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Monetary Policy Rules for Managing Aid Surges in Africa

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Abstract

This paper examines the properties of alternative monetary policy rules in response to large aid surges in low-income countries characterized by incomplete capital market integration and currency substitution. Using a dynamic stochastic general equilibrium model, it is shown that simple monetary rules that stabilize the path of expected future seigniorage for a given aid flow have attractive properties relative to a range of conventional alternatives, including those involving heavy reliance on bond sterilization or a commitment to a pure exchange rate float. These simple rules, which are shown to be robust across a range of fiscal responses to aid inflows, appear to be consistent with actual responses to recent aid surges in a range of post-stabilization countries in Sub-Saharan Africa.

1. Introduction

> Even if government's domestic borrowing requirement remains low, a large aid-funded fiscal deficit can destabilize domestic financial markets . . . To control the money supply in the face of a steep rise in liquidity arising from fiscal operations, the Central Bank had to step up the issuance of government securities to the domestic financial market . . . The only alternative sterilization instrument . . . was larger sales of foreign exchange, but this would have risked destabilizing the exchange rate. (Brownbridge and Tumusiime-Mutebile, 2007)

Monetary management in the face of surging aid flows is a difficult business for African central bankers. Since the turn of the century, aid flows to the continent have, on average, increased in volume and become more volatile (Gupta et al., 2006; Bulíř and Hamann, 2005). Moreover, inflows have been increasingly targeted to general budget support and program assistance rather than to project financing; a larger proportion of aid therefore now passes through the government budget, reinforcing the link between aid and domestic credit creation. As a result, policymakers, particularly in countries where inflation has only recently been brought under control, have been increasingly preoccupied with how best to deploy the available instruments of monetary policy without yielding on hard-won inflation gains.

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These concerns span three main areas. The first is the perennial anxiety about 'Dutch Disease' effects of aid which may draw the authorities into attempts to prevent the temporary (or persistent) appreciation of the real exchange rate in order to forestall perceived losses in competitiveness. The second is the fear of fiscal destabilization arising out of the risk that aid surges may induce difficult-to-reverse public spending commitments, thereby increasing the risk that the authorities will fall back on inflationary domestic deficit financing when aid inflows recede. Third, as the opening quotation from Brownbridge and Tumusiime-Mutebile indicates, even when questions of medium term credibility and competitiveness are not in play, policymakers may still believe that large aid inflows force them to steer between the Scylla and Charybdis of nominal (and real) exchange rate volatility on the one hand and high and volatile interest rates on the other, where the latter, in turn, raise concerns about private investment, the lending behavior of the banking system, and the quasi-fiscal burden of increased domestic borrowing.

We will consider how these concerns may be managed over the short to medium run. By casting the monetary problem in terms of how the volatility of aid flows transmits into volatility in the path of expected future seigniorage, we show that simple monetary rules that stabilize this path for a given aid flow have attractive properties relative to a range of conventional alternative strategies, including those involving heavy reliance on bond sterilization or a commitment to a "pure" exchange rate float. We examine two specific rules that achieve this objective, albeit in different ways. The first, which we refer to as a *reserve buffer plus float*, directly stabilizes the path of seigniorage by synchronizing foreign exchange sales to the growth in liquidity generated by domestic spending out of aid. This entails initially accumulating aid inflows as official foreign exchange reserves and then sterilizing the full domestic currency counterpart of aid-financed non-import spending through foreign exchange sales as it occurs.[1] The defining feature of the buffer plus float is that it sets a time-varying reserve target that corresponds to the unspent component of aid, and allows the exchange rate to float freely once this reserve target is satisfied. The second rule, the *exchange rate crawl*, does not target liquidity growth directly but rather the authorities intervene in the foreign exchange market to keep the nominal exchange rate close to its long-run equilibrium rate of depreciation. In doing so, the authorities respond to the latent pressures coming through the private capital account which, in turn, reflect underlying changes in the demand for and supply of domestic liquidity.

Although operationally very different, both rules imply broadly similar patterns of reserve accumulation and exchange rate movements in the face of an aid surge. Moreover, both are robust to plausible variations in the fiscal response to aid, albeit to different degrees. This matters, for, as Table 1 indicates, aid has rarely increased the fiscal deficit dollar-for-dollar. This is despite the conventional development rationale that aid should both be fully spent, so as to maximize the contribution to public goods and services, and the current account deficit before grants should increase by the full amount of the aid flow, so as to maximize the resource transfer from donors (IMF, 2005). In practice, spending out of positive aid surges has averaged about 75 cents on the dollar across sub-Saharan Africa (SSA), with *pre-stabilization* countries showing a much lower propensity to spend than *post-stabilization* ones,[2] reflecting a greater weight attached to current inflation control; in these countries a larger proportion of any aid inflow will tend to be used to substitute for seigniorage.[3] Amongst *post-stabilization* countries, in contrast, there is less intrinsic need to reduce seigniorage if inflation is already anchored by ongoing fiscal discipline. As such, the path of domestic financing is more likely to reflect other considerations. Here, the fiscal authorities may primarily be concerned to smooth the profile of government expenditure relative to

Table 1. Spending and Reserve Accumulation Responses to Aid Surges in sub-Saharan Africa (SSA)

	1990–97		*1998–2004*	
Mean expenditure out of positive aid inflows (%)				
All SSA countries	76		76	
High inflation/pre-stabilization	62		69	
Low inflation/post-stabilization	80		78	
Mean official reserve accumulation out of large aid surges (%)				
	Impact	*Long-run*	*Impact*	*Long-run*
All SSA (excl. CFA zone)	0	1	1	4
Post-stabilization	22	25	34	27

Source: Adam and O'Connell (2006).
Notes: Post-stabilization countries are defined in note 2. Large aid surges are episodes where aid increases by at least 2% of GDP and is sustained for at least two years. "Long-run" denotes reserve accumulation over the first three years following an aid surge as a percentage of the initial surge. CFA: Communauté Financièrè Africaine Franc

that of aid, either for conventional welfare-based expenditure smoothing motives, to avoid excessive real exchange rate volatility, or out of a desire to manage credibility in circumstances when donors cannot commit to aid flows on an ongoing basis and where public expenditure is difficult to reverse (see Buffie et al., 2006).

Thus, while there is a strong general presumption that a portion of any large aid surge should be held aside initially, rather than being immediately spent, a distinction must be made between responses that reduce the present value of expected future seigniorage, which we refer to as *deficit-reducing* aid, and *expenditure smoothing* responses that alter the pattern of seigniorage over time. Our results suggest that while both rules deliver very similar outcomes where only expenditure smoothing considerations are in play, the two may perform rather differently when deficit-reduction considerations are important. In such circumstances the reserve plus buffer strategy is inefficiently tight; a managed float, on the other hand, with little or no sterilization of increases in the monetary base, better accommodates the increased demand for money associated with declining inflation and delivers a more attractive way of smoothing macroeconomic volatility. Common to both strategies, we should emphasize, is substantial reserve accumulation in the face of an aid surge; as indicated in the lower panel of Table 1 this is consistent with the observed behavior of African central banks, particularly in *post-stabilization* environments.

We develop these arguments using a short-run stochastic simulation model calibrated to reflect key structural features of low-income African economies in both pre- and post-stabilization countries. On the demand side, the key feature of this model is a characterization of households' portfolio choices and the financing options facing government, which reflects the "imperfectly open" capital account structures pervasive in much of sub-Saharan Africa. Thus the private sector engages in currency substitution but neither it nor the public sector has direct access to world capital markets. Hence domestic government debt, which is the only marketable debt instrument in the economy, is effectively non-tradable so that domestic interest rates are not tied down by interest parity conditions. On the supply side, given our focus on short-run management of aid flows, matters are kept deliberately simple. The capital stock is fixed and there is no investment in physical assets. Aid inflows thus have no impact on potential output in the economy and all saving occurs through the accumulation of foreign financial assets.

