestic and foreign currency, households have access to government bonds whose yield is indexed to P. Financial wealth acquired in period t is given by $W_t = M_t + P_t b_t^P + E_t f_t$. Using Y to denote the non-interest income of the household sector and TR to denote taxes net of transfers received from the government, the household sector's overall budget constraint in nominal terms is

$$W_t = M_{t-1} + R_{t-1} P_t b_{t-1}^P + E_t f_{t-1} + Y_t - TR_t - P_t C_t,$$

where $P_t C_t = (P_{Nt} C_{Nt} + P_{It} c_{It})$ and where $R_{t-1} = 1 + r_{t-1}$ is the real interest factor applicable to bonds carried over from period t–1. Assuming PPP for traded goods and normalizing the foreign price of importables to 1, we can divide by E_t to express this in terms of imports. Using lower-case letters to denote stocks or flows measured in terms of imported goods, this yields

$$w_t = m_t + p_t b_t^P + f_t = X_t^{-1} m_{t-1} + R_{It} p_{t-1} b_{t-1}^P + f_{t-1} + y_t - tr_t - p_t C_t,$$

where $\Pi_t = 1 + \pi_t = P_t / P_{t-1}$ and $X_t = 1 + x_t = E_t / E_{t-1}$ are the current-period inflation and depreciation factors and $R_{It} = 1 + r_{It} = R_{t-1} \Pi_t / X_t$ is the real interest factor in terms of importables (note that as of period t–1, the real yield R_{It} is uncertain even though R_{t-1} is known). The price of the consumption aggregate in terms of imported goods, p_t, is a function of the real exchange rate for imports, $e_t \equiv P_{Nt} / E_t$:

(3) $$p_t \equiv \frac{P_t}{E_t} = \left(k_N^{\alpha} e_t^{1-\alpha} + k_I^{\alpha} \right)^{\frac{1}{1-\alpha}}.$$

Rearranging terms and using $R_{It} = I_t / X_t$ (for $I_t = 1 + i_t = R_{t-1} \Pi_t$) to simplify further, we can write the household sector's budget constraint as

[9] P is the minimum nominal expenditure required to achieve a value of 1 for the consumption index C. In the CES case P takes the form $P_t = \left(k_N^{\alpha} P_{Nt}^{1-\alpha} + k_I^{\alpha} P_{It}^{1-\alpha} \right)^{\frac{1}{1-\alpha}}$.

(4) $$\Delta w_t = r_{It} w_{t-1} - \frac{i_t}{1+x_t} m_{t-1} - \frac{i_t - x_t}{1+x_t} f_{t-1} + y_t - tr_t - p_t C_t .$$

The first-order conditions for maximizing utility subject to the sequence of budget constraints include, along with appropriate transversality conditions, the consumption Euler equation

(5) $$C_t^{-\tau^{-1}} = \beta E_t \left[\frac{R_{I,t+1} p_t}{p_{t+1}} C_{t+1}^{-\tau^{-1}} \right] = \beta R_t E_t C_{t+1}^{-\tau^{-1}} .$$

The CES structure for C implies the commodity demands $c_{I,t} = (1-\gamma_t) p_t C_t$ and $\frac{e_t C_{N,t}}{c_{I,t}} = \frac{\gamma_t}{1-\gamma_t}$, where $\gamma_t = \frac{k_N^\alpha e^{1-\alpha}}{k_N^\alpha e^{1-\alpha} + k_I^\alpha}$ is the share of spending allocated to non-traded goods.

Similarly, optimization with respect to domestic and foreign currency, given the CES structure for liquidity services, leads to the following currency demand conditions

(6) $$\left(\frac{m_t}{p_t} \right)^{-\frac{1}{\sigma}} = \left(\frac{1}{hk_M} \right) L_t^{\left(\frac{\sigma-\tau}{\sigma\tau}\right)} \beta E_t \left[\frac{i_{t+1}}{1+\pi_{t+1}} C_{t+1}^{-\tau^{-1}} \right]$$

and

(7) $$\left(\frac{f_t}{p_t} \right)^{-\frac{1}{\sigma}} = \left(\frac{1}{hk_F} \right) L_t^{\left(\frac{\sigma-\tau}{\sigma\tau}\right)} \beta E_t \left[\frac{i_{t+1} - x_{t+1}}{1+\pi_{t+1}} C_{t+1}^{-\tau^{-1}} \right].$$

Given the central role that portfolio behaviour plays in our analysis, it is convenient to examine the properties of the currency demand function in a little more detail. From (6) and (7) we can express the relative demand for domestic and foreign currencies as

$$\log \frac{m_t}{f_t} = \phi_0 - \phi_i \cdot_t i_t + \phi_x \cdot (i_t -_t x_{t+1}),$$

where $\phi_i > \sigma / \bar{i} > 0$ and $\phi_x = \sigma / (\bar{i} - \bar{x}) > 0$.. Here i_t is the nominal interest rate on government securities and ${}_t x_{t+1}$ is the expected rate of depreciation of the local currency between periods t and t+1[10], and $\bar{i}$ is the steady-state value of the interest rate. Relative

[10] Expected depreciation is ${}_t x_{t+1} \equiv ({}_t E_{t+1} - E_t) / E_t$, where E_t is the nominal exchange rate in local currency per unit of foreign exchange.

currency demand thus depends on the relative opportunity cost of holding domestic or foreign currency, i_t and $i_t - {}_t x_{t+1}$ respectively, rather than government bonds. The sensitivity of relative currency demand to these opportunity costs is an increasing function of the elasticity of currency substitution.

The demand for domestic currency, in turn, is given by

$$\log M_t - \log P_t = \eta_0 - \eta_i \cdot i_t + \eta_x \cdot {}_t(i_t - {}_t x_{t+1}) + \log C_t,$$

where C is total spending by the private sector. The semi-elasticities of domestic currency demand are given by $\eta_i = [\tau + (1-v)(\sigma - \tau)]\bar{i}^{-1} > 0$ and $\eta_x = (1-v)(\sigma - \tau)/(\bar{i} - \bar{x}) > 0$, where v is the steady-state share of domestic currency in liquidity services, $\bar{\bar{i}} = \rho + \bar{\pi}$ is the nominal interest rate and ρ the rate of time preference.

The steady-state inflation elasticity of the demand for domestic money is defined as

$$\varepsilon = \bar{\pi} \cdot \eta_i = [\tau + (1-v)(\sigma - \tau)](\bar{\pi} / \bar{i}).$$

For any positive steady-state inflation rate, this is a small number when the currency substitution and intertemporal substitution elasticities are the same ($\sigma = \tau$). But, as noted below, most evidence suggests that $\sigma >> \tau$ so that empirically realistic calibrations can easily generate large elasticities.

The portfolio behaviour described in these equations has conventional properties. First, the demands for both currencies are unit-elastic with respect to spending on goods and services. Second, holding the nominal interest rate constant, an increase in expected depreciation $({}_t x_{t+1})$ shifts desired portfolios in favour of foreign currency. As long as $\sigma > \tau$, this is accomplished in part through an absolute reduction in the real demand for domestic currency. Finally, a rise in the domestic interest rate reduces the real demand for domestic currency, as long as steady-state inflation is not too high.[11]

The parameters σ and τ therefore play a critical role in governing the behaviour of the private sector. On their own, higher degrees of substitutability (σ) tend to provoke larger portfolio reallocations and therefore greater pressures on the nominal exchange rate in

---

[11] When steady-state inflation is zero, steady-state nominal depreciation, $\bar{x}$, must also be zero, and the impact of higher nominal interest rates is negative, because $\eta_x - \eta_i = -\tau / \bar{i}$. This effect can be reversed when steady-state inflation is positive, if there is a high degree of portfolio substitution $(\sigma >> \tau)$. Holding expected depreciation constant, a rise in the nominal interest rate *increases* the relative demand for domestic currency as long as steady-state inflation is positive. This effect emerges because a higher nominal interest rate, given a fixed, positive rate of expected depreciation, reduces the *relative* opportunity cost of domestic currency, $i_t / (i_t - {}_t x_{t+1})$.

response to shocks. A higher value of the inter-temporal elasticity of substitution (τ), other things equal, tends to produce greater volatility in consumption and the current account and less volatility in the real interest rate. In this paper, we set $\sigma = 2$ and $\tau = 0.50$ which correspond to mid-range values from the limited empirical evidence of these parameters.[12] Combined with initial steady state values of π, i, and v, these values imply steady state inflation elasticities of the demand for money of 0.54 for mature stabilizers and 0.62 for high-inflation, low-credibility countries (see Table 3a).

Aggregate Supply

For given fixed capital endowments, aggregate domestic output is defined in terms of a CES aggregator over exportable and non-tradable production

$$\bar{Q} = \left[\delta Q_N^{(1-\eta)/\eta} + (1-\delta) Q_X^{(1-\eta)/\eta} \right]^{\eta/(1-\eta)} \tag{8}$$

where η is the elasticity of transformation in output. Measured in importables, full-employment GDP is given as:

$$y = e\left(1 - \omega_N \left(\frac{p^0}{e}\right)\right) Q_N + p_X \left(1 - \omega_X \left(\frac{p^0}{p_X}\right)\right) Q_X \tag{9}$$

for sectoral supply functions Q_N and Q_X, where p_X is the world price of the exportable in terms of the importable (the barter terms of trade), p^o the world oil price and ω_N and ω_X the cost share of intermediate inputs in gross costs in the non-tradable and tradable sectors respectively.

Sticky Prices

While our PPP assumption rules out sticky prices for exports, the assumption of flexible domestic prices is less appealing for nontraded goods. To accommodate the possibility of price stickiness, we allow for Calvo (1983) pricing in the non-tradable goods market. Assuming that an individual firm's opportunity to change its price arrives as a Poisson process with parameter λ, the price level chosen by adjusting firms in period *t* satisfies

$$\log P_{Nt}^A = [1-(1-\lambda)\beta] \log P_{Nt}^* + (1-\lambda)\beta E_t \log P_{N,t+1}^A .$$

---

[12] There are no reliable direct estimates for the elasticity of substitution between domestic and foreign money for any African countries. Estimates for Latin America generate numbers in the range 0.75 to as much as 7, although the top-end estimates appear extremely large (e.g. Ramirez-Rojas (1985), Giovannini and Turtleboom (1994)). Hence our choice of 2.00. There is a stronger degree of consensus concerning the value of inter-temporal elasticity of substitution (see, for example Agenor and Montiel, 1999). However, in view of the uncertainty on these key parameter values we re-run the simulations under lower values of both parameters (i.e. $\sigma = 0.75$ and $\tau = 0.25$). These simulations are available on request. Changing these parameters alters the model properties in intuitive ways but do not substantially alter our central insights.

where $\log P^*_{N,t+k}$ is the target (log) price in $t+k$ Since a proportion λ of (the large number of) firms ends up changing prices in period t, the aggregate price level for nontraded goods satisfies $\log P_{Nt} = \lambda \log P^A_{Nt} + (1-\lambda)\log P_{N,t-1}$. In the meantime, the actual output of nontraded goods is demand determined. We model the optimal price as a function of the aggregate price level and the gap between the output of nontraded goods and their supply at full employment. Thus

$$\log P^*_{Nt} = \log P_{Nt} + \zeta \cdot \left[\frac{C_{Nt}(e, C_t) + G_{Nt} - \varphi_{Nt} Q_N(e_{Xt})}{\varphi_{Nt} Q_N(e_{Xt})}\right], \qquad \zeta > 0.$$

These three equations yield the sector-specific Phillips Curve

$$\text{(10)} \qquad \log P_{Nt} - \log P_{N,t-1} = \beta E_t[\log P_{N,t+1} - \log P_{Nt}] + \psi \cdot \left[\frac{C_{Nt}(e_t, C_t) + G_{Nt} - \varphi_{Nt} Q_N(e_{Xt})}{\varphi_{Nt} Q_N(e_{Xt})}\right],$$

where $\psi \equiv \frac{\zeta\lambda}{1-\lambda}[1-(1-\lambda)\beta] > 0$. High values of ψ imply greater price flexibility, and as $\psi \to \infty$ equation (10) approaches the flexible-price market-clearing condition in the nontraded goods market, $\varphi_{Nt} Q_N(e_{Xt}) = C_{Nt}(e_t, C_t) + G_{Nt}$. To ensure that the Natural Rate Hypothesis holds, we impose $\beta = 1$.

The public sector

The central bank's balance sheet, in nominal terms, reads $\Delta M_t = E_t \Delta z_t + P_t \Delta b^C_t$, where z and b^C are international reserves and government securities held by the central bank. Assuming the central bank transfers its operating surplus to government, the government budget constraint takes the form

$$P_t(\Delta b^P_t + \Delta b^C_t) = P_{Nt} G_{Nt} + E_t g_{It} + P_t r_{t-1} b^P_{t-1} - TR_t - E_t a_t,$$

where we are assuming no interest on reserves and no foreign debt accumulation, and where a is foreign aid net of interest payments on any existing foreign debt of the public sector. The consolidated public sector budget constraint is therefore

$$M_t + P_t b^P_t - E_t z_t = M_{t-1} + P_t R_{t-1} b^P_{t-1} - E_t z_{t-1} + P_{Nt} G_{Nt} + E_t g_{It} - TR_t - E_t a_t$$

or, in terms of importables,

$$\text{(11)} \qquad \Delta m_t + p_t \Delta b^P_t - \Delta z_t = def_t - a_t - \frac{x_t}{1+x_t} m_{t-1},$$

where the fiscal deficit is defined as $def_t \equiv g_t - t_t + p_t r_{t-1} b^P_{t-1}$. Equation (9) can be combined with the household sector's flow budget constraint (2) to yield the current account identity

$$(12) \qquad \Delta f_t + \Delta z_t = y_t - g_t - p_t C_t + a_t .$$

External shocks
To close the model, we need a stochastic specification for the external shocks and a set of fiscal and monetary policy reaction functions. We characterize the former by assuming that the vector $v_t = [\log a_t - \log \overline{a}, \log p_{Xt} - \log \overline{p}_X]'$ follows a stationary vector AR(p) process, for given steady-state mean values $\overline{a}$ and $\overline{p}_X$. Thus

$$(13) \qquad v_t = \sum_{i=1}^{p} N_i v_{t-i} + \varepsilon_{vt}, \qquad E_t \varepsilon_{vt} \varepsilon'_{vt} = \begin{bmatrix} \sigma_a^2 & \sigma_{a\tau} \\ \sigma_{a\tau} & \sigma_\tau^2 \end{bmatrix},$$

where N_i is a 2x2 matrix of coefficients, ε_{vt} is serially uncorrelated, and the roots of the lag polynomial are all stable. In general both N_i and $E_t \varepsilon_{vt} \varepsilon'_{vt}$ are triangular. However in the simulations reported below we restrict both to be diagonal so as to completely isolate aid shocks from any other source of variation. Parameterization of (13) is based on a cross-country VAR analysis. In this paper we limit ourselves to a single characterization of the aid process in which aid shocks are scaled to an equivalent of 2 percent of GDP and follow a first-order AR process with an autoregressive parameter of 0.50.

Fiscal and monetary policy rules
To complete the model, equations (1) to (13) are combined with a set of rules governing fiscal and monetary policy choices.

<u>Fiscal policy rules</u>
Given our focus on the monetary management of shocks to aid, we adopt a very simple description of fiscal behaviour, in which the government uses net aid and lump-sum taxes to purchase imports and nontraded goods and to finance transfers to the private sector. Specifically we assume the following features.

- We assume inflation tax finances the budget after aid in the steady state.
- There is no revenue volatility: shocks come instead from changes in net budgetary aid.
- Spending takes the form of transfers to the private sector, rather than direct purchases of goods and services. In other versions of the model we allow for the authorities to alter the composition of public expenditure at the margin between tradable and non-tradable consumption. Earlier work using this model suggests that plausible changes in expenditure composition at the margin generate modest (and intuitive) differences in volatilities in the real

exchange rate and the real interest rate. We lose relatively little, therefore, by excluding this additional policy choice here.

- When aid moves above its long-run mean, a portion of the increase may be devoted to reducing the government's domestic financing needs. We call this the *deficit-reducing* component and summarize it in a parameter *dr* that takes on the values 0 and 0.25. The remainder of aid is used to increase government spending.

Finally, we allow for the authorities to actively manage foreign exchange reserves *as a fiscal choice* so as extend the duration of public expenditure out of temporary aid beyond that of the aid itself. To implement this we introduce an aid account, denoted A, as a component of official foreign reserves. Thus total public reserves, denoted $j = z + A$, consist of those notionally under the management of the central bank, z, plus A. In steady state, all aid is spent so that the aid account has a zero balance. Out of steady state, we assume that, each period, government spends a constant fraction μ of the total aid account which consists of the opening stock of aid plus inflows in the current period. Hence, denoting public expenditure (in excess of the steady state value) be g_t and A_t the end-of-period stock of 'aid reserves', we define

(14) $$g_t = \mu(a_t + A_{t-1})$$

where the equation of motion for A is $A_t = A_{t-1} + a_t - g_t = (1-\mu)(A_{t-1} + a_t)$.

This smoothing rule is applied to the expenditure out of aid net of any *dr* component. Clearly, as $\mu \to 1$ the profile of expenditure matches that of aid. In the simulations reported below we fix $\mu = 0.5$. Given the AR(1) process for aid shocks, with an autoregression parameter of 0.50, the half-life of the aid shock is therefore one year with 94% of the aid is received within four years. With $\mu = 0.5$, the half-life of spending out of aid is two years and only 81% of the aid is spent within four years. A value of $\mu = 0.25$ would increase the half-life of spending to almost four years with 56% of the shock 'spent' by year four.

Fiscal behaviour therefore boils down to determination of the spending response to aid, as summarized by the *dr* component and/or the degree of expenditure smoothing undertaken by government.

Monetary policy rules

Monetary policy involves a simple choice between transactions in foreign exchange and government securities with the private sector.[13] With respect to intervention behaviour, we begin with two polar alternatives:

[13] With no banking system in model, there is no role for reserve requirements or deposit placement policies in the central bank's toolkit.

- A (de facto) *free float*, under which the central bank's net international reserves do not change in response to shocks, including shocks to foreign aid. All foreign exchange available to the economy is immediately priced in a competitive foreign exchange market and either 'absorbed' by the private sector (i.e., used to increase the current account deficit) or added to private net foreign assets (foreign currency).

- A (de facto) *aggressive crawl*, under which the central bank applies a feedback rule in the foreign currency market, so as to keep the rate of depreciation within a few percentage points of long-run inflation. It reduces its reserve position whenever the rate of depreciation exceeds the steady-state inflation rate, and increases its reserve position whenever the rate of depreciation falls below the steady-state inflation rate.

While these rules represent natural polar extremes in de facto exchange rate policy, neither provides for any direct coordination with the fiscal management of aid. We therefore consider a third intervention rule, in which the central bank earmarks aid dollars, holding them as international reserves until the corresponding government spending is undertaken. The domestic liquidity generated by aid-financed government spending is then sterilized in full through sales of foreign exchange to the private sector.[14]

In this case – which we refer to as a *buffer+float* policy -- the central bank retains aid until aid-financed government spending takes place. It then uses foreign exchange sales to sterilize the domestic liquidity generated by this spending. The central bank floats with respect to all other shocks.

If aid is immediately spent, a *buffer+float* is equivalent to a pure float. When aid has a deficit-reduction component, however, a *buffer+float* involves reserve accumulation during an aid boom, with reserves continuing to build as long as aid remains above its long-run mean. In its pattern of reserve accumulation and exchange rate depreciation, therefore, a *buffer+float* may look much closer to a crawl than to a pure float. The difference is operationally significant, however. In a crawl, the central bank targets the nominal exchange rate, without reference to the pattern of government spending and liquidity creation. In a *buffer+float*, the central bank pays no direct attention to the nominal exchange rate. Instead it sets a time-varying reserve target that corresponds to aid financing that has not yet been spent, and allows the exchange rate to float freely as it satisfied this reserve target.

In effect, a *buffer+float* policy corresponds to using foreign exchange sales to target seigniorage: until aid is spent or aid dollars are sold by the central bank, an aid surge has no impact on seigniorage, because net international reserves and net budgetary aid each change by the same amount. As aid is spent (increasing the fiscal deficit), the import component of spending continues to leave domestic liquidity unchanged because net

[14] Note that the import component of aid-induced spending (zero in our runs) is self-sterilizing. It generates no increase in the monetary base because government deposits decline (and net domestic credit rises) as reserves decline.

international reserves fall by the import component of the rise in the fiscal deficit (while in the background, net domestic credit rises by the same amount). The liquidity injection associated with aid corresponds to the non-import component of aid-financed spending. A *buffer+float* policy uses foreign exchange sales to sterilize this in full, leaving seigniorage unchanged.

These alternatives are summarized in the following reaction function

(15) $$\frac{\Delta z_{t-1}}{\bar{z}} = z_1 \cdot \frac{\bar{\pi} - x_t}{(1+\bar{x})} + z_2 \cdot \frac{\bar{z} - z_{t-1}}{\bar{z}} + [1 - z_3(1-dr)] \cdot \frac{(a_t - \bar{a})}{\bar{z}},$$

where $z_1 \geq 0, \quad z_2 > 0, \quad 0 \leq z_3 \leq 1/(1-dr).$

Here $\bar{z}$ is the steady-state level of reserves, x_t the rate of depreciation of the nominal exchange rate, and $\bar{\pi}$. the long-run steady-state rate of inflation. The parameters z_1 and z_2 govern the degree of commitment to the steady-state rate of crawl, which is tied down by the long-run inflation rate. As $z_1 \to \infty$ and $z_2 \to 0$, the regime approaches a predetermined crawl in which $x_t = \bar{\pi}$ on a continuous basis. Lower values of z_1 represent looser commitments to the reference rate of crawl. For $z_1 = 0$ the exchange rate floats: central bank intervention, if any, is independent of movements in the nominal exchange rate.

The last term on the right-hand side of (15) allows the central bank to tie foreign exchange sales directly to the time path of aid-induced government spending. When $z_3 = 1/(1-dr)$, this term drops out completely and reserve accumulation is governed solely by exchange rate policy as characterized by z_1 and z_2.[15]

The parameter z_3 governs the response of reserve sales to aid-financed spending. A policy of $z_3 = 1$ and $z_1 = 0$ corresponds to the *buffer+float* strategy in which the central bank sells aid dollars in the precise amount required to finance the domestic-currency value of aid-induced spending. Any *dr* component is then accumulated as reserves. Lower values of z_3 induce smaller foreign exchange sales and greater reserve accumulation, implying faster expansion of the monetary base, other things equal.

Bond operations represent an alternative way of targeting the monetary base. Any foreign exchange intervention that is pursued using (15) changes the monetary base. We allow the monetary authority to sterilize a portion of this impact on a temporary basis, and also to use bond operations to target the domestic credit component of the monetary base. A bond-sterilization function with these properties takes the form

[15] The combination z_3 = 1/(1-*pdr*) and z_1 =0, this generates a pure float: it corresponds to unchanged reserves.

(16) $$p_t \Delta b_t^P = b_1 \Delta z_t + b_2 \left[def_t - a_t - \frac{\bar{\pi}}{1+x_t} m_{t-1} \right] + b_3 p_t (\bar{b}^P - b_{t-1}^P) + b_4 (1-dr) \cdot (a - \bar{a}),$$

where $b_1 \geq 0, \quad b_2 \geq 0, \quad 0 < b_3 \leq 1, \quad b_4 \geq 0.$

For $b_1 > 0,$ bond operations are used to offset at least a portion of the impact of foreign exchange intervention on the monetary base; for $b_2 > 0,$ they are used to offset a portion of the difference between the government's current domestic borrowing requirement and the steady-state growth in domestic credit. A policy of $b_1 = b_2 = 1$ corresponds to using bond operations to target the growth of the monetary base at its steady state value of $\bar{\pi}$. Lower values of $b_1 = b_2$ correspond to weaker commitments to the baseline growth rate of the monetary base.

In combination with z_3, the parameter b_4 allows us to investigate alternative mechanical rules for sharing the burden of liquidity control between reserve sales and bond operations. To analyze such rules we set b_1 and b_2 to zero and restrict attention to cases in which $b_4 = 1 - z_3$. These have a straightforward interpretation: the central bank uses a combination of foreign exchange sales and bond sales to neutralize the full 'counterfactual' increase in base money growth due to aid-induced spending, with $100 \cdot z_3$ percent neutralized through foreign exchange sales and the remaining $100 \cdot (1 - z_3)$ percent neutralized through bond sales. We investigate both [100,0] allocations, in which foreign exchange sales take the full brunt of liquidity control – these correspond to the *buffer+float* approach described above – and [50,50] allocations, in which the task is evenly shared.