While this paper is entirely focussed on the management of aid flows, the close parallels with the management of commodity price volatility should not be overlooked. Similar macroeconomic management concerns preoccupy policymakers in commodity-dependent economies, especially in natural-resource economies where fiscal linkages via the budget give rise to transmission channels from external price volatility to the domestic economy that closely resemble those operating in the presence of aid volatility. The basic arguments from this paper therefore carry over (see, for example, Adam and Goderis, 2007).

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 and we briefly describe the simulation model. Section 3 presents and discusses the simulation results and section 4 concludes.

2. Model Structure and Core Arguments

The central insights from our paper derive directly from the accounting identities constraining public sector behavior and the reaction functions that frame fiscal and monetary policy choices. To ensure consistency with our model-based results we define these identities and the policy rules in terms of the world (import) price, which serves as the *numéraire* in our simulation model. The first identity is the consolidated budget constraint:

$$\Delta m_t + t + p_t \Delta b_t - \Delta z_t = d_t - a_t, \tag{1}$$

where d is the consolidated public sector deficit before aid, and a is the net budgetary aid. Equation (1) states that the fiscal deficit net of aid is ultimately financed through some combination of seigniorage ($\Delta m_t + t_t$, where m denotes real money balances, $t_t = \dfrac{x_t}{1 + x_t} m_{t-1}$ is the inflation tax, and x_t is the rate of depreciation of the exchange rate), domestic borrowing ($p_t \Delta b_t$), and depletion of official net international reserves ($-\Delta z_t$).[4] Given the normalization, p_t is the aggregate consumption price in terms of the world price and b denotes an indexed bond. The second identity is the balance of payments:

$$y_t - g_t - p_t C_t + \Delta f_t = a_t - \Delta z_t, \tag{2}$$

where $y_t - g_t - p_t C_t$ is the current account deficit before aid, with g as government consumption and C as private consumption, and f denotes private net foreign assets. Although net aid flows may in practice include flows that do not enter the fiscal accounts, we assume for convenience that all aid is net budgetary aid, so that the term a is the same across (1) and (2).

The right-hand side of (1)—which determines the government's domestic financing requirement—is the province of fiscal policy. Assuming government revenue is constant, the key fiscal choice is how much of the temporary aid inflow to spend in the current period. This choice fully determines the deficit net of aid period-by-period. Monetary policy, in turn, may have important indirect effects on the fiscal position (for example via domestic debt service costs), but its fundamental domain is the composition of the left-hand side of (1), taking the right-hand side as given. The monetary authorities' instruments are Δz, which is determined by foreign exchange intervention, and Δb, which is determined through open-market operations. Together these instruments determine the path of Δm_t and t_t conditional on the private sector's demand for money (discussed in detail below). Given the aid inflow and fiscal response, the path for the current account is determined by the monetary response to the aid inflow (via Δz) and the private sector's consequent choices over Δf and C.

To study the monetary and fiscal responses to aid shocks, we start from a steady state in which the fiscal deficit is financed by a combination of aid and the inflation tax, and the current account deficit is fully financed by aid. Writing (1) in terms of deviations from the steady state, the path of seigniorage then satisfies

$$\Delta m_t + t - \bar{t} = \left(d_t - \bar{d}\right) - [\Delta z_t - (a_t - \bar{a})] - p_t \Delta b_t. \tag{3}$$

On receipt, any aid that is not immediately self-sterilizing through increased government imports creates an equal and offsetting increase in foreign exchange reserves and net central bank credit to the government. Ignoring self-sterilizing aid, then, domestic liquidity is "instantaneously" unchanged by the receipt of aid ($d_t - \bar{d} = 0$ and $\Delta z_t = a_t - \bar{a}$). The subsequent macroeconomic response to aid is shaped by the government's spending decision $\left(d_t - \bar{d}\right)$ and the monetary authority's choices regarding reserve accumulation (Δz_t) and bond operations (Δb_t) given the endogenous response of the private sector. Our interest is in finding monetary policy rules that have straightforward operational features and that deliver acceptable responses of inflation, real exchange rates, and real interest rates for plausible aid-induced spending responses to large and temporary shocks to aid.

2.1 Model Structure

Before considering these monetary and fiscal rules we briefly describe the behavioral structure of the model.[5] We work with a simple optimizing two-sector dependent economy model with currency substitution, in which both domestic and foreign currencies delivery liquidity services. The representative private agent consumes traded imports and non-traded final goods and accumulates financial wealth in the form of three assets: domestic currency (m), foreign currency (f), and government bonds (b). There are no banks in the model, so that money is base money and foreign currency balances are held in non-interest-bearing forms. Capital mobility is imperfect: government bonds, which are indexed to consumer prices, are non-traded, while the private agent has no access to foreign bonds. Nonetheless, the private agent can accumulate or decumulate foreign currency directly through transactions with the central bank or through the current account, depending on the exchange rate regime.

Utility maximization by the representative agent generates conventional first-order conditions determining the optimal path for consumption and financial asset demands. Aggregate consumption, C_t, is determined by the Euler equation

$$C_t^{-1/\tau} = \beta R_t E_t C_{t+1}^{-1/\tau},$$

and domestic and foreign currency demands by

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

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

where p_t is the price of aggregate consumption in terms of imported goods (the *numéraire* in the simulation model); R_t is the real interest factor, also in terms of importables; β is the subjective discount factor; τ is the intertemporal elasticity of substitution in consumption; and σ is the intratemporal elasticity of substitution between domestic and foreign currency. L_t denotes the liquidity services generated by money balances in total, i_t is the nominal interest rate on government securities, and x_{t+1} and π_{t+1} are the expected rate of depreciation of the local currency and the rate of inflation between periods t and $t+1$, respectively. Finally, E_t is the expectations operator and k_m and k_f are constants. These asset demands can be expressed more conveniently in relative terms as

$$\frac{\tilde{m}_t}{\tilde{f}_t} = \phi_0 - \phi_i \cdot i_t + \phi_x \cdot (i_t - E_t x_{t+1}), \tag{4}$$

where $\tilde{m}_t$ and $\tilde{f}_t$ denote log deviations of domestic and foreign currency balances from their steady-state values. The parameters describing relative demands are $\phi_i = \sigma/\bar{i} > 0$ and $\phi_x = \sigma/(\bar{i} - \bar{x}) > 0$, where $\bar{i}$ and $\bar{x}$ are the steady-state values of the interest rate and the rate of exchange rate depreciation. Relative currency demand thus depends on the relative opportunity cost of holding domestic or foreign currency, i_t and $i_t - E_t x_{t+1}$, respectively. The sensitivity of relative currency demand to these opportunity costs is an increasing function of the elasticity of currency substitution.

Combined with the consumption Euler equation the demand for domestic currency can be expressed as

$$\log \tilde{m}_t = \eta_0 - \eta_i \cdot i_t + \eta_x \cdot (i_t - E_t x_{t+1}) + \log \tilde{C}_t,$$

where $\tilde{C}_t$ is (the log deviation from the steady state of) total spending by the private sector. The semi-elasticities of domestic currency demand with respect to the interest rate and currency depreciation are given by $\eta_i = [\tau + (1-\nu)(\sigma - \tau)]\bar{i}^{-1} > 0$ and $\eta_x = (1-\nu)(\sigma-\tau)/(\bar{i} - \bar{x}) > 0$, where ν is the steady-state share of domestic currency in liquidity services. The steady-state inflation elasticity of the demand for domestic money is defined as $\varepsilon = \bar{\pi} \cdot \eta_i = [\tau + (1-\nu)(\sigma-\tau)](\bar{\pi}/\bar{i})$. 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. In particular, holding the nominal interest rate constant, an increase in expected depreciation ($E_t x_{t+1}$) shifts desired portfolios in favor of foreign currency; but when $\sigma > \tau$, this is accomplished partly through an *absolute* reduction in the real demand for domestic currency.

The parameters σ and τ therefore play a critical role in governing the behavior of the private sector and, in consequence, the effectiveness or otherwise of monetary policy rules. On their own, higher degrees of substitutability (σ) tend to provoke larger portfolio reallocations and therefore greater pressures on the nominal exchange rate in response to shocks. A higher value of the intertemporal elasticity of substitution (τ), other things being 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 on these parameters.[6] Combined with initial steady-state values of π, i, and ν, these values imply steady-state inflation elasticities of the demand for money of 0.53 for post-stabilization countries and 0.62 for high-inflation, pre-stabilization countries (see Table 2a).

Table 2a. Simulation Model Calibration Values

Parameter	*Post-stabilization*	*Pre-stabilization*
Intertemporal elasticity, τ	0.50	0.50
Currency substitution elasticity, σ	2.00	2.00
Elasticity of production substitution, ν	0.10	0.10
Foreign currency holdings, % of GDP (f)	0.12	0.12
Domestic currency holdings, % of GDP (m)	0.08	0.08
Private holdings of government securities, % of GDP (b)	0.09	0.20
Net official reserves, % of GDP (z)	0.04	0.04
Inflation rate, π(%)	0.10	0.25
Government spending, % of GDP (s)	0.25	0.25
Aid (aid shock), both % of GDP (a)	0.10 (0.02)	0.10 (0.02)
Deficit reduction share *dr* (δ)	0.25	0.25
Fiscal smoothing parameter (μ)	0.50	0.50
Implied values		
Nominal interest rate (i)	0.210	0.375
Steady-state inflation elasticity of money demand	0.53	0.62

As noted above, the supply side of the economy is simple. 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. Tradable prices are fully flexible but we assume Calvo (1983) pricing in the non-traded goods market. This stickiness ensures that the output of non-traded goods is demand-determined in the short run so that macroeconomic adjustment can then take place off the production frontier, via temporary booms or recessions in the non-traded goods sector.

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.[7] The aid shock, which follows a stationary AR(1) process around a steady-state mean value, is scaled to an equivalent of 2% of GDP and is characterized by an autoregressive parameter of 0.50.

2.2 Policy Rules

We now return to macroeconomic policy choices. On the fiscal side, our focus is on the financing implications of fiscal policy, and in particular on the consequences of deficit reduction or delayed expenditure out of aid. We therefore adopt a simple structure in which domestic revenue takes the form of lump-sum taxes and government spending consists of transfers to the private sector.[8] Taxes are held constant throughout so that aid shocks constitute the only source of revenue volatility.

Fiscal behavior is then governed by two decisions determining the level and timing of spending out of aid. First, a portion δ of aid may be devoted to *deficit reduction*. Hence for a given aid surge, an amount $\delta(a_t - \bar{a})$ is used to substitute for domestic deficit financing and $(1-\delta)(a_t - \bar{a})$ is spent. Based on the evidence from Table 1, we consider just two values, $\delta = 0$ or $\delta = 0.25$. Second, given this planned spending out of aid, the fiscal authorities may choose to *smooth* the path of spending relative to that of the aid inflow. To track the spending carried over to future periods we introduce an "aid account," denoted W. In a steady state, all aid is spent so that the aid account has a zero balance. Outside of the steady state, the government spends a constant fraction $(1-\mu)$ of the balance in the aid account each period; the remaining fraction μ is devoted to smoothing. Denoting W_t as the end-of-period balance in the aid account, the fiscal deficit in period t is given by

$$d_t - \bar{d} = (1-\mu)[(1-\delta)(a_t - \bar{a}) + W_{t-1}], \tag{5}$$

and the implied evolution of the aid account by $W_t = \mu[(1-\delta)(a_t - \bar{a}) + W_{t-1}]$.

For $\mu = 0$ the aid account remains at zero and the profile of expenditure matches that of aid. The higher the value of μ the more the path of expenditure is attenuated relative to aid. Assuming an autoregressive parameter of 0.50, the half-life of the aid shock in our model is one year, with 94% of the aid being received within four years. With an expenditure smoothing parameter of $\mu = 0.5$, used in the simulations reported below, the half-life of aid-induced spending is double that of aid and only 81% of the aid is spent within four years. A higher value of $\mu = 0.75$ would increase the half-life of spending to almost four years, with only 56% of the shock spent by year four.

The instruments of monetary policy are transactions in foreign exchange and in government securities with the private sector.[9] To characterize reserve management, we begin with the simplest reaction function that accommodates alternative degrees of commitment to a fixed rate of crawl: $\Delta z_t = -\alpha_1(x_t - \bar{x})$, for $\alpha_1 \geq 0$. To this we add a fixed long-run reserve target $\bar{z}$, in order to preserve the stationary structure of the analysis; and—possibly—a time-varying reserve target that is tied to the pattern of fiscal spending out of aid. Reserve policy is therefore given by

$$\frac{\Delta z_t}{\bar{z}} = -\alpha_1 \frac{x_t - \bar{x}}{\bar{x}} - \alpha_2 \frac{z_{t-1} - \bar{z}}{\bar{z}} + \alpha_3 \frac{(a_t - \bar{a}) - \gamma \cdot \left(d_t - \bar{d}\right)}{\bar{z}}, \tag{6}$$

where $\alpha_1 \geq 0$, $\alpha_2 > 0$, $\alpha_3 \in \{0, 1\}$, and $0 \leq \gamma \leq 1$. Here $\bar{x}$ is the steady-state rate of depreciation, which is tied down by the long-run inflation rate, and $\bar{z}$ is the steady-state level of reserves.

The parameter α_1 governs the degree of commitment to the steady-state rate of crawl. As $\alpha_1 \to \infty$ the regime approaches a predetermined *crawl* in which $x_t = \bar{x}$ on a continuous basis. Lower values of α_1 represent looser commitments to the reference rate of crawl, and for $\alpha_1 = 0$ the exchange rate floats: central bank intervention, if any, is independent of movements in the nominal exchange rate.[10] In the floating case, all foreign exchange available to the economy is immediately priced in a competitive foreign exchange market and either added to private foreign currency holdings or absorbed through an increased current account deficit.

We will refer to the combination of $\alpha_1 = 0$ and $\alpha_3 = 0$ as a *pure float*: this is the textbook case in which the monetary authority not only ignores the exchange rate but also keeps international reserves unchanged in the face of shocks. The final term in (6), however, allows the central bank to tie foreign exchange sales directly to the path of aid-induced government spending. A policy of $\alpha_1 = 0$, $\alpha_3 = 0$, and $\gamma = 1$ corresponds to what we call a *buffer plus float*. This approach is simple and intuitive: the central bank sells aid dollars in the precise amount required to finance aid-induced spending as it occurs, but floats with respect to all other shocks.[11] In a buffer plus float, any aid that is not spent in the current period is retained as reserves. Of course, if $\delta = \mu = 0$, so that aid is always spent immediately, there is no operational difference between a buffer plus float and a pure float. In the presence of deficit-reduction or expenditure-smoothing components, however, a buffer plus float involves a period of potentially substantial reserve accumulation during an aid boom.