As we have defined the intervention rules here, when bond operations are used to mop up liquidity growth resulting from domestic credit creation or reserve accumulation, the resulting interest burden feeds back into inflation by increasing future seigniorage requirements. This feedback would not be present if the primary deficit were allowed (or required) to adjust in the face of higher interest payments, so as to keep the overall deficit net of aid unchanged (as under a cash budget). Our objective here is to understand the scope for alternative monetary policies in the absence of such fiscal support.

Both foreign exchange operations and bond operations are unwound over time, at rates determined by z_2 and b_3. These ensure that reserves eventually return to their original steady-state level, so that aid is ultimately fully absorbed regardless of the values of z_1, z_3 and *dr,* and leave interest payments and the fiscal deficit unchanged in the long run, as required by consistency with the long-run inflation target.

Model Calibration
To solve and simulate this model we first calibrate it to the initial conditions of two archetype economies (*pre-stabilization* and *mature stabilizer*) which we define on the

basis of the evidence from Section 2. The full set of calibration parameters is reported in Table 3a and the variables to be tracked in the simulations in Table 3b. Our archetype economies differ in only four respects:

- Initial (steady state) inflation is assumed to be 25% per annum in pre-stabilization countries and 10% in mature stabilizers.

- Initial (steady state) debt is set to 20% of GDP in pre-stabilization countries and 9% in mature stabilizers.

- The degree of dollarization is assumed not to differ systematically between pre-stabilization countries and mature stabilizers.

- Aid shocks are assumed to be more persistent in pre-stabilization countries (AR=0.90) compared to mature stabilizers (AR=0.50).

Summary
Before turning to the simulations themselves we make two important general points regarding the relationship between fiscal deficits and inflation. The first point is that a long-run inflation target cannot succeed without a supportive fiscal policy (Anand and van Wijnbergen 1989). Since, in our analysis, inflation remains below the 'revenue-maximizing' rate, a long-run reduction in inflation requires a commensurate adjustment in the fiscal deficit net of budgetary aid. The latter may play a role in supporting a durable disinflation, either by substituting for the domestic financing of an existing deficit or by softening the fiscal austerity that is required to achieve any given reduction in steady-state inflation.

The second, related point is that when portfolio substitution is high, the government's solvency constraint can make the current demand for domestic currency highly sensitive to expectations about future fiscal performance. Solvency means that from the perspective of any given period, the present value of future primary fiscal surpluses, plus seigniorage and net budgetary aid, must be at least as large as the existing stock of domestic debt. Hence, an increase in expected future primary deficits, or a reduction in expected future aid, therefore implies higher future seigniorage and an increase in expected future inflation. If current money demand is highly sensitive to expected future inflation, this deterioration in fiscal expectations can create immediate inflationary pressure.

These considerations mean that the steady-state elasticity of money demand with respect to inflation plays a key role in transmitting expectations of future seigniorage and inflation to current money demand. The same considerations imply that when currency substitution is reasonably active, monetary policy may have a difficult time controlling inflation even in the short run, in the absence of a supportive fiscal policy. Other things equal, therefore, a monetary tightening brought about through bond sales implies an increase in expected future fiscal deficits, because interest payments must be made on a higher stock of government securities. Unless the fiscal authorities are expected to reduce primary deficits net of aid, the current monetary tightening, which reduces *current* seigniorage, implies an even larger increase in expected *future* seigniorage. This weakens the traction from open-market operations to current inflation and, other things equal, reduces the appeal of bond sterilization strategies in targeting inflation. The same logic implies that expectations about the permanence of an aid surge may have important implications for portfolio behaviour and therefore for capital flows, exchange rates, and inflation.

4. Results

Our discussion of aid shocks is based around the results summarized in Tables 4 and 5. In each case we report the simulated impulse response functions (IRFs) of real and monetary variables in response to a *positive* shock to aid of 2% of GDP, around its steady state mean value of 10% of GDP. Given our focus on policy responses to discrete events ('positive aid surges') we emphasis the IRFs. However the final column of each table also reports the theoretical standard deviations of the endogenous variables given the specification of the stochastic process for aid. We limit the presentation of the results to a core set of variables as listed in Table 3b.[16]

In Section 4.1, we examine responses to positive aid shocks in pre- and post-stabilization settings, focusing in particular on monetary policy strategies under different assumptions about the degree of fiscal smoothing. The simulations in this section therefore provide a counterfactual-based approach to the analysis of aid surges presented in IMF (2005). In doing so we contrast two alternative spending responses to surges in aid. In the first case spending follows aid dollar-for-dollar so that the total domestic financing requirement is fully insulated from the direct effects of the aid inflow. Some volatility in domestic financing may remain as a result of volatility in domestic revenue and other components in the budget.[17]

In the second case, public spending increases by less than the full amount of the aid inflow: based on evidence suggested in Section 2 we assume this spending propensity is 0.75. Thus we assume that public spending therefore adjusts by $(1-dr)(a-\overline{a})$ of the aid shock, where $dr = 0.25$. The remainder, $dr(a-\overline{a})$, is passed on to the monetary authorities in the form of a reduction in domestic credit growth.

With dr fixed by fiscal policy, the task of monetary policy is to manage the composition of *DF*, as described in equation (1) above. A major component of this is controlling the path of net international reserves; as emphasized above, this is not the same thing as

[16] All the simulations presented here are generated by the Dynare-Matlab routines (Julliard 1996) using a first-order Taylor approximation to the nonlinear model around the non-stochastic steady state

[17] The cash-budget rules employed in the mid-1990s by countries such as Zambia and Uganda took the object of smoothing domestic financing a step further (Adam and Bevan, 1999). Not only were aid financed expenditures fully aligned with aid flows as described above, but conventional domestic expenditure was also tied directly to domestic revenue generation so that domestic finance was 'smoothed' to zero on a month-to-month basis. Non-statutory government expenditure therefore shouldered the full burden of aid and domestic revenue volatility.

controlling the current account absorption of aid, because the private sector may be accumulating or decumulating foreign currency. In what follows we study four main alternatives for the monetary policy response to aid:

- A *pure float* where $\Delta z = 0$

- An *aggressive crawl* under which the authorities intervene in the foreign exchange market to keep the nominal exchange rate close to its long-run equilibrium rate of depreciation.

- A *buffer+float* (in which the dr component is accumulated as reserves and the authorities float with respect to all other shocks). In the case where the aid flow is the only source of volatility on the budget and there is no recourse to bond financing, the *buffer+float* is tantamount to targeting base money with respect to aid shocks by sterilizing 100 percent of the domestic currency counterpart of aid-financed spending with foreign exchange sales.

- *Bond sales*. We examine a '50-50' rule that sterilizes half of the liquidity injection associated with aid-financed spending using foreign exchange sales and half using bond sales. We find, not surprisingly, that it performs distinctly less well than the *buffer+float* (a '100-0' rule). The fiscal danger associated with aggressive bond operations is a robust feature of our analysis: under managed exchange rates, offset coefficients are substantial, while under a float the impact on exchange rates and inflation can rapidly become destabilizing.

Section 4.2 retains the focus on managing aid surges but considers two further aspects. The first is the case in which the authorities use nominal exchange rate policy to prevent the equilibrium real appreciation that accompanies an aid boom. As suggested in the theoretical and empirical literatures on real exchange rate targeting, a sharp tradeoff – and a largely unfavorable one, in our view – emerges between real exchange rate stability and the stability of inflation. Sterilized intervention is feasible given imperfect asset substitutability, but results from Section 4.1 suggest that using bond operations to maintain a money anchor during the intervention phase would produce high real interest rates and – given a mounting interest burden – few gains on the inflation front.

In the second part of Section 4.2, we examine the 'fiscal smoothing' case where the fiscal authorities use foreign exchange reserves to extend the duration of public expenditure relative to that of the aid surge.

4.1 Managing Aid Surges

Core results

Before turning to the details, we briefly summarize the central insights emerging from the simulation evidence presented in this section:

- First, in cases where aid is "fully spent and fully absorbed" macroeconomic adjustment to a temporary aid surge is smooth and the choice of nominal anchor makes relatively little difference to the adjustment path. The aid surge facilitates higher private consumption and entails a modest appreciation of both the real and nominal exchange rate appreciation. Under a float this appreciation ensures that the aid inflow is mildly deflationary. Under a crawl a modest initial inflation is required to effect the real exchange rate appreciation.

- Second, when the fiscal impacts of temporary aid shocks are passed on to the monetary authority in the form of a volatile seigniorage requirement, changes in velocity now play a potentially important role in the macroeconomic dynamics. Under a "(fully) absorb but don't (fully) spend" policy – one in which the monetary authority accumulates no additional reserves, even though the public spending impact of aid is less than dollar-for-dollar – required seigniorage falls sharply, producing an overshooting real appreciation as the private sector substitutes out of foreign currency and into domestic currency. This in turn increase inflation volatility as well as promote recessionary pressures in the short-run if domestic prices are sticky.

- Third, by contrast, macroeconomic outcomes are considerably better under an aggressive crawl, which limits the disinflationary impact of the aid surge and automatically accommodates any remaining fall in velocity. In the post-stabilization case, a very similar improvement emerges under the *buffer+float* case; however, if the monetary authority simply aligns the sale of aid dollars with the time pattern of aid-financed fiscal spending. In this '*buffer+float*' policy, the monetary authority satisfies a time-varying reserve target but one that is exogenous to movements in the nominal exchange rate.

- Finally, while the distinction between the crawl and *buffer+float* is relatively modest for mature stabilizers, the distinction does matter for 'pre-stabilization' settings where efficient responses to the fall in velocity associated with an aid-supported inflation stabilization appear to require greater intervention than provided by the *buffer+float* so as to match the rise in domestic money demand with an increase in reserve money.

Preliminaries: the counterpart fallacy

Discussions of the monetary consequences of aid are sometimes organized around a version of the 'counterpart fallacy,' a counterfactual in which aid inflows produce public spending increases without ever being absorbed in a corresponding current account deficit. A recent version of this is Burnside and Fanizza (2005). It is therefore useful to clear the ground for our subsequent analysis by beginning with such a situation. In Table 4a, the fiscal authorities increase spending by the full amount of the aid, while the central bank accumulates the full amount as international reserves $(z_3 = 0)$ and makes no attempt to sterilize the liquidity injection through bond sales $(b_1 = b_2 = b_4 = 0)$. Higher spending is therefore fully financed by an increase in domestic credit. Inflation goes off the rails immediately, but this outcome has nothing directly to do with aid: what has occurred is large, temporary, money-financed increase in the fiscal deficit. A massive depreciation of the nominal exchange rate is matched in the flexible-price case by rapid inflation of non-traded goods prices, and the real exchange rate appreciates mildly and with a lag. Under sticky prices, the same nominal depreciation produces an immediate large real depreciation and a demand-switching boom in the non-traded goods sector. The current account (after grants) shows a substantial temporary surplus in all cases, consistent with the private sector's desire to smooth the temporary increase in its disposable income. The message here is clear: a policy that spends but does not absorb aid is a recipe for macroeconomic destabilization.[18]

Mature stabilizers

We turn next to cases where aid inflows are spent (either fully or partially) and focus on monetary policy choices under which the aid inflow is partly or fully absorbed in the short-run.

a) All aid is spent

Tables 4b and 4c compare two alternative approaches to "spending and absorbing" the aid in the short run. In Table 4b the authorities sell aid as it is received, accumulating no reserves and allowing the exchange rate to float. In 4c they adopt an aggressive crawl $(z_1 = 15, z_2 = 0.05)$, intervening continuously to prevent the rate of depreciation from diverging from its steady state value. For both policy rules we report the outcomes under alternative assumptions concerning the flexibility of non-tradable goods prices.

The central bank's alternative policy rules differ sharply and imply different paths for the nominal exchange rate (Figure 2) and aggregate prices, at least in the short run, macroeconomic outcomes are similar in the two cases and most importantly, are largely benign. The initial real exchange rate appreciation requires an inflationary spike in the crawl case, and marginally more so when prices are flexible, but the increase is small and transitory.

While the crawl delivers less volatility for both inflation and the real exchange rate, the differences between these polar approaches to exchange rate policy are second-order. When all aid is spent, little happens to the exchange rate in the float case: the required real appreciation is modest, and it is accomplished with relatively little volatility in the nominal exchange rate. Even a tight crawl therefore requires little net foreign exchange accumulation (the impulse responses report percentage changes in reserves), implying that in both cases the bulk of the aid is sold – and absorbed – roughly as rapidly as it is spent.

b) Bond sterilization

Foreign exchange sales and bond sales represent alternative ways of sterilizing the liquidity injection implied by aid-induced spending. The crawl and float policies in

[18] Given the stationary nature of our model, it is more accurate to describe this as an example of a temporary "spend and don't absorb" policy since ultimately the aid is absorbed as reserves revert to their long-run equilibrium (a process that commences between years 3 and 4 in our simulations).

Tables 4b and 4c each end up allocating 100 percent of the burden of liquidity control to foreign exchange sales. Macroeconomic adjustment is smooth, suggesting that there is no obvious case for shifting some of the burden to bond operations. In Table 4d we confirm this impression. In contrast to the [100,0] allocation, we investigate a [50,50] alternative in which the domestic currency value of aid spending is matched in equal amounts by central bank sales of foreign exchange and government securities. Compared with either the clean float or the aggressive crawl, this rule does poorly. We get a large nominal depreciation, an inflationary spike and, in the sticky price case, an up-front real depreciation as well. Not surprisingly, bond sales drive real interest rates up and private consumption down, relative to the pure float case.

c) Aid not fully spent

Aid that is not fully spent provides an element of fiscal stabilization. In terms of equation (1) a pure float entails setting $\Delta NIR = 0$ so that the contraction in the fiscal deficit after net budgetary aid is met by a contraction in the government's seigniorage requirement for a given stock of domestic debt (ΔH<0 if $\Delta B = 0$). The consequent reduction in expected inflation shifts the private sector's asset portfolio in favour of domestic money and the resulting decline in velocity can generate substantial volatility in inflation. As explained in Buffie *et al* (2004) this short-run *over-absorption* of the aid through a pure float can result in the nominal exchange rate to appreciate very sharply in the short run and by more that the real exchange rate appreciation required to absorb the aid inflow. This in turn requires non-tradable prices to fall sharply which, in the face of downward price stickiness raises the risk of a sharp recession in the non-tradable goods sector. Against this counterfactual, strategies that align absorption more closely to spending and hence smooth the path for seigniorage can substantially close off this source of macroeconomic volatility.

These effects are shown in Table 4e where, to save space, we report only the results for the sticky-price case.[19] In Panel 1, aid is fully absorbed via foreign exchange sales, and the exchange rate is allowed to float $(z_1 = 0,\ z_3 = 1/(1-dr))$. In this case the aid inflow is over-absorbed and the macroeconomic volatility analyzed by Buffie *et al* 2004 is evident. The decline in velocity induced by lower expected inflation as a result of the government's reduced seigniorage requirement serves to accentuate the nominal and real exchange rate appreciation compared to the no-*dr* case with the nominal rate appreciating by around 14% on impact (compared to an appreciation of around 2.4% in the no-*dr* case in Table 4b), and the real rate appreciating by 6.5% (compared to 2.4%). Given the lower persistence of the aid shock, the impacts are milder here than in Buffie *et al* but they are nonetheless non-trivial, inducing a contraction in non-tradable output of 1.6% on impact compare to an increase in Table 4b.

By contrast, a tight predetermined crawl (Panel 2) and a *buffer+float* approach (Panel 3) both do rather well in these circumstances. The pattern of reserve accumulation is broadly similar in the two cases as are the macroeconomic outcomes. In both cases, but particularly under the crawl, the disruptive volatility in inflation and real exchange rate

[19] The full set of results is available on request.

have been greatly reduced with the consequence that the recessionary pressures on the non-tradable sector are avoided.

It is worth noting that the similarity observed here between an aggressive crawl and a buffer+float policy carries over, in a formal sense, to the case in which aid is fully spent. In this case the *dr* element is zero, so there is no role for a reserve buffer; the pure float and *buffer+float* are identical. The near-equivalence of an aggressive crawl and a pure float when aid is fully spent is therefore a special case of the broad equivalence of an aggressive crawl and an appropriately constructed *buffer+float* policy.

The pre-stabilization case
The distinction between the crawl and *buffer+float* strategies, which align absorption with spending, and the pure float, which does not, emerges much more forcefully in pre-stabilization settings. Here, not only is it more likely that aid shocks will include a *dr* component but with higher initial inflation (which implies a higher inflation elasticity of the demand for money, *ceteris paribus)* the strength of portfolio adjustments induced by the fall in expected inflation brought about by an aid-financed fiscal adjustment will be stronger. As shall become clear, under pure float (the *over-absorption* case) the strength of this portfolio adjustment poses potentially severe macroeconomic management problems. The *buffer+float* and the crawl allow for a more orderly accommodation of the desired private sector portfolio adjustments associated with the lower seigniorage requirement and hence lower expected inflation over the duration of the aid surge. This case is discussed in some detail in Buffie *et al* (2004) for the case of a permanent aid shock which supports a credible and permanent reduction in steady-state inflation. Since our simulation model is stationary there can be no *permanent* reduction in inflation. However, the calibration our stationary model to a highly persistent aid shock in this instance means that the central qualitative aspects of the permanent aid-shock case emerge from the results presented in Table 4f. As in the case of the mature stabilizer case, we limit our discussion to the results for the sticky-price version of the model only.

Panel 1 clearly illustrates the severe volatility associated with the sharp contraction in seigniorage arising from the *over-absorption* of aid through a pure float: velocity falls very sharply which, combined with the associated private capital inflow (as seen by the switch from *m* to *f*) generate a dramatic initial overshoot of the nominal exchange rate, with the non-tradable sector experiencing a sharp and rather prolonged recession.

The highly volatile transition paths in Panel 1 are unlikely to be observed in reality. However they do provide a powerful counterfactual against which to understand how a managed exchange rate and to a lesser extent a *buffer+float* strategy contribute to a much smoother adjustment path in response to the aid surge. Specifically, the central bank's tight crawl aligns movements in the nominal exchange rate much more closely to the modest real exchange rate adjustment required to absorb the aid inflow while the (unsterilized) liquidity injection arising from reserve accumulation ensures that the sharp contraction in the domestic money supply observed under the pure float is forestalled. Hence in this case adjustment is associated with virtually stable prices and a modest decline in velocity. Domestic output is hardly affected and total private spending follows a smoother path.

The transition path under the *buffer+float* strategy lies between the pure float and the craw although substantially closer to the latter than the former. The excessive volatility seen in Panel 1 is absent, but the adjustment trajectory under the *buffer+float* still entails much more nominal and real exchange rate movement in the short run, a sharper decline in volatility and much stronger private capital inflows than are observed under a crawl.

The reason for this difference lies in the underlying exchange rate rule. As defined, the *buffer+float* involves accumulating reserves with respect to the unspent portion of aid only – thereby stabilizing seigniorage (assuming no change in domestic borrowing) – but maintaining a free float with respect to absorption of the spent portion of the aid and all other shocks. [20] Notice also that public spending takes the form of income transfers to the private sector. But since their expenditure is not exclusively on imports, the private sector will want to swap some of this foreign exchange for domestic currency in the market. It is this which appreciates the nominal exchange rate and puts downward pressure on prices which in turn cause the fall in velocity. By contrast, under a crawl, the central bank stands ready to exchange domestic for foreign currency at the prevailing (targeted) exchange rate: hence the higher official reserve accumulation in Panel 2 compared to Panel 3.

4.2 Extending the analysis

Targeting the real exchange rate

We have seen that when all aid is spent, a surge in aid generates a modest and ultimately transitory real appreciation. Efficiency concerns or political constraints may nonetheless draw the monetary authority into attempting to prevent any loss in competitiveness. Both theory and empirical evidence suggest, however, that although monetary policy can influence the real exchange rate on a temporary basis (for a given long-run inflation target), using monetary instruments to target a temporarily depreciated level of the real exchange rate will require some combination of higher inflation and higher real interest rates (Calvo, Reinhart and Végh 1995).

Our model is free of Dutch-disease distortions, adjustment costs, distributional concerns or other features that might provide a welfare rationale for resisting an equilibrium real appreciation, and as we pointed out earlier, monetary instruments are unlikely to be first-best for such purposes in any case. Rather than attempting a comprehensive treatment of real exchange rate targeting, therefore, we ask a more modest question: what are the macroeconomic costs of using monetary policy to resist an equilibrium real appreciation? Table 5a suggests that the inflation costs of real exchange rate targeting may be substantial for aid-receiving African countries. We focus on mature stabilizers. To implement a real exchange rate target, we replace the first term in equation (14) with the gap between the real exchange rate and its long-run equilibrium value. An incipient real

[20] Recall from equation (1) that if aid is not full spent the fiscal deficit net of aid will fall. Under a *buffer+float* this fall is exactly offset by the increase in *NIR*, leaving $\Delta H + \Delta B$ unchanged.

appreciation now generates reserve accumulation as the authorities use nominal depreciation to neutralize increases in the prices of nontraded goods. Results for the case in which all aid is spent appear in the first two panels (flexible and sticky prices, respectively) of Table 5a. Cumulative intervention is substantial in all cases, and especially under flexible prices, the initial inflationary impact is severe.[21]

While these results suggest caution in using monetary policy alone to resist an equilibrium real appreciation, there may be greater scope for policies designed to prevent unnecessary overshooting of the real exchange rate. In the bottom half of Table 5a we look at the case in which aid is only partially spent. Our earlier results showed the relative attractiveness, in this context, of an aggressive crawl or (somewhat less so) a *buffer+float* policy, in preventing the severe short-run real appreciation associated with a pure float. A real exchange rate target pursues this objective directly. Not surprisingly, it generates most of the advantages of the crawl and *buffer+float* alternatives, by comparison with the pure float. Reserve-accumulation is substantial, and inflation is higher than in the pure float counterfactual; but since disinflation was a source of macroeconomic volatility in the pure float case, the real exchange rate target represents a substantial improvement. Buffie *et al* 2004 obtain a very similar result for a permanent shock to aid.

This discussion suggests that the case for real exchange rate targeting depends not just on an assessment of the welfare effects of real appreciation, but also on the nature of the fiscal response, the likely persistence of aid, and the ability to make an empirical distinction between the equilibrium path of the real exchange rate and the short-run volatility of the real exchange rate around this path. The latter consideration is not trivial; the equilibrium real exchange rate is itself an unobservable variable, and the difficulties in generating timely and reliable estimates are well known. These considerations suggest that there is considerably more scope for policies that smooth real exchange rate movements by avoiding sharp short-run volatility in the nominal exchange rate than those that seek to target some reference (and possibly non-equilibrium) level of competitiveness.

Smoothing public expenditure

Our final set of simulations considers the case where the fiscal authorities seek to stretch aid-funded public spending over a longer horizon than the aid shock. These are reported in Table 5b where, to save space, we report only the results for the mature stabilizer economy operating under a flex-price adjustment. In addition to the variables listed for each table in Section 4.1, we also report the IRFs for: aid (a), government discretionary expenditure (g), the 'aid account' (A) and total public foreign reserves ($j=z+A$). For reference, Panel 1 repeats the results for the top panel of Table 4b (panel 1).

In Panel 2 the authorities are assumed to apply the smoothing rule defined by (14) with $\mu = 0.5$. The immediate effect is that, compared to Panel 1, this rule decisively reduces the standard deviation of government expenditure (g). In this case, the monetary

[21] Inflation rises much less in the sticky-price runs, but if prices are less sticky in the upward direction than in the downward direction, these runs may be of limited relevance in the case of aid surges.

authorities continue to maintain a float with respect to the net spending out of aid, in a manner directly analogous to the *buffer+float* strategies examined above, but the central bank accumulates reserves with respect to the unspent portion of aid only – thereby stabilizing seigniorage – but maintaining a free float with respect to the absorption of the spent portion of the aid (this can be seen in the paths for *A, z* and *j*) . As expected, the macroeconomic response to the aid shock in this case is relatively benign; the fiscal response combined with the *buffer+float* monetary policy dampens the path of the real exchange rate (*e*) and money growth (*mg*) although, as is clear from equation (2) above, the short-run current account adjustment is necessarily larger. As Panel 3 indicates, however, a very similar outcome can be obtained if the monetary authorities were to adopt a crawl; in this instance, only very modest intervention is required by the central bank.