To complete the description of monetary policy we turn briefly to bond operations. The conventional role of bond operations is to offset the net impact of domestic credit creation or foreign exchange intervention on the monetary base. The reaction function

$$p_t \Delta b_t = \beta_1 (d_t - a_t - \bar{t}) + \beta_2 \Delta z_t - \beta_3 (b_{t-1} - \bar{b}) \tag{7}$$

accommodates this role, where $\beta_3 > 0$ allows for a gradual return of bond holdings to a long-run level.[12] For $\beta_1 > 0$, bond operations offset a portion of the difference between the government's domestic borrowing requirement and the steady-state inflation tax; for $\beta_2 > 0$ they offset a portion of the impact of reserve accumulation on the monetary base. With $\beta_1 = \beta_2 = 1$, bond operations stabilize total reserve money growth over time, at a level equal to the steady-state inflation tax.[13]

In the context of handling aid shocks, monetary policy discussions often center on a "burden sharing" approach to managing the liquidity generated out of aid-induced spending. It is therefore useful to consider (6) and (7) together. In a buffer plus float, where $\gamma = 1$ in the reserve equation (6), the liquidity effect of aid-induced spending is fully offset through the sale of aid dollars. However, the same liquidity injection could be absorbed wholly or partially through bond sales. IMF (2005), for example, advocates a "50–50" approach that allocates half of the task of liquidity management to forex sales and half to bond sales. Generalizing this to $[\gamma, 1 - \gamma]$ and gearing bond operations to actual foreign exchange intervention (rather than to reserve accumulation) gives us a bond reaction function of the form

$$p_t \Delta b_t = \beta_1 (1 - \gamma)(d_t - \bar{d}) + \beta_2 [\Delta z_t - (a_t - \bar{a})] - \beta_3 (b_{t-1} - \bar{b}). \tag{8}$$

With $\beta_1 = \beta_2 = 1$ and $\gamma = 0$, bond operations have the conventional role of targeting money growth. In what follows we restrict ourselves to the case in which $\beta_2 = 0$, so that the role for bond sales is simply to offset a fixed portion of the domestic liquidity expansion produced by aid. When $\gamma = 1$, foreign exchange sales take the full brunt of liquidity control, as in the pure float and buffer plus float approaches described above; for $0 < \gamma < 1$ the burden is shared. In the simulations reported below we examine the specific case where $\gamma = 0.50$.

Both foreign exchange operations and bond operations are unwound over time, at rates determined by α_2 and β_3. Because private foreign currency holdings return to a steady-state level over time, the long-run reserve target implies that aid is ultimately fully absorbed in current account deficits, regardless of the time pattern of aid-induced public spending and the other parameters of the monetary policy reaction functions. In the simulations reported below, we assume a relatively slow rate of adjustment, setting $\alpha_2 = \beta_3 = 0.05$ throughout.

3. Results

We now turn to the simulation results. These are generated from a calibration designed to represent two archetypal economies (pre-stabilization and post-stabilization). Calibration parameters are reported in Table 2a and the variables tracked in the simulations in Table 2b. The archetypal economies differ in terms of initial inflation (25% per annum in pre-stabilization countries and 10% in post-stabilization countries) and initial domestic debt (20% of GDP in pre-stabilization countries and 9% in post-stabilization countries) but are identical in all other respects.

In Tables 3 and 4 we first consider the performance of the three monetary policy rules introduced earlier (float, buffer-plus-float and crawl) when the total volume of

Table 2b. Definition and Scaling of Variables in Simulation Runs

Variable	*Definition*	*Scaling of IRFs and standard deviations*
In	Inflation rate = π	Percentage points from SS (steady state)
NER	Nominal exchange rate	″
RER	Real exchange rate for imports = EP_I / P_N	″
RIR	Real interest rate	″
Ca	Current account surplus including grants	Percentage points of GDP from SS
DN	Output of non-traded goods	% deviation from SS
C	Private consumption	″
Dz	Change in central bank international reserves	″
Db	Change in privately held government debt	″
mg	Growth in nominal domestic money stock	″
A	Aid	Percentage points of GDP from SS
S	Government discretionary spending	″
dW	Change in aid account	″

spending out of aid is varied. In Table 3 spending follows aid dollar-for-dollar so that the total domestic financing requirement is fully insulated from the direct effects of the aid inflow, although some volatility in domestic financing may remain as a result of volatility in the budget induced by movements in prices, interest rates, and the exchange rate. In Table 4 public spending increases by less than the full amount of the aid inflow by assuming that public spending adjusts by $(1 - \delta)$ of the aid shock, and the remainder, $\delta(a_t - \bar{a})$, is passed on to the monetary authorities in the form of a reduction in domestic credit growth, where $\delta = 0.25$. In Table 5 we broaden the range of instruments to introduce partial bond sterilization under which the authorities choose to sterilize a portion of the liquidity injection associated with aid-financed spending using bond sales and a portion using foreign exchange sales. Finally, in Table 6 we briefly examine the expenditure smoothing case, in which the fiscal authorities extend the duration of public expenditure relative to that of the aid surge.

Although relevant for some countries and episodes, we do not report in detail the results for the case in which an aid inflow produces a public spending increase but where the monetary authority, having initially accumulated the full amount of the aid inflow as reserves, neither runs these down nor attempts to sterilize the liquidity injection through bond sales. This case, which draws directly on the earlier literature on the use of counterpart funds arsing from the sale of commodity aid (for example, Roemer, 1989), and which we refer to as the *counterpart fallacy*, corresponds directly to a deficit-financed expansion in public expenditure.[14] Not surprisingly in these circumstances, inflation immediately surges and the nominal exchange rate depreciates sharply, creating a marked demand-switching boom in the non-traded goods sector which, in turn, generates a substantial temporary current account surplus as the private sector seeks to smooth the temporary increase in its disposable income. However, this outcome has nothing directly to do with aid: what has occurred is simply a large, temporary, money-financed increase in the fiscal deficit whose macroeconomic consequences are largely well understood.[15]

In each table 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

Table 3. Aid Fully Spent and fully Absorbed (% Change from Baseline)

	Horizon (years)							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable	Aid inflow (%GDP)							
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
3(a) Post-stabilization countries								
1. Buffer + float								
In	–1.131	–1.179	–1.258	–1.004	–0.723	–0.494	–0.004	2.491
NER	–2.436	–1.226	–1.056	–0.720	–0.466	–0.295	–0.002	3.071
RER	–2.372	–2.458	–2.090	–1.575	–1.107	–0.745	–0.007	4.549
RIR	–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
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mg	–0.075	–2.118	–1.704	–1.091	–0.696	–0.406	–0.003	3.084
2. Crawl								
In	1.089	0.046	–0.311	–0.369	–0.320	–0.246	–0.027	1.324
NER	0.245	–0.139	–0.188	–0.158	–0.119	–0.088	–0.026	0.524
RER	–1.534	–1.870	–1.646	–1.261	–0.897	–0.609	–0.008	3.406
RIR	–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
dz	–3.338	2.062	2.625	2.088	1.455	0.954	1.410	5.507
mg	–1.179	–0.281	0.285	0.355	0.289	0.203	–0.002	1.809

3(b) Pre-stabilization countries

1. Buffer + float								
In	–4.475	–5.261	–1.987	–3.170	–0.782	–1.754	–0.152	8.186
NER	–5.981	–6.077	–0.951	–3.364	–0.062	–1.918	–0.234	9.575
RER	–2.410	–3.716	–2.059	–2.370	–1.019	–1.281	–0.079	5.742
RIR	–2.800	0.085	–1.587	0.359	–0.955	0.391	0.113	3.540
ca	0.714	0.201	–0.180	–0.118	–0.207	–0.089	0.005	0.821
DN	0.781	–0.752	–0.025	–0.713	–0.019	–0.465	–0.053	1.436
C	2.322	1.049	1.087	0.366	0.529	0.096	–0.025	2.866
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mg	–0.820	–10.416	0.231	–5.663	1.354	–3.366	–0.500	12.999
2. Crawl								
In	1.103	–0.075	–0.412	–0.458	–0.400	–0.319	–0.057	1.602
NER	0.304	–0.311	–0.322	–0.265	–0.205	–0.157	–0.054	1.015
RER	–1.278	–1.655	–1.512	–1.203	–0.890	–0.631	–0.013	3.106
RIR	–1.170	–0.947	–0.678	–0.462	–0.309	–0.203	–0.003	1.763
ca	1.012	0.229	–0.058	–0.138	–0.139	–0.114	–0.004	1.070
DN	0.921	0.351	0.079	–0.029	–0.060	–0.060	–0.002	0.995
C	1.887	1.355	0.924	0.616	0.406	0.266	0.005	2.630
dz	–3.652	3.610	3.860	2.971	2.103	1.429	2.479	7.779
mg	–2.022	–0.552	0.136	0.295	0.277	0.210	–0.047	2.281

Source: Authors' calculations. All subsequent tables are also from our own calculations.
Notes: An increase in *NER* and *RER* denotes a depreciation in the nominal and real exchange rates, respectively. See Tables 2a and 2b for parameter settings. For float, z1 = 0; for crawl, z1 = 15 and z2 = 0.95. dr = 0.00. Since μ = 0, dW = 0.

Table 4. Deficit: Reducing Aid

	Horizon							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable	Aid inflow (%GDP)							
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
4(a) Post-stabilization countries								
Panel 1: Pure float								
In	–10.465	–2.983	–2.206	–1.478	–0.956	–0.608	–0.005	11.269
NER	–14.056	–1.737	–1.479	–0.951	–0.582	–0.352	–0.002	14.290
RER	–6.529	–4.264	–2.941	–1.984	–1.303	–0.839	–0.006	8.733
RIR	–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
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mg	–7.749	–4.395	–3.191	–1.877	–1.065	–0.603	–0.003	9.733
Panel 2: Crawl								
In	–0.016	–0.420	–0.518	–0.467	–0.379	–0.296	–0.098	1.596
NER	–0.824	–0.518	–0.379	–0.275	–0.207	–0.165	–0.096	1.679
RER	–1.471	–1.648	–1.394	–1.045	–0.734	–0.496	–0.014	2.984
RIR	–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
dz	11.243	6.498	4.276	2.655	1.506	0.933	0.643	14.107
mg	–0.675	–1.210	–0.352	–0.061	0.013	0.011	–0.096	1.899

Panel 3: Buffer + float								
In	−4.199	−2.128	−2.097	−1.791	−1.488	−1.242	−0.496	6.401
NER	−5.993	−1.772	−1.790	−1.494	−1.244	−1.061	−0.492	7.347
RER	−3.262	−2.616	−2.058	−1.518	−1.074	−0.746	−0.070	5.132
RIR	−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
dz	12.500	5.625	2.129	0.545	−0.263	−0.641	−7.760	14.265
mg	−0.343	−2.145	−2.340	−1.919	−1.568	−1.321	−0.607	5.333
4(b) Pre-stabilization countries								
Panel 1: Pure float								
In	−13.436	−6.132	−4.219	−2.776	−1.885	−1.207	−0.012	15.805
NER	−17.218	−5.212	−3.442	−2.133	−1.441	−0.870	−0.005	18.533
RER	−6.051	−4.579	−3.336	−2.307	−1.597	−1.059	−0.013	8.866
RIR	−0.938	−0.767	−0.499	−0.390	−0.229	−0.185	−0.006	1.406
ca	0.791	0.112	−0.121	−0.180	−0.163	−0.132	−0.003	0.864
DN	−1.377	−1.087	−0.834	−0.577	−0.415	−0.269	−0.003	2.101
C	1.511	1.084	0.736	0.509	0.332	0.228	0.004	2.111
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mg	−10.311	−8.547	−5.233	−2.957	−1.936	−1.061	0.003	14.874
Panel 2: Crawl								
In	−0.047	−0.610	−0.647	−0.566	−0.462	−0.369	−0.133	2.264
NER	−0.804	−0.771	−0.533	−0.386	−0.293	−0.234	−0.130	2.314
RER	−1.212	−1.470	−1.289	−1.000	−0.729	−0.513	−0.017	2.709
RIR	−0.967	−0.707	−0.498	−0.341	−0.230	−0.153	−0.002	1.376
ca	1.220	0.404	0.070	−0.051	−0.081	−0.076	−0.005	1.297

Table 4. Continued

	Horizon							
Variable	*0*	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
				Aid inflow (%GDP)				
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
DN	0.613	0.165	−0.007	−0.061	−0.067	−0.057	−0.001	0.647
C	1.453	1.013	0.692	0.465	0.310	0.206	0.008	2.002
dz	9.650	8.768	5.480	3.432	2.145	1.333	−0.065	14.851
mg	−1.753	−1.182	−0.372	−0.069	0.017	0.018	−0.126	2.839
Panel 3: Buffer + float								
In	−6.446	−5.966	−3.404	−4.040	−2.182	−2.737	−0.927	11.795
NER	−8.118	−6.401	−2.556	−4.094	−1.523	−2.811	−0.982	12.694
RER	−2.675	−3.370	−2.013	−2.099	−1.045	−1.162	−0.136	5.519
RIR	−2.237	−0.095	−1.222	0.194	−0.716	0.252	0.079	2.761
ca	0.855	0.272	−0.095	−0.092	−0.171	−0.091	−0.010	0.943
DN	0.401	−0.677	−0.140	−0.606	−0.094	−0.395	−0.059	1.135
C	1.974	0.957	0.914	0.359	0.447	0.121	−0.003	2.467
dz	12.500	5.625	2.219	0.545	−0.263	−0.641	−0.643	14.265
mg	−1.206	−9.519	−1.819	−5.851	−0.744	−3.974	−1.250	13.246

Notes: See Table 3, except dr = 0.25.

Table 5. Mixed Foreign Exchange and Bond Sterilization, 50–50 Rule

	Horizon							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable	Aid inflow (%GDP)							
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
Post-stabilization countries								
1. All aid spent with 50–50 sterilization rule								
In	12.805	4.624	4.195	3.795	3.501	3.275	1.933	18.357
NER	15.227	3.014	3.631	3.555	3.394	3.230	1.939	19.639
RER	4.404	1.477	0.451	0.015	–0.179	–0.262	–0.209	4.792
RIR	–1.072	–0.058	0.014	–0.006	–0.021	–0.028	–0.021	1.080
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
C	0.831	0.344	0.317	0.324	0.321	0.311	0.189	1.461
dz	25.000	11.250	4.438	1.091	–0.526	–1.281	–1.286	28.531
db	11.111	5.000	1.972	0.485	–0.234	–0.569	–6.898	12.681
mg	1.112	1.514	3.644	3.995	3.988	3.877	2.380	14.446
Memo items								
Dint(%GDP)	–0.218	0.129	0.184	0.184	0.176	0.168	0.101	0.675
Table 4a (Buffer plus float)								
RIR	–1.571	–1.296	–0.847	–0.528	–0.325	–0.199	–0.001	2.305
Dint(%GDP)	0.117	–0.126	–0.124	–0.092	–0.064	–0.042	–0.000	0.246

Table 5. Continued

	Horizon							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable	Aid inflow (%GDP)							
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
Post-stabilization countries								
2. Partial deficit reduction with 50–50 sterilization rule								
In	–0.014	1.370	1.883	2.121	2.212	2.220	1.449	8.529
NER	–0.809	1.443	2.036	2.255	2.313	2.292	1.454	8.740
RER	–1.447	–1.313	–1.035	–0.791	–0.608	–0.477	–0.159	2.635
RIR	–0.022	–0.031	–0.064	–0.070	–0.063	–0.053	–0.016	0.163
ca	1.699	0.714	0.244	0.028	–0.067	–0.105	–0.079	1.906
DN	–0.309	–0.261	–0.155	–0.075	–0.022	0.011	0.043	0.482
C	0.387	0.377	0.363	0.334	0.302	0.274	0.142	1.118
dz	18.750	8.438	3.328	0.818	–0.395	–0.961	–0.965	21.398
db	8.333	3.750	1.480	0.363	–0.175	–0.428	–5.173	7.258
mg	–6.859	–0.671	0.820	1.938	2.427	2.609	1.785	12.126
Memo items								
Dint(%GDP)	–0.072	0.073	0.098	0.109	0.113	0.114	0.076	0.450
Table 4a (Buffer plus float)								
RIR	–1.041	–1.072	–0.718	–0.449	–0.276	–0.169	–0.003	1.753
Dint(%GDP)	0.161	–0.111	–0.112	–0.082	–0.056	–0.036	–0.000	0.251

Notes: See Table 3.