Both of these cases entail coordinated fiscal and monetary policies. In the final panel we examine the uncoordinated case where the monetary authorities do not internalize the actions of the fiscal authorities but instead seek to maintain a float with respect to the entire aid inflow and therefore act to 'unwind' the reserve accumulation resulting from the fiscal authorities' actions. The results in this case are somewhat unpleasant and reminiscent of the 'float + *dr'* case reported in Table 4e in which the aid flow is 'over absorbed' at the margin, accentuating the nominal exchange rate appreciation and, to the extent that this exceeds the real appreciation required to absorb the aid inflow, putting downward pressure on nontraded goods prices. In the face of downward price stickiness (not shown here) this would again raise the risk of a short-run recession in the nontraded goods sector. Thus, as in the case where spending out of aid is driven by concerns over inflation stabilization, strategies that align sterilization with the path of spending close of this potential source of short-run macroeconomic volatility.

5. Conclusions and Extensions

Since the late 1980s, African countries have made extraordinary gains in putting the relation between fiscal and monetary policy on a stable footing consistent with decontrol of key macro prices, more transparent financing of public spending, and consistency with low inflation. These developments improve long-run growth by reducing distortions and rent-seeking, reducing excess macro volatility, and promoting the development of financial markets. They are subject to a virtuous circle because they enhance the effectiveness of existing policy instruments. They are also subject, however, to slippage and uncertainties, and to monetary/fiscal coordination issues that need to be ironed out; and a number of countries remain clearly pre-stabilization.

The structure of external shocks in SSA differs from that of emerging-market economies, especially with respect to the character of capital flows. This difference is heightened by the scaling-up of donor ambitions and financing in the late 1990s, which has generated a major and persistent surge in aid in a number of countries and the prospect of a major surge in others. Aid surges affect real exchange rates, banking sector balance sheets, and perceptions of fiscal stability. The resulting challenges for monetary management should be viewed in context of the broader challenge of maximizing the contribution of scaled-up and externally financed public spending to long-run growth. A distinction can be drawn between policy initiatives that seek to improve the institutional capacity to absorb aid (e.g., through better monetary/fiscal coordination) and those that govern the monetary policy response to aid (e.g., through the degree of real exchange rate targeting or the relative commitment to exchange rate or monetary anchors).

We have focused on the macroeconomic implications of alternative monetary responses to aid. We find that macroeconomic tradeoffs are more difficult under pre-stabilization conditions, both because concerns about fiscal stability are more plausible and because portfolio behaviour generates greater volatility in inflation and capital flows for a given impact on fiscal stability. Even in post-stabilization cases, however, there are considerable macroeconomic challenges given the size of aid and the salience of policy concerns about real appreciation and the volatility of inflation.

Monetary policy can alter the path of the real exchange rate in the short to medium run, but aggressively targeting the real exchange rate to avoid an equilibrium real appreciation has non-trivial costs in terms of inflation. Substantial benefits would therefore have to accrue to a more depreciated real exchange rate to justify the use of monetary policy in this mode. Moreover, were the source of such benefits to be identified, policy discussion should focus first on the appropriate division of labour between monetary and fiscal policy, since fiscal instruments (including those that directly or indirectly influence the supply-side impact of aid) may well be first-best. The developmental role, if any, of real exchange rate targeting remains a serious and open empirical issue, and one that deserves further study. In the meantime our analysis shows is that the costs of avoiding an aid-induced real appreciation, in terms of traditional monetary policy objectives, may be substantial.

African economies do not float freely and we have observed a strong pattern of intervention and reserve accumulation in response to aid surges. Our simulations suggest that the impact of aid on the domestic financing requirement is a key determinant of monetary policy incentives. When aid is fully spent as it is received, a policy that aligns foreign exchange sales with the fiscal absorption of aid produces a smooth adjustment with only a modest impact on the nominal exchange rate and inflation. A tight crawl, in this case, delivers very similar dynamics, as the central bank is drawn into selling aid dollars at a roughly equivalent pace to prevent nominal depreciation. If aid is used partly to reduce the domestic financing requirement, the same pattern of foreign exchange sales – equal to 100 percent of the increase in the fiscal deficit after grants – continues to generate smooth adjustment, while also generating a transitory increase in reserves corresponding to the non-spent component of aid. This pattern can be implemented in two very different ways: by a buffer+float arrangement in which the authorities observe a mechanical reserve target tied to the fiscal absorption of aid, or an aggressive crawl, in which the sales of aid dollars are endogenous to actual exchange rate movements. If implemented as general rules, these policies differ dramatically in their treatment of non-aid shocks. But in response to an aid surge, they both generate a very substantial improvement in macroeconomic stability relative to a 'pure float' benchmark in which the central bank sells all aid dollars as they arrive (thereby accumulating no reserves), without regard to the pattern of fiscal spending. A second case in which reserve buffer behaviour appears to be part of the optimal response to an aid surge is when the authorities seek to smooth the path of public expenditure for purely fiscal reasons.

Our analysis therefore suggests two alternative robust approaches to the monetary management of aid surges. One is a *buffer+float* policy that aligns the domestic sale of aid funds with the fiscal spending of aid; the other is an aggressive crawl. The two produce broadly similar dynamic responses to aid, inducing similar patterns for reserve accumulation, money growth, and real appreciation. It is premature to stop at this point, however. As general policy rules, the two approaches have radically different interpretations. The first is a float with respect to all other shocks; the second, a crawl. In a context in which aid shocks compete with other shocks for policymakers' attention, the two policies are likely to produce very different patterns of macroeconomic volatility. The two policies may also have different implications for financial sector development; the *buffer+float* confronts market participants with greater exchange rate risk, but may reduce systemic risk by discouraging market participants from taking excessive open positions in foreign exchange, and may offer relatively greater incentives for the development of foreign exchange markets.

A natural next step in this work, therefore, is to extend this analysis to place the management of aid within the context of other real-side shocks. For mineral exporters, export price shocks raise many of the same issues as aid shocks. But this is unlikely to be true more broadly when we turn to consider shocks to agricultural output, intermediate input prices (such as oil shocks for oil importers), and commodity export prices.

REFERENCES

Adam, Christopher S. and David L. Bevan, (1999), "Fiscal Restraint and the Cash Budget in Zambia" in Paul Collier and Catherine Patillo (eds) *Risk and Investment in Africa* , (London: Macmillan, 1999).

Agenor, Pierre-Richard and Peter Montiel (1999), *Development Macroeconomics* (Princeton University Press)

Anand, Ritu and Sweder van Wijnbergen (1989), "Inflation and the Financing of Government Expenditure: In Introductory Analysis with an Application to Turkey," *World Bank Economic Review* 3(1), January: 17-38.

Buffie, Edward (2003), "Tight Money, Interest Rates and Inflation in Sub-Saharan Africa," *IMF Staff Papers* 50(1): 115-35.

Buffie, Edward, Christopher Adam, Stephen O'Connell, and Catherine Pattillo (2004), "Exchange Rate Policy and the Management of Official and Private Capital Inflows in Africa," *IMF Staff Papers 51* (Special Issue): 126-160.

Bulíř, Aleš and A. Javier. Hamann (2003), "Aid Volatility: An Empirical Assessment," *IMF Staff Papers* 50(1): 64-89.

Bulíř, Aleš and A. Javier. Hamann (2005), "Volatility of Development Aid: From the Frying Pan into the Fire?" in Peter Isard, Leslie Lipschitz, Alexandros Mourmouras, and Boriana Yontcheva (eds) *The Macroeconomic Management of Foreign Aid: Opportunities and Pitfalls* Washington: International Monetary Fund.

Burnside, Craig and Domenico Fanizza (2005), "Hiccups for HIPCs? Implications of Debt Relief for Government Budgets and Monetary Policy," *Contributions to Macroeoconomics* 5(1).

Calvo, Guillermo. A., Carmen. Reinhart, and Carlos. Vegh (1995), "Targeting the Real Exchange Rate: Theory and Evidence," *Journal of Development Economics* 47: 97-133.

Calvo, Guillermo A. (1983), "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics* 12: 383-398.

Eifert, Benn and Alan Gelb (2005) "Coping with Aid Volatility" *IMF: Finance and Development* September 2005.

Foster, Mick and Tony Killick (2006) "What would doubling aid do for macroeconomic management in Africa?" (*mimeo* ODI, London, April).

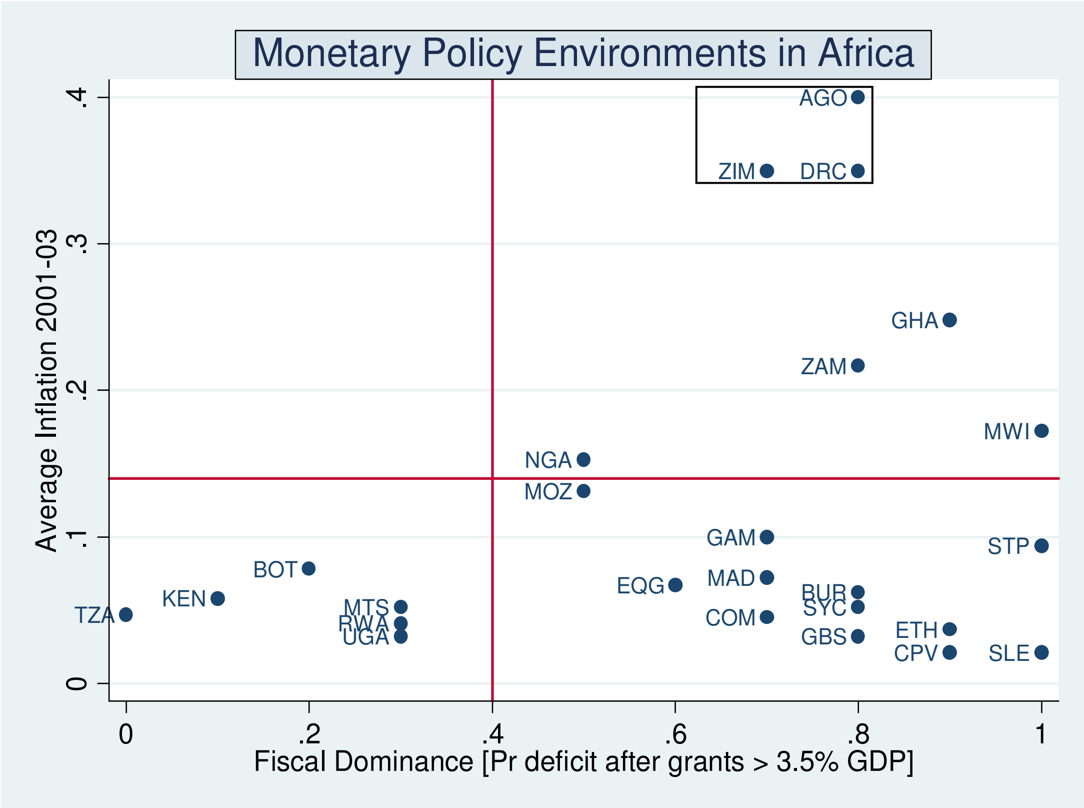
Giovannini, A. and B.Turtleboom (1994) "Currency Substitution" in F. van der Ploeg (ed) *Handbook of International Macroeconomics* (Cambridge MA, Blackwells).

IMF (2005) "The Macroeconomics of Managing Increased Aid Inflows: Experience of Low-Income Countries and Policy Implications" (PDR, August 2005)

Juilliard, Michel (1996), "Dynare: A Program for the Resolution and Simulation of Dynamic Models With Forward Variables Through the Use of a Relaxation Algorithm," *CEPREMAP Working Paper* 9602.