Table 6. Fiscal Smoothing in Post-Stabilization Economies

	Horizon							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable	Aid inflow (%GDP)							
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
6(a) Aid fully spent (dr = 0.0)								
1. Float with fiscal smoothing (cf. Table 3(a) panel 1)								
In	–2.527	2.190	1.715	0.971	0.442	0.141	–0.008	3.912
NER	–4.604	3.004	2.105	1.171	0.586	0.264	–0.003	6.037
RER	–3.776	–2.296	–1.588	–1.225	–0.963	–0.739	–0.013	5.061
RIR	1.438	0.018	–0.575	–0.644	–0.529	–0.384	–0.003	1.833
ca	1.390	0.207	–0.238	–0.335	–0.302	–0.233	–0.003	1.530
DN	–1.098	0.030	0.334	0.284	0.168	0.076	–0.003	1.197
C	0.634	1.287	1.296	1.034	0.742	0.501	0.004	2.405
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
s	1.000	1.000	0.750	0.500	0.312	0.187	0.000	1.721
dW	25.000	0.000	–6.250	–6.250	–4.688	–3.125	–0.011	27.217
2. Crawl with fiscal smoothing (cf. Table 3(a) panel 2)								
In	–0.574	0.225	0.249	0.115	–0.002	–0.067	–0.014	0.707
NER	–1.666	0.192	0.398	0.299	0.177	0.091	–0.009	1.765
RER	–1.986	–2.045	–1.773	–1.438	–1.112	–0.826	–0.013	3.990
RIR	–0.107	–0.307	–0.497	–0.509	–0.427	–0.322	–0.004	0.995
ca	1.235	0.252	–0.160	–0.276	–0.266	–0.214	–0.003	1.361
DN	0.157	0.095	0.101	0.067	0.026	–0.004	–0.002	0.226
C	1.284	1.235	1.096	0.870	0.638	0.444	0.005	2.427
dz	22.717	–3.754	–6.378	–4.705	–2.810	–1.494	0.003	24.571
s	1.000	1.000	0.750	0.500	0.312	0.187	0.000	1.721
dW	25.000	0.000	–6.250	–6.250	–4.688	–3.125	–0.011	27.217

Table 6. Continued

	Horizon							
	0	*1*	*2*	*3*	*4*	*5*	*15*	*Stdev*
Variable				*Aid inflow (%GDP)*				
a	*2.000*	*1.000*	*0.500*	*0.250*	*0.125*	*0.063*	*0.001*	
6(b) Aid not fully spent, sticky prices with dr = 0.25								
1. Float with fiscal smoothing (cf. Table 4(a) panel 1)								
In	−11.512	−0.456	0.023	0.003	−0.082	−0.131	−0.007	11.525
NER	−15.682	1.436	0.891	0.467	0.207	0.067	−0.003	15.781
RER	−7.581	−4.143	−2.565	−1.721	−1.196	−0.835	−0.012	9.323
RIR	1.861	0.026	−0.505	−0.549	−0.444	−0.320	−0.003	2.098
ca	1.258	0.148	−0.226	−0.299	−0.263	−0.201	−0.002	1.375
DN	−3.003	−0.903	−0.231	−0.054	−0.025	−0.029	−0.002	3.145
C	0.239	1.085	1.097	0.867	0.618	0.416	0.003	1.966
dz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
s	0.750	0.750	0.562	0.375	0.234	0.141	0.000	1.291
dW	18.750	−0.000	−4.688	−4.688	−3.516	−2.344	−0.008	20.412
2. Crawl with fiscal smoothing (cf. Table 4(a) panel 2)								
In	−1.263	−0.286	−0.098	−0.104	−0.140	−0.161	−0.087	1.730
NER	−2.258	−0.269	0.061	0.067	0.015	−0.031	−0.084	2.520
RER	−1.809	−1.779	−1.490	−1.178	−0.896	−0.659	−0.018	3.423

RIR	–0.173	–0.239	–0.369	–0.379	–0.320	–0.242	–0.003	0.762
ca	1.377	0.416	–0.009	–0.155	–0.176	–0.151	–0.005	1.474
DN	0.021	–0.027	0.011	0.012	–0.002	–0.015	–0.002	0.058
C	1.012	0.933	0.824	0.657	0.484	0.339	0.008	1.858
dz	30.784	2.135	–2.476	–2.440	–1.603	–0.902	–0.068	31.128
s	0.750	0.750	0.562	0.375	0.234	0.141	0.000	1.291
dW	18.750	0.000	–4.688	–4.688	–3.516	–2.344	–0.008	20.412
3. Buffer + float with fiscal smoothing (cf. Table 4(a) panel 3)								
In	–4.567	–1.585	–1.709	–1.606	–1.419	–1.219	–0.418	6.198
NER	–6.344	–1.121	–1.479	–1.400	–1.225	–1.050	–0.413	7.318
RER	–3.231	–2.387	–1.968	–1.592	–1.238	–0.930	–0.066	5.095
RIR	0.076	–0.536	–0.571	–0.469	–0.348	–0.244	–0.004	1.033
ca	1.180	0.234	–0.118	–0.215	–0.211	–0.174	–0.013	1.273
DN	–0.446	–0.065	–0.077	–0.120	–0.135	–0.128	–0.015	0.539
C	1.180	1.215	0.971	0.712	0.499	0.341	0.016	2.188
dz	31.250	4.688	–3.359	–4.754	–4.126	–3.138	–0.545	32.797
s	0.750	0.750	0.562	0.375	0.234	0.141	0.000	1.291
dW	18.750	0.000	–4.688	–4.688	–3.516	–2.344	–0.008	20.412

Notes: See Table 3. Smoothing parameter = 0.50.

well-defined discrete events (i.e. positive aid surges) we emphasize 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 2b.[16]

We contrast the behavior of pre- and post-stabilization countries. In the interest of space, however, we limit the results to the case where we assume some price stickiness in non-tradable price adjustments. With minor exceptions, mentioned as we present the results, the qualitative insights of our analysis are not radically altered if we assume that prices are fully flexible.[17]

3.1 All Aid Is Spent

When the fiscal authorities spend all the aid inflow as it is received, domestic financing is fully and continuously insulated (see equation (1) above). Moreover, full spending implies there is no distinction between a pure float and a buffer plus float. Both, however, entail a different path for the nominal exchange rate and aggregate prices compared to the crawl, at least in the short run, even though macroeconomic outcomes are similar in the two cases and, most importantly, are largely benign. The only significant difference is how the initial real exchange rate appreciation associated with the aid inflow is effected: an initial inflationary spike is required under the crawl whereas under a float the initial adjustment is mildly deflationary as the nominal exchange rate appreciates. In neither case are the effects large. While the crawl delivers marginally less volatility for both inflation and the real exchange rate, and marginally more current account volatility, the differences between these polar approaches to exchange rate policy are second order, particularly for the post-stabilization countries. 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, while inflation falls slightly along the transition path. This follows directly from equation (5) where, under a float, $\Delta z_t = 0$. Assuming the authorities do not engage in bond operations, then if the fiscal authorities spend aid as it is received so that $\left(d_t - \overline{d}\right) = (a_t - \overline{a})$, the right-hand side of (5), the fiscal authority's seigniorage requirements, will be zero on a continuing basis.[18] At the same time, however, the demand for domestic money is increasing as a result of higher private incomes and the substitution of domestic for foreign currency balances as the nominal exchange rate appreciates. More surprisingly, perhaps, the same logic suggest that there will be relatively little to differentiate an aggressive crawl from a pure float. Because the bulk of the aid is sold—and absorbed—roughly as rapidly as it is spent, even a tight crawl therefore requires little net foreign exchange accumulation. These features carry over to the case of pre-stabilization countries although, as a result of the higher inflation elasticity of the demand for money, the IRFs and volatilities are magnified, and the differences between the monetary rules larger, compared to the post-stabilization results.

3.2 Aid Not Fully Spent

Matters are rather different when aid is not fully spent but is used to provide an element of fiscal stabilization. From equations (1) or (3), we see that when $\left(d_t - \overline{d}\right) < (a_t - \overline{a})$ this generates a first-order decline in domestic financing requirements and confronts the monetary authorities with the explicit challenge of how to manage this alteration to the path of domestic financing. In this case the buffer plus float rule is no longer equivalent to a pure float. Although it is doubtful that any country pursues a pure float, in the strict sense that the aid inflow is met with absolutely no change in official reserves, it is important to understand the consequences of adopting such a rule, if only to shed light on why the buffer plus float delivers the outcomes it does. Hence we start with the pure float, which is illustrated in panel 1 of Tables 4a and 4b, respectively. By setting $\Delta z = 0$ (and assuming for the moment that the authorities do not engage in bond sterilization) the pure float implies that the contraction in the fiscal deficit after net budgetary aid is fully met by a contraction in the government's seigniorage requirement for a given stock of domestic debt. The consequences are dramatic, even for the post-stabilization countries: the nominal exchange rate appreciates by around 14% on impact (compared to an appreciation of around 2.4% in the corresponding no-deficit reduction case reported in Table 3), and the real rate appreciates by 6.5% (again compared to 2.4%). These powerful price effects induce a contraction in non-tradable output of 1.6% on impact compared to an *increase* of around 0.8% in Table 3. What has happened here is that the reduction in expected inflation as a result of the fiscal adjustment shifts the private sector's asset portfolio in favor of domestic money: given the contraction in the supply of money and the fact that the authorities are not intervening in the foreign exchange market, this requires the nominal exchange rate to overshoot in the short run to restore portfolio equilibrium. Because the nominal appreciation is much larger than the real appreciation required to absorb the aid inflow, non-tradable prices must fall sharply. If, as we assume here, there is a measure of price stickiness, a sharp short-run recession in the non-tradable goods sector ensues.

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. Both the crawl (panel 2) and a buffer plus float (panel 3) do rather well in these circumstances. In both cases, but particularly under the crawl, the disruptive volatility in inflation and the real exchange rate are greatly reduced. The sharp deflationary impact under the pure float is substantially eliminated, with prices falling by 4% under the buffer plus float and virtually not at all under the crawl, compared to a 10% fall under the pure float. By the same token, the impact on real exchange rate appreciation is pegged back to around 1.5% under the crawl and 3.3% under the buffer plus float, compared to 6.5% under a pure float, and the strong recessionary pressures on non-traded output are completely eliminated.

Although the pattern of reserve accumulation is broadly similar under the crawl and buffer plus float, as indeed are the real outcomes, these two approaches are not the same. Moreover, the differences between them emerge much more forcefully in pre-stabilization settings where, as Table 1 suggests, the fiscal authorities are more likely to direct a proportion of aid towards deficit reduction. As Table 4b shows the crawl contributes to a much smoother adjustment path in response to the aid surge than does the buffer plus float. Here, 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 latent contraction in the domestic money supply observed under the float is forestalled. Instead, the increased demand for liquidity as a result of the decline in the seigniorage requirement is accommodated without requiring a sharp price adjustment so that the economy responds to the aid inflow with virtually stable prices. Domestic output is hardly affected and total private spending follows a smoother path. As with the post-stabilization case, this "crawl-with-no-bond-sterilization" strategy appears to deliver an extremely attractive response to a temporary aid inflow.

The buffer plus float strategy goes some way to delivering this same outcome, although much less successfully in the pre-stabilization case compared to the post-stabilization calibration. The high nominal volatility seen in panel 1 is still avoided, but the adjustment trajectory still entails 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 is that the buffer plus float involves reserve accumulation with respect to the unspent portion of aid only—thereby stabilizing seigniorage (assuming no change in domestic borrowing)—but maintains a free float with respect to absorption of the spent portion of the aid and all other shocks. This rule, in effect, serves to efficiently match the *supply* of domestic liquidity but does not fully accommodate changes in the *demand* for domestic liquidity arising from the fall in expected inflation. By contrast, under a crawl, the central bank stands ready to exchange however much domestic for foreign currency is required at the prevailing (targeted) exchange rate: hence the higher official reserve accumulation. Given the higher elasticity of demand for money with respect to expected inflation in the pre-stabilization calibration, this difference in the degree of intervention is magnified and with it the difference in performance of the two strategies. Put simply, as the inflation elasticity of the demand for money rises, the buffer plus float does less well in aligning the demand and supply of domestic liquidity compared to the float.

3.3 Bond Sterilization

The crawl and buffer plus float policies in Tables 3 and 4 each end up allocating 100% 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 stabilization burden to bond operations. This impression is confirmed in Table 5 where we examine the case where the authorities are assumed to adopt the [γ, 1 − γ] rule described in section 2.2 under which domestic currency value of aid spending is matched in equal amounts by sales of foreign exchange and government securities. Compared with either the buffer plus float or the crawl, however, this rule does relatively poorly. When aid is fully spent, bond sterilization makes very little sense: it contributes to a steady depreciation in the nominal exchange rate and persistent domestic inflation. When aid is partly used for deficit reduction we already know that a pure float performs very poorly so that by comparison the relatively good performance under the mixed sterilization rule gives little comfort. This is not the correct comparison, however, and a closer look at the simulations suggests that the mixed sterilization rule is decisively dominated by the crawl and buffer plus float, and in one respect in particular. Compared with both, the path for the real interest rate under bond sterilization is substantially higher than under the relevant counterfactuals considered in Table 4. The reason is that the path of domestic deficit financing is affected by domestic interest costs arising from sterilization. With domestic debt a state variable in this system, domestic interest costs rise sharply, relative to the no-bond sterilization case beyond the first period, and hence reverse the tendency for expected inflation to decline as would otherwise be the case (see the memo items to Table 5). This is not surprising because, as we have stressed above, the aid inflow is deflationary, especially if there is a deficit-reduction component, so that there is no intrinsic inflationary problem associated with the growth of liquidity; indeed, as the distinction between the crawl and the buffer plus float highlights, the problem may be the reverse. Ironically, therefore, a strategy such as that expressed by Brownbridge and Tumusiime-Mutubile at the start of this paper, which is built around a narrow focus on nominal liquidity growth, may prompt the authorities into using bond sterilization at exactly the time when a liquidity injection rather than a withdrawal is required.

3.4 Smoothing Public Expenditure

We close by briefly considering the case where the fiscal authorities operate an "aid account" in order to stretch aid-funded public spending over a longer horizon than the aid shock, possibly in response to conventional smoothing considerations or to avoid placing excessive pressure on the absorptive capacity of the public sector. As before, we focus on the characteristics of monetary responses given the fiscal stance. For each reported simulation we also assume that the fiscal authorities apply the smoothing rule defined by (5) with $\mu = 0.5$, which approximately doubles the half-life of the expenditure response relative to that of the aid shock. In addition to the variables reported earlier, Table 6 also records the IRFs and volatility for the government discretionary expenditure (denoted by s) and the change in the "aid account" (dW). Again in the interest of space we limit our attention to the post-stabilization calibration only; the results for each panel are directly comparable to the corresponding panels in Tables 3(a) and 4(a). Three key features emerge from Table 6. First, fiscal smoothing reduces the volatility of total spending, regardless of the monetary policy response; this is unsurprising given that public spending in these simulations consists entirely of a transfer to the private sector. Second, however, although fiscal smoothing does not alter the total volume of spending out of aid—only its timing—the operation of the "aid account" removes the previous insulation of domestic liquidity afforded by the pure float. Hence, although the aid shock is smoothed, inflation and exchange rate volatility is higher under a float than in the case where there is no fiscal smoothing. The reverse is true under the crawl where volatility is marginally reduced relative to the no-fiscal-smoothing case. This result is consistent with our earlier discussion of the distinction between the float and the crawl when domestic financing is not fully insulated, even though for the calibration considered here the differences are not substantial. Third, as is shown in Table 6 panel (b) however, when some of the aid is used for deficit reduction, an aggressive crawl remains much the most effective way of minimizing macroeconomic volatility, even when the fiscal authorities act to smooth spending out of the aid inflow. In other words, the same argument applies: regardless of the fiscal motive for expenditure smoothing, monetary policy is at its most efficient when it serves to appropriately align the supply and demand for domestic liquidity.