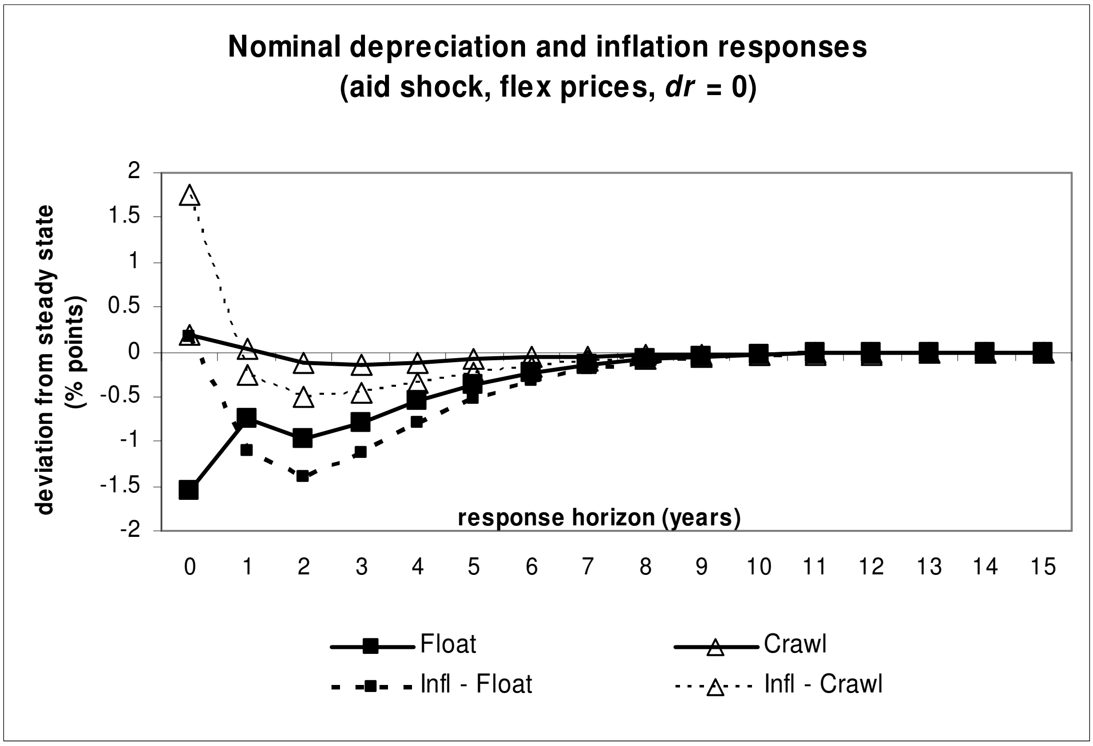
Ramirez-Rojas, C. (1985) "Currency Substitution in Argentina, Mexico and Uruguay" *IMF Staff Papers* 32: 629-667.

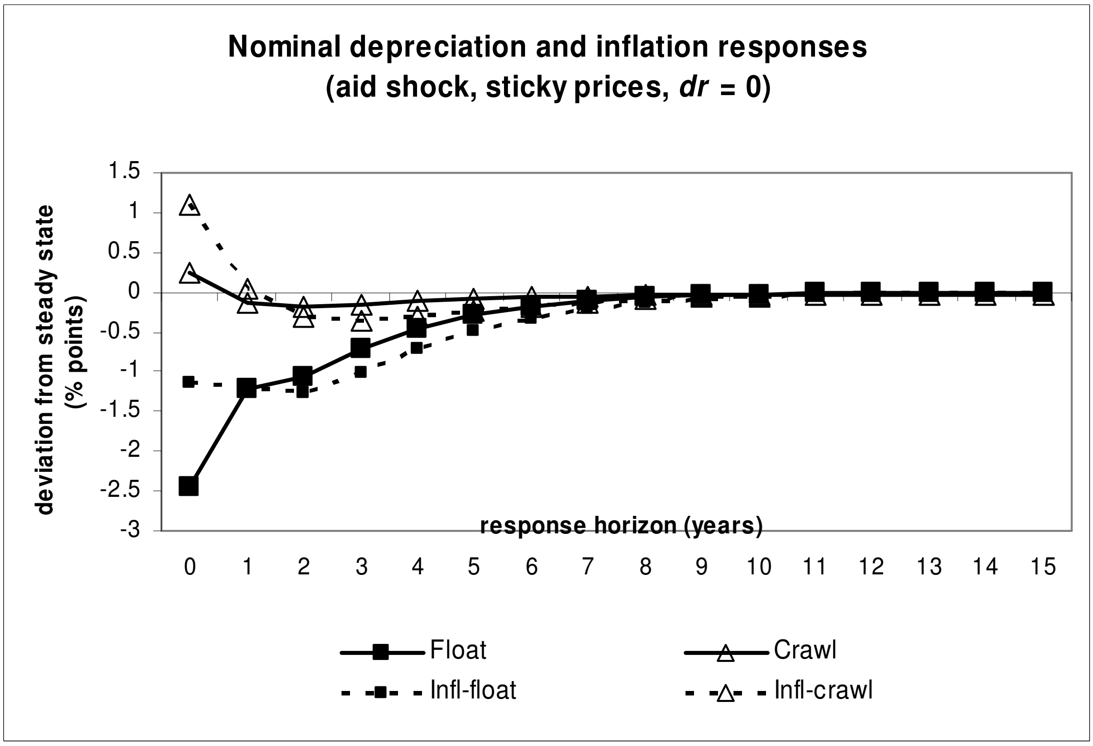
Figure 1. *Monetary Policy Environments outside Institutional Hard Peg Arrangements*



Note: Inflation not to scale for countries inside box [See Table.1]

Figure 2





Notes: Parameter settings as described in text and Tables 4b and 4c.

Table 1. Share of Aid Spent by Country Group

	1990-2004	1990-97	1998-2004
		All Aid Changes	
SSA	77	76	78
Low Income	76	75	77
Mature Stabilizers	79	77	79
High Inflation	72	73	72
Low Inflation	79	77	79
		Positive Aid Changes	
SSA	76	76	76
Low Income	75	74	76
Mature Stabilizers	78	74	78
High Inflation	65	62	69
Low Inflation	78	80	78

Source: IMF Africa Department

Table 2: Country Characteristics

	Average Inflation 2001-2003	Change in inflation 2001-03 over 1997-99	Fiscal Balance after grants (% GDP) 1997-1999	Change in fiscal balance 2001-03 over 1997-99	Average Domestic Debt (% GDP) 2001-2003	Change in Domestic Debt 2001-03 over 1997-99	Net ODA as % GDP 2001-03	Banking Sector Foreign exchange liabilities (as% total liabilities) 2000-04
I: Pre-Stabilization								
Mean	78%	10%	-8%	3%	20%	4%	16%	19%
Median	25%	-4%	-6%	3%	19%	5%	12%	17%
II: Low Institutional Credibility								
Mean	6%	-4%	-7%	0%	24%	2%	22%	23%
Median	5%	-1%	-6%	1%	23%	3%	17%	17%
III: Mature Stabilizers								
Mean	5%	-2%	-1%	-2%	13%	0%	9%	22%
Median	5%	-1%	-1%	-1%	10%	-1%	9%	20%

Source: IMF WETA / WEO

Table 3a *Pre-Stabilization and Mature Stabilizers calibration values*

Parameter	*'Mature stabilizers''*	*'Pre-stabilization'*
intertemporal elasticity, τ	0.50	0.50
currency substitution elasticity, σ	2.00	2.00
elasticity of production substitution, *nu*	0.10	0.10
foreign currency holdings	0.12	0.12
domestic currency holdings	0.08	0.08
private holdings of government securities	0.09	0.20
inflation rate, π	0.10	0.25
Aid (aid shock)	0.10 (0.02)	0.10 (0.02)
Implied values:		
nominal interest rate	0.210	0.375
steady-state inflation elasticity of money demand	0.53	0.62

Table 3b *Definition and scaling of variables in simulation runs*

Variable	*Definition*	*Scaling of IRs and Standard Deviations*
`In`	Inflation rate = π	percentage points from SS
`E`	Real exchange rate for imports $= P_N / EP_I$	% deviation from SS
`R`	Real interest rate	percentage points from SS
`Ca`	Current account surplus including grants	percentage points of GDP from SS
`QN (DN)`	Output of nontraded goods	% deviation from SS
`qX`	Output of exported goods	% deviation from SS
`C`	Private consumption	% deviation from SS
`Z`	Central bank international reserves	% deviation from SS
`B`	Privately-held government debt	percentage points of GDP from SS
`X`	Depreciation rate	percentage points from SS
`Mg`	Money growth rate	percentage points from SS
`Mp`	Domestic money balances	% deviation from SS
`Fp`	Foreign currency balances	% deviation from SS
`V`	Velocity of circulation	% deviation from SS

Note: QN denotes output of nontraded goods under flex-price adjustment (i.e. when output is supply determined) and DN the demand-determined level of output under sticky prices. Under sticky prices, the output of qX is fixed in terms of the numeraire.

Impulse Response Functions and Standard Deviations

Table 4a *Aid spent but not absorbed (the counterpart fallacy)*

Mature Stabilizers
Response Horizon

Variable	0	1	2	3	4	5	15	Stdev
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50, z2 = 0.05]								
in	37.357	3.881	−0.930	−2.743	−3.301	−3.362	−1.977	39.296
e	0.117	1.356	1.409	1.137	0.843	0.611	0.131	2.639
r	1.657	0.071	−0.364	−0.393	−0.310	−0.218	−0.010	1.794
ca	1.954	0.467	−0.054	−0.197	−0.206	−0.178	−0.052	2.062
QN	0.006	0.067	0.070	0.056	0.042	0.030	0.007	0.131
qX	−0.006	−0.068	−0.071	−0.057	−0.043	−0.031	−0.007	0.133
C	0.071	0.825	0.857	0.691	0.513	0.372	0.080	1.605
z	50.000	72.500	81.375	83.556	82.503	79.941	48.901	309.923
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	37.292	3.200	−0.959	−2.593	−3.140	−3.235	−1.973	39.118
mg	30.897	15.382	4.443	−0.433	−2.513	−3.320	−2.429	37.116
v	5.878	−4.517	−9.398	−11.512	−12.243	−12.292	−7.812	46.202
mp	−5.872	4.583	9.467	11.567	12.284	12.322	7.818	46.289
fp	−0.442	−4.668	−8.099	−10.330	−11.551	−12.060	−8.276	46.767
Sticky Price [sigma = 2.00, tau = 0.50, z2 = 0.05]								
in	23.932	2.240	−0.819	−2.257	−2.848	−3.030	−1.970	26.461
e	−10.695	−4.135	−1.443	−0.289	0.192	0.373	0.262	11.648
r	−4.153	−1.743	−0.882	−0.477	−0.266	−0.152	−0.008	4.626
ca	1.173	0.510	0.156	−0.002	−0.066	−0.087	−0.052	1.322
DN	7.334	3.117	1.373	0.578	0.208	0.039	−0.060	8.115
C	3.672	1.784	0.992	0.591	0.374	0.253	0.065	4.284
z	50.000	72.500	81.375	83.556	82.503	79.941	48.901	309.923
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	29.815	−1.368	−2.299	−2.893	−3.112	−3.130	−1.962	31.980
mg	29.549	6.880	1.700	−1.261	−2.678	−3.277	−2.418	33.000
v	−2.010	−7.987	−11.006	−12.247	−12.561	−12.412	−7.781	46.899
mp	5.106	9.324	11.613	12.519	12.674	12.450	7.765	47.576
fp	−1.548	−8.080	−11.081	−12.404	−12.843	−12.804	−8.223	48.884

Table 4b *Aid fully spent and fully absorbed, under a floating exchange rate*

Mature stabilizers

Variable	0	1	2	3	4	5	15	Stdev
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50 AR = 0.50]								
in	0.166	−1.108	−1.388	−1.129	−0.791	−0.514	−0.002	2.346
e	3.140	2.503	1.738	1.123	0.694	0.416	0.001	4.599
r	−0.853	−1.023	−0.823	−0.574	−0.372	−0.230	−0.001	1.733
ca	0.766	0.017	−0.183	−0.191	−0.148	−0.101	−0.000	0.834
QN	0.155	0.124	0.086	0.056	0.034	0.021	0.000	0.228
qX	−0.159	−0.126	−0.088	−0.057	−0.035	−0.021	−0.000	0.232
C	1.910	1.522	1.057	0.683	0.422	0.253	0.001	2.797
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−1.562	−0.757	−0.967	−0.791	−0.556	−0.361	−0.001	2.256
mg	0.052	−1.117	−1.361	−1.099	−0.768	−0.498	−0.002	2.301
v	0.257	0.234	0.172	0.115	0.072	0.044	0.000	0.414
mp	−0.103	−0.111	−0.087	−0.060	−0.038	−0.024	−0.000	0.191
fp	4.813	5.270	4.128	2.843	1.828	1.126	0.004	9.020
Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.50]								
in	−1.131	−1.179	−1.258	−1.004	−0.723	−0.494	−0.004	2.491
e	2.372	2.458	2.090	1.575	1.107	0.745	0.007	4.549
r	−1.571	−1.296	−0.847	−0.528	−0.325	−0.199	−0.001	2.305
ca	0.725	0.051	−0.143	−0.170	−0.144	−0.107	−0.001	0.787
DN	0.785	0.197	−0.104	−0.184	−0.173	−0.135	−0.002	0.874
C	2.306	1.592	1.003	0.618	0.378	0.230	0.001	3.077
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−2.436	−1.226	−1.056	−0.720	−0.466	−0.295	−0.002	3.071
mg	−0.075	−2.118	−1.704	−1.091	−0.669	−0.406	−0.003	3.048
v	−0.453	0.113	0.352	0.365	0.297	0.218	0.002	0.807
mp	0.960	0.107	−0.299	−0.377	−0.328	−0.248	−0.003	1.178
fp	4.852	5.237	4.231	3.073	2.109	1.398	0.012	9.278