4. Conclusions and Extensions

We argued at the beginning of this paper that central bankers in Africa face substantial problems in managing aid surges. In practice, many central banks appear to have adopted strategies involving substantial intervention and reserve accumulation in response to aid surges, accompanied in many cases by fairly aggressive bond sterilization. The simulations presented in this paper suggest that this pattern of foreign exchange intervention is consistent with efficient monetary policy responses to substantial aid volatility, particularly in circumstances where countries continue to use part of the aid inflow for inflation stabilization purposes. The case for bond sterilization is less well grounded, however.

Our simulations suggest that efficient monetary management of aid inflows centres on the extent to which it can successfully align the path of domestic deficit financing with the demand for domestic base money. This requirement reflects the central role we ascribe to private sector portfolio behavior in such countries, and as such takes on a particular importance when fiscal decisions lead to sharp changes in seigniorage requirements. Thus when aid is fully spent as it is received, domestic financing needs are perturbed very little, with the consequence that 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. If, however, aid is used partly to reduce the domestic financing requirement, consequent portfolio adjustment effects play a potentially important role in the macroeconomic dynamics. Realignment of absorption with spending in these circumstances—either through a crawl, in which the sales of aid dollars are endogenous to actual exchange rate movements, or a buffer plus float rule, which ties the reserve target to the fiscal absorption of aid—significantly reduces macroeconomic volatility. For "prestabilization" settings where the inflation elasticity of the demand for money is likely to be higher, efficient responses to the fall in velocity associated with an aid-supported inflation stabilization appear to require greater intervention than provided by the buffer plus float. In these circumstances the superiority of the crawl in reducing nominal and real volatility on the adjustment path is decisive.

Our simulations also demonstrate that, contrary to much popular thinking, aggressive bond sterilization does not have a central role to play in the efficient management of aid surges, at least in those circumstances where aid inflows do not trigger a generalized loss of fiscal control. There may, of course, be circumstances where fiscal control is less assured or where foreign exchange markets are perceived to be too shallow or otherwise distorted such as to limit the scope for intervention, in which case bond sterilization may constitute one component of a stabilization strategy.

We close with three important caveats. First, the superiority of the crawl over the buffer plus float may need to be set against other considerations weighing in favor of exchange rate flexibility. For example, a buffer plus float may be better aligned with broader policy objectives aimed at supporting financial sector development or laying the foundations for a more explicit inflation targeting regime. Second, our analysis ascribes a central role to the private sector's portfolio behavior as a potential source of macroeconomic volatility. Clearly, if portfolio effects are weak, the distinction between alternative policy rules diminishes. However, as capital market integration increases, either formally or informally, portfolio effects of the kinds emphasized here are likely to increase rather than decreases in importance.

Finally, we have abstracted entirely from issues of donor or government credibility, by assuming that the stochastic process for aid is common knowledge and that the government's expenditure plans (as a function of aid) are known and fully credible. In reality, however, donors cannot commit to enhanced aid flows on an ongoing basis, and recipient governments, in turn, are unlikely to find it optimal to reduce spending point for point with unanticipated declines in aid. These realities suggest that a surge in aid, if it is aggressively spent at the outset, may create the expectation of fiscal destabilization even if both donor and recipient expect the aid to be highly persistent. In a related paper (Buffie et al., 2006), we have examined how these private sector perceptions of fiscal stability may also shape the appropriate monetary response to aid. We argue that, faced with credibility issues of this kind, a full "absorb and spend" policy is potentially destabilizing because it provides no buffer against private-sector concerns about higher future seigniorage. By contrast, a strategy embodying some near-term fiscal restraint, combined with either a temporary accumulation of reserves or a temporary buyback of domestic debt, is a necessary component of a successful strategy until it becomes clear that the scaling up of aid flows is permanent.

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Notes

1. Throughout this paper, we model budgetary aid as accruing in the form of dollar deposits owned by the Central Bank. Until aid dollars are sold by the central bank, an aid surge has no impact on seigniorage, because net international reserves and net domestic credit to government change in equal and opposite directions. As aid is spent (increasing the fiscal deficit), the import component of spending continues to leave domestic liquidity unchanged because net 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 plus float* policy uses foreign exchange sales to sterilize this in full, leaving seigniorage unchanged.
2. *Post-stabilization* countries—referred to as *mature stabilizers* by the IMF—are those that have established track records of fiscal discipline and low inflation over a sustained period of time. These include, for example, Tanzania and Uganda since the mid-1990s.
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.

4. To keep the exposition simple, we have assumed that no non-grant foreign financing passes through the budget.
5. A complete statement of the model can be found in Adam et al. (2007).
6. 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 2.0. There is a stronger degree of consensus concerning the value of inter-temporal elasticity of substitution. Changing these parameters alters the model properties in intuitive ways but do not substantially alter our central insights.
7. This simple one-shock structure is nested within a higher dimension structure in which we allow for the stochastic determination of commodity export prices, 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.
8. In this paper we assume that 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 (see O'Connell et al. 2007). 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.
9. With no banking system in model, there is no role for reserve requirements or deposit placement policies in the central bank's toolkit.
10. Equation (6) can be adapted to accommodate a real rather than a nominal exchange rate target by replacing the exchange rate term $(x_t - \bar{x})$ with $(e_t - \bar{e})$, where e denotes the real exchange rate. We do not examine this option here, although this case is examined in some detail in Adam et al. (2007).
11. 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.
12. Ensuring that bonds held by the private sector return to their steady-state level means in turn that interest payments and the fiscal deficit are unchanged in the long run. This is required by consistency with the long-run inflation target.
13. The dynamics of bond sterilization are of course not as simple as portrayed here since the path of the fiscal deficit, d_t is itself a function of the interest burden on domestic debt. The simulation model used in the next section fully reflects this quasi-fiscal effect.
14. IMF (2005) refers to this as a case of 'spend and don't absorb' although strictly this refers only to the public sector response to the aid inflow: the extent to which absorption changes in these circumstances depends on the evolution of the private capital account.
15. Simulations for the counterpart fallacy case are available from the authors.
16. All the simulations presented here are generated by the Dynare–Matlab routines (Juillard 1996) using a first-order Taylor approximation to the nonlinear model around the non-stochastic steady state.
17. The full set of simulation results for the flex-price case is available on request from the authors.
18. In the simulations reported here this is not strictly true because of other second-order influences on liquidity growth. In particular, the model assumes that government current expenditure is split between tradables (g_T) and non-tradables (g_N). Measured in units of the numeraire good government expenditure is defined as $g = g_T + eg_N$. In the simulation model used here, we assume that government expenditure is set in volume terms so that changes in the real exchange rate (e) alter the fiscal stance through revaluation of eg_N; these have (second-order) consequences for the fiscal deficit and hence the growth of liquidity. Were we to assume that government expenditure is set in value terms, relative price movements would have no impact on liquidity growth.