Table 4c *Aid fully spent and fully absorbed, under a crawl*

Mature stabilizers

Variable	0	1	2	3	4	5	15	Stdev
	Response Horizon							
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50 AR = 0.50, z1=15, z2=0.05]								
in	1.749	-0.260	-0.492	-0.448	-0.338	-0.235	-0.020	1.959
e	2.838	2.322	1.653	1.095	0.694	0.427	0.003	4.260
r	-0.691	-0.895	-0.747	-0.536	-0.357	-0.227	-0.001	1.528
ca	0.885	0.088	-0.150	-0.180	-0.148	-0.105	-0.001	0.941
QN	0.141	0.115	0.082	0.054	0.034	0.021	0.000	0.211
qX	-0.143	-0.117	-0.083	-0.055	-0.035	-0.022	-0.000	0.215
C	1.726	1.412	1.005	0.666	0.422	0.260	0.002	2.591
z	-2.559	-2.766	-0.935	1.030	2.580	3.660	5.329	69.265
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	0.188	0.025	-0.124	-0.141	-0.117	-0.089	-0.019	0.397
mg	-1.215	-0.696	0.183	0.376	0.339	0.247	-0.017	1.551
v	2.833	3.204	2.558	1.781	1.146	0.694	-0.074	5.565
mp	-2.694	-3.091	-2.477	-1.728	-1.112	-0.673	0.074	5.364
fp	6.806	7.863	6.341	4.464	2.917	1.813	-0.073	13.522
Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.50, z1=15, z2=0.05]								
in	1.089	0.046	-0.311	-0.369	-0.320	-0.246	-0.027	1.324
e	1.534	1.870	1.646	1.261	0.897	0.609	0.008	3.406
r	-1.371	-1.159	-0.812	-0.531	-0.336	-0.209	-0.001	2.085
ca	0.863	0.127	-0.108	-0.154	-0.136	-0.103	-0.002	0.914
DN	1.023	0.400	0.088	-0.036	-0.069	-0.066	-0.001	1.109
C	2.159	1.536	1.009	0.639	0.398	0.245	0.003	2.949
z	-3.338	-1.276	1.349	3.437	4.892	5.846	7.256	94.469
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	0.245	-0.139	-0.188	-0.158	-0.119	-0.088	-0.026	0.524
mg	-1.719	-0.281	0.285	0.355	0.289	0.203	-0.023	1.869
v	3.135	3.141	2.432	1.692	1.104	0.683	-0.099	5.669
mp	-2.552	-2.849	-2.306	-1.647	-1.094	-0.685	0.098	5.130
fp	7.540	7.740	6.074	4.288	2.856	1.826	-0.096	13.689

Table 4d *[50,50] Aid fully spent and partially absorbed with bond sterilization*

Mature stabilizers

Variable	0	1	2	3	4	5	15	Stdev
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50, z2 = b3 = 0.05]								
in	17.383	5.021	4.094	3.640	3.379	3.195	1.939	21.807
e	-0.631	0.177	0.458	0.528	0.521	0.491	0.270	1.836
r	1.082	0.376	0.094	-0.009	-0.041	-0.045	-0.018	1.155
ca	2.248	0.930	0.320	0.042	-0.080	-0.130	-0.106	2.515
QN	-0.031	0.009	0.023	0.026	0.026	0.024	0.013	0.091
qX	0.032	-0.009	-0.023	-0.027	-0.026	-0.025	-0.014	0.093
C	-0.384	0.108	0.278	0.321	0.317	0.299	0.164	1.117
z	25.000	36.250	40.688	41.778	41.252	39.970	24.451	154.961
b	11.111	16.111	18.083	18.568	18.334	17.765	10.867	68.872
x	17.730	4.577	3.940	3.601	3.383	3.211	1.947	21.977
mg	1.573	4.610	4.311	4.146	4.009	3.867	2.389	15.383
Sticky Price [sigma = 2.00, tau = 0.50 , z2 = b3 = 0.05]								
in	12.805	4.624	4.195	3.795	3.501	3.275	1.933	18.357
e	-4.404	-1.477	-0.451	-0.015	0.179	0.262	0.209	4.792
r	-1.072	-0.058	0.014	-0.006	-0.021	-0.028	-0.021	1.080
C	0.831	0.344	0.317	0.324	0.321	0.311	0.189	1.461
ca	1.978	0.962	0.389	0.100	-0.040	-0.105	-0.106	2.297
DN	2.494	0.887	0.435	0.256	0.173	0.130	0.058	2.720
z	25.000	36.250	40.688	41.778	41.252	39.970	24.451	154.961
x	15.227	3.014	3.631	3.555	3.394	3.230	1.939	19.639
mg	1.112	1.514	3.644	3.995	3.988	3.877	2.380	14.466
b	11.111	16.111	18.083	18.568	18.334	17.765	10.867	68.872

Table 4e *Responding to deficit reducing aid*

Mature stabilizers
Response Horizon

Variable	0	1	2	3	4	5	15	Stdev
				Panel 1: Float +DR				
Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.50; pdr=0.25]								
in	−10.465	−2.983	−2.206	−1.478	−0.956	−0.608	−0.005	11.269
e	6.529	4.264	2.941	1.984	1.303	0.839	0.006	8.733
r	−0.396	−0.960	−0.709	−0.462	−0.291	−0.181	−0.001	1.390
ca	0.759	0.031	−0.155	−0.174	−0.145	−0.107	−0.001	0.821
DN	−1.591	−0.778	−0.559	−0.405	−0.281	−0.188	−0.002	1.937
C	1.494	1.314	0.877	0.555	0.345	0.213	0.001	2.286
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−14.056	−1.737	−1.479	−0.951	−0.582	−0.352	−0.002	14.290
mg	−7.749	−4.395	−3.191	−1.877	−1.065	−0.603	−0.003	9.733
v	−2.930	−1.357	−0.420	−0.029	0.097	0.116	0.002	3.263
mp	2.469	1.186	0.291	−0.072	−0.171	−0.167	−0.003	2.772
fp	3.061	4.454	3.826	2.851	1.985	1.328	0.011	7.677
				Panel 2: Crawl+DR				
Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.50 pdr=0.25, z2=0.05]								
in	−0.016	−0.420	−0.518	−0.467	−0.379	−0.296	−0.098	1.596
e	1.471	1.648	1.394	1.045	0.734	0.496	0.014	2.984
r	−1.121	−0.878	−0.605	−0.396	−0.251	−0.157	−0.001	1.629
ca	1.098	0.322	0.029	−0.063	−0.078	−0.068	−0.004	1.154
DN	0.670	0.202	0.000	−0.066	−0.074	−0.062	−0.001	0.713
C	1.668	1.158	0.759	0.484	0.304	0.190	0.007	2.256
z	11.243	17.741	22.017	24.672	26.268	27.201	27.844	365.037
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−0.824	−0.518	−0.379	−0.275	−0.207	−0.165	−0.096	1.676
mg	−0.675	−1.210	−0.352	−0.061	0.013	0.011	−0.096	1.899
v	1.005	1.500	1.236	0.817	0.442	0.157	−0.397	5.671
mp	−0.600	−1.318	−1.166	−0.798	−0.442	−0.163	0.397	5.554
fp	4.668	5.094	4.039	2.802	1.774	1.019	−0.415	10.291
				Panel 3: Buffer+ Float +DR				
Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.50 PDR=0.25]								
in	−4.199	−2.128	−2.097	−1.791	−1.488	−1.242	−0.496	6.401
e	3.262	2.616	2.058	1.518	1.074	0.746	0.070	5.132
r	−1.041	−1.072	−0.718	−0.449	−0.276	−0.169	−0.003	1.753
ca	0.871	0.146	−0.080	−0.133	−0.125	−0.102	−0.014	0.920
DN	0.047	−0.048	−0.189	−0.214	−0.186	−0.144	−0.016	0.413
C	1.835	1.362	0.875	0.548	0.344	0.219	0.017	2.549
z	12.500	18.125	20.344	20.889	20.626	19.985	12.225	77.481
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−5.993	−1.772	−1.790	−1.494	−1.244	−1.061	−0.492	7.347
mg	−0.343	−2.145	−2.340	−1.919	−1.568	−1.321	−0.607	5.333
v	−3.320	−3.383	−3.260	−3.182	−3.118	−3.041	−1.944	12.562
mp	3.506	3.490	3.269	3.152	3.079	3.007	1.939	12.589
fp	1.461	1.125	−0.002	−1.018	−1.753	−2.222	−2.047	10.501

Table 4f *Responding to deficit reducing aid*

Pre-Stabilization countries

	Response Horizon							
Variable	0	1	2	3	4	5	15	Stdev

Panel 1: *Float +DR*

Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.90; pdr=0.25]

Variable	0	1	2	3	4	5	15	Stdev
in	-32.894	-16.756	-15.970	-12.024	-11.796	-9.123	-3.023	48.509
e	13.154	9.241	8.243	6.005	5.655	4.260	1.299	22.020
r	-0.369	-2.044	-0.025	-1.339	0.065	-0.928	-0.215	2.829
ca	-0.688	-0.485	-0.147	-0.118	0.050	0.021	0.052	0.914
DN	-2.894	-1.379	-1.677	-0.745	-1.068	-0.459	-0.130	4.064
C	3.412	3.244	2.315	2.303	1.695	1.724	0.538	6.948
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	-41.115	-14.311	-15.346	-10.625	-11.577	-8.250	-2.851	52.837
mg	-13.980	-15.031	-19.779	-11.357	-14.991	-8.961	-3.262	42.055
v	-15.906	-16.732	-13.882	-14.066	-11.688	-11.585	-4.058	41.641
mp	15.131	16.511	13.464	13.998	11.442	11.571	4.058	40.941
fp	-12.313	-14.395	-15.123	-14.987	-14.397	-13.527	-5.212	45.853

Panel 2: *Crawl+DR*

Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.90+Slow unwind; pdr=0.25]

Variable	0	1	2	3	4	5	15	Stdev
in	0.028	-0.700	-0.875	-0.951	-0.978	-0.976	-0.715	8.301
e	2.161	2.924	3.077	3.009	2.852	2.657	1.022	9.037
r	-0.663	-0.330	-0.280	-0.280	-0.281	-0.273	-0.113	1.126
ca	0.758	0.636	0.513	0.416	0.343	0.288	0.075	1.376
DN	0.847	0.294	0.114	0.044	0.011	-0.005	-0.014	0.907
C	2.272	1.971	1.821	1.694	1.566	1.439	0.538	5.435
z	15.874	29.205	39.391	48.333	56.465	63.886	107.719	1895.440
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	-1.323	-1.177	-0.971	-0.909	-0.879	-0.854	-0.648	8.299
mg	2.182	-1.250	-1.392	-1.295	-1.175	-1.073	-0.680	8.777
v	-1.196	-0.992	-0.660	-0.422	-0.288	-0.229	-0.539	12.302
mp	1.723	1.283	0.870	0.594	0.437	0.359	0.584	12.485
fp	-0.054	0.417	1.219	1.739	1.965	1.984	0.105	19.438

Panel 3: *Buffer+ Float +DR*

Sticky Price [om=5, sigma = 2.00, tau = 0.50 AR = 0.90 PDR=0.25]

Variable	0	1	2	3	4	5	15	Stdev
in	-9.293	-5.410	-6.093	-5.743	-6.202	-5.904	-5.144	30.302
e	5.272	4.488	4.314	3.727	3.577	3.125	1.388	12.688
r	-0.335	-0.801	-0.286	-0.623	-0.246	-0.488	-0.156	1.448
ca	0.252	0.189	0.193	0.141	0.140	0.099	-0.013	0.485
DN	-0.052	0.160	-0.048	0.098	-0.058	0.046	-0.071	0.491
C	2.801	2.649	2.284	2.155	1.872	1.760	0.663	6.730
z	12.500	23.125	32.094	39.602	45.823	50.913	63.706	328.488
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	-12.588	-4.921	-5.984	-5.376	-6.108	-5.622	-5.053	30.941
mg	-1.694	-3.900	-6.133	-4.741	-6.327	-5.274	-5.297	29.433
v	-5.842	-6.984	-7.064	-7.822	-7.807	-8.283	-7.637	41.737
mp	6.079	7.288	7.256	8.057	7.957	8.462	7.671	42.096
fp	-4.700	-6.278	-7.569	-8.604	-9.437	-10.086	-11.020	57.950

Table 5a *Targeting the real exchange rate: resisting an equilibrium real appreciation*

Mature Stabilizers

No DR

Variable	0	1	2	3	4	5	15	Stdev
				Response Horizon				
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50, z1=15, z2=0.05]								
in	25.231	7.187	4.495	2.510	1.127	0.200	−1.243	27.581
e	−0.104	0.907	1.075	0.947	0.752	0.571	0.105	2.115
r	1.353	0.224	−0.170	−0.262	−0.241	−0.190	−0.006	1.453
ca	2.041	0.643	0.078	−0.122	−0.170	−0.162	−0.041	2.179
QN	−0.005	0.045	0.053	0.047	0.037	0.028	0.005	0.105
qX	0.005	−0.046	−0.054	−0.048	−0.038	−0.029	−0.005	0.107
C	−0.063	0.552	0.654	0.576	0.457	0.347	0.064	1.287
z	−1.564	12.123	27.638	40.465	49.716	55.798	55.715	326.401
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	25.289	6.630	4.403	2.580	1.234	0.299	−1.240	27.482
mg	1.432	12.031	10.955	8.219	5.493	3.291	−1.340	20.672
v	21.631	17.277	11.412	6.215	2.237	−0.583	−5.078	41.189
mp	−21.636	−17.232	−11.359	−6.169	−2.200	0.610	5.083	41.173
fp	17.582	17.876	13.268	8.037	3.632	0.345	−5.374	41.448
Sticky Price [sigma = 2.00, tau = 0.50, z1=15, z2=0.05]								
in	6.560	2.798	1.775	0.961	0.411	0.058	−0.436	7.853
e	−0.617	0.435	0.579	0.504	0.389	0.285	0.052	1.253
r	−1.001	−0.837	−0.706	−0.526	−0.364	−0.241	−0.002	1.645
ca	1.174	0.299	−0.035	−0.128	−0.132	−0.109	−0.015	1.239
DN	1.709	0.915	0.561	0.344	0.208	0.124	−0.004	2.064
C	1.876	1.421	1.041	0.720	0.481	0.315	0.023	2.750
z	−9.257	−2.268	6.525	13.765	18.906	22.240	23.900	149.045
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	6.899	2.219	1.696	1.002	0.475	0.115	−0.435	7.945
mg	−4.502	3.870	4.877	3.828	2.583	1.560	−0.462	9.515
v	10.872	9.557	6.568	3.851	1.803	0.391	−1.787	19.504
mp	−10.056	−9.082	−6.261	−3.655	−1.681	−0.315	1.787	18.678
fp	13.179	12.818	9.526	6.078	3.323	1.358	−1.888	24.467

With DR

Variable	0	1	2	3	4	5	15	Stdev
Flex Price [nu = 0.10, sigma = 2.00, tau = 0.50, z1=15, z2=0.05]								
in	13.454	4.129	2.538	1.270	0.350	−0.282	−1.227	15.838
e	0.541	1.003	0.981	0.812	0.629	0.475	0.102	2.027
r	0.619	−0.029	−0.226	−0.245	−0.206	−0.155	−0.005	0.765
ca	1.788	0.606	0.115	−0.069	−0.122	−0.124	−0.040	1.920
QN	0.027	0.050	0.049	0.040	0.031	0.024	0.005	0.100
qX	−0.027	−0.051	−0.050	−0.041	−0.032	−0.024	−0.005	0.102
C	0.329	0.610	0.597	0.494	0.382	0.289	0.062	1.233
z	8.108	22.746	36.323	46.686	53.780	58.212	54.822	325.977
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	13.157	3.875	2.550	1.363	0.450	−0.198	−1.224	15.517
mg	−1.186	7.097	7.016	5.340	3.492	1.947	−1.332	13.960
v	13.336	10.660	6.588	2.881	0.015	−2.019	−5.009	33.149
mp	−13.309	−10.611	−6.540	−2.841	0.015	2.042	5.014	33.138
fp	11.924	11.863	8.302	4.357	1.068	−1.367	−5.304	34.728
Sticky Price [sigma = 2.00, tau = 0.50, z1=15, z2=0.05]								
in	3.182	1.524	0.839	0.275	−0.116	−0.370	−0.675	5.452
e	0.332	0.742	0.679	0.534	0.399	0.294	0.079	1.403
r	−0.660	−0.647	−0.557	−0.417	−0.289	−0.192	−0.003	1.218
ca	1.300	0.406	0.049	−0.071	−0.096	−0.088	−0.022	1.381
DN	0.971	0.567	0.366	0.232	0.142	0.085	−0.007	1.219
C	1.438	1.138	0.844	0.591	0.401	0.270	0.034	2.181
z	4.987	15.863	25.259	32.010	36.388	38.983	36.910	235.540
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	2.999	1.298	0.873	0.355	−0.041	−0.313	−0.674	5.277
mg	−3.839	2.513	3.282	2.522	1.578	0.792	−0.725	7.671
v	6.880	5.801	3.478	1.362	−0.230	−1.320	−2.769	19.235
mp	−6.383	−5.484	−3.263	−1.220	0.320	1.377	2.770	18.938
fp	9.006	8.564	5.871	3.106	0.917	−0.629	−2.931	22.380

Table 5b. *Public Expenditure Smoothing*

	Response Horizon							
Variable	0	1	2	3	4	5	15	Stdev
1.Aid fully spent as received. Flex Price [nu=0.10, sigma = 2.00, tau =0.50 AR = 0.50]								
in	0.166	−1.108	−1.388	−1.129	−0.791	−0.514	−0.002	2.346
e	3.140	2.503	1.738	1.123	0.694	0.416	0.001	4.599
r	−0.853	−1.023	−0.823	−0.574	−0.372	−0.230	−0.001	1.733
ca	0.766	0.017	−0.183	−0.191	−0.148	−0.101	−0.000	0.834
QN	0.155	0.124	0.086	0.056	0.034	0.021	0.000	0.228
qX	−0.159	−0.126	−0.088	−0.057	−0.035	−0.021	−0.000	0.232
C	1.910	1.522	1.057	0.683	0.422	0.253	0.001	2.797
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−1.562	−0.757	−0.967	−0.791	−0.556	−0.361	−0.001	2.256
mg	0.052	−1.117	−1.361	−1.099	−0.768	−0.498	−0.002	2.301
v	0.257	0.234	0.172	0.115	0.072	0.044	0.000	0.414
mp	−0.103	−0.111	−0.087	−0.060	−0.038	−0.024	−0.000	0.191
fp	4.813	5.270	4.128	2.843	1.828	1.126	0.004	9.020
a	2.000	1.000	0.500	0.250	0.125	0.063	0.000	2.309
g	2.000	1.000	0.500	0.250	0.125	0.063	0.000	2.309
A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
j	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2. Government expenditure smoothed by fiscal authorities. [mu=0.50]								
Flex Price [nu=0.10, sigma = 2.00, tau =0.50 AR = 0.50]								
in	−0.001	0.118	−0.438	−0.681	−0.683	−0.570	−0.007	1.345
e	2.030	2.046	1.777	1.390	1.011	0.697	0.005	3.907
r	0.022	−0.360	−0.518	−0.508	−0.420	−0.314	−0.003	1.008
ca	1.202	0.196	−0.198	−0.296	−0.272	−0.211	−0.002	1.330
QN	0.100	0.101	0.088	0.069	0.050	0.035	0.000	0.193
qX	−0.103	−0.103	−0.090	−0.070	−0.051	−0.035	−0.000	0.197
C	1.235	1.245	1.081	0.845	0.615	0.424	0.003	2.376
z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	−1.118	0.109	−0.290	−0.468	−0.474	−0.398	−0.005	1.455
mg	0.024	0.060	−0.461	−0.681	−0.673	−0.559	−0.006	1.333
v	0.077	0.130	0.138	0.120	0.092	0.066	0.001	0.270
mp	0.023	−0.030	−0.051	−0.052	−0.043	−0.032	−0.000	0.102
fp	0.671	2.295	2.860	2.668	2.152	1.589	0.013	5.505
a	2.000	1.000	0.500	0.250	0.125	0.063	0.000	2.309
g	1.000	1.000	0.750	0.500	0.312	0.187	0.000	1.721
A	25.000	25.000	18.750	12.500	7.813	4.688	0.012	43.033
j	25.000	25.000	18.750	12.500	7.813	4.688	0.012	43.033

3. Public Expenditure Smoothing with Crawl

Flex Price [nu=0.10, sigma = 2.00, tau =0.50 AR = 0.50, z1=15, z2=0.05]

in	0.953	0.172	-0.091	-0.230	-0.260	-0.231	-0.004	1.090
e	1.906	1.936	1.697	1.342	0.988	0.691	0.006	3.726
r	0.039	-0.320	-0.475	-0.473	-0.398	-0.303	-0.003	0.942
ca	1.251	0.239	-0.167	-0.277	-0.263	-0.209	-0.002	1.372
QN	0.094	0.096	0.084	0.066	0.049	0.034	0.000	0.184
qX	-0.096	-0.098	-0.086	-0.068	-0.050	-0.035	-0.000	0.188
C	1.159	1.177	1.032	0.816	0.601	0.420	0.003	2.266
z	1.297	-0.837	-1.388	-0.905	-0.014	0.904	3.443	171.846
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	-0.095	0.156	0.041	-0.035	-0.065	-0.067	-0.002	0.232
mg	0.822	-1.075	-0.561	-0.159	0.054	0.133	0.003	1.498
v	0.212	1.347	1.763	1.681	1.379	1.033	0.007	3.426
mp	-0.119	-1.253	-1.680	-1.616	-1.330	-0.999	-0.007	3.271
fp	0.705	3.397	4.394	4.183	3.431	2.574	0.022	8.553
a	2.000	1.000	0.500	0.250	0.125	0.063	0.000	2.309
g	1.000	1.000	0.750	0.500	0.312	0.187	0.000	1.721
A	25.000	25.000	18.750	12.500	7.813	4.688	0.012	43.033
j	26.297	24.163	17.362	11.595	7.798	5.592	3.456	177.108

4. Fiscal smoothing but central bank unwinds fiscal sterilization
Flex Price [nu=0.10, sigma = 2.00, tau =0.50 AR = 0.50]

	Response Horizon							
Variable	0	1	2	3	4	5	15	Stdev
in	-4.875	2.166	2.012	1.196	0.550	0.176	-0.006	5.856
e	1.872	1.903	1.742	1.426	1.074	0.761	0.006	3.793
r	0.041	-0.216	-0.423	-0.471	-0.419	-0.329	-0.003	0.914
ca	1.264	0.252	-0.185	-0.310	-0.297	-0.237	-0.002	1.410
QN	0.093	0.094	0.086	0.071	0.053	0.038	0.000	0.188
qX	-0.095	-0.096	-0.088	-0.072	-0.054	-0.038	-0.000	0.192
C	1.139	1.158	1.060	0.867	0.653	0.463	0.003	2.307
z	-25.000	-25.003	-18.753	-12.502	-7.814	-4.688	-0.012	43.037
b	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
x	-5.905	2.149	2.101	1.370	0.744	0.349	-0.003	6.817
mg	-14.171	1.115	4.315	3.772	2.556	1.541	-0.001	15.647
v	8.543	9.500	7.399	5.042	3.202	1.946	0.006	16.106
mp	-8.451	-9.407	-7.314	-4.972	-3.149	-1.909	-0.005	15.923
fp	9.599	11.685	10.227	7.798	5.497	3.681	0.021	21.143
a	2.000	1.000	0.500	0.250	0.125	0.063	0.000	2.309
g	1.000	1.000	0.750	0.500	0.312	0.187	0.000	1.721
A	25.000	25.000	18.750	12.500	7.813	4.688	0.012	43.033
j	0.000	-0.002	-0.003	-0.002	-0.001	-0.001	-0.000	0.004