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Monetary Policy and Oil Price Surges in Nigeria
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6.1 Introduction

The management of oil revenues is the past, present and future of macroeconomic policy in Nigeria. As Paul Collier describes (Chapter 2), the long history of fiscal mismanagement of oil booms in Nigeria saw the Central Bank of Nigeria’s ability to pursue a coherent monetary policy severely circumscribed. Without the support of a disciplined and broadly predictable fiscal stance, the Central Bank was unable to make credible commitments to an inflation target or, indeed, to any other intermediate target such as the money supply or the exchange rate. Monetary policy could not reliably anchor inflation expectations. Since the turn of the century, however, the landscape has started to change. Harnessed to a stronger political commitment, the successful consolidation in the financial sector concluded at the end of 2005 and the de facto unification of the foreign exchange markets in early 2006, measures such as the Fiscal Responsibility Bill, currently working its way through the legislature, are laying the foundations for improved fiscal management of oil revenues. As a result, and for possibly the first time in its history, the prospects now exist for genuinely ‘independent’ Central Banking in Nigeria. It now makes sense to consider monetary policy playing a more central role in short-run macroeconomic management in Nigeria.

In this chapter, we are concerned with just one specific aspect of this management challenge. Specifically, we use a formal model that examines the properties of alternative monetary policy rules geared towards the efficient macroeconomic management of short-run volatility in oil revenues. In the model, we start from the premise that the Central Bank sees its core remit as pursuing low and stable inflation, even though it does not at present explicitly see itself as an ‘inflation targeter’. However, we also assume that, quite reasonably, other concerns compete for the Central Bank’s attention. First, there may be an anxiety about the level and volatility of the nominal and real exchange rates. Fears of adverse ‘Dutch disease’ effects accompanying oil surges 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. But concerns about exchange rate volatility may centre less on the question of competitiveness than on the political costs of temporary exchange rate appreciations which first confer big income gains on net consumers of imported goods before reversing them. The Central Bank may also be concerned about interest rate volatility. Attempts to address nominal (and real) exchange rate volatility through exchange rate intervention – a fear of floating – are often accompanied by a belief that some form of domestic liquidity sterilization is necessary to deliver on an inflation target. Sterilization, in turn, raises concerns over interest rate volatility, the effects on private investment, and the quasi-fiscal burden of increased domestic borrowing. Finally, the Central Bank may also seek to avoid excessive volatility in output, particularly in the non-tradable sector where prices are more likely to adjust sluggishly to demand shocks.

The challenge facing the Central Bank in dealing with oil price surges is to identify operational monetary rules that navigate these competing concerns without losing their anchor on inflation, or, more precisely, inflation expectations. This challenge can be distilled into three specific questions. First, to what extent does it make sense for the monetary authorities to seek to manage the path of the nominal exchange rate, if at all? Second, what is the role for using official foreign reserves as a buffer to smooth the spending and absorption of the oil windfall? Finally, how should windfall-related liquidity growth be sterilized, through bond sales or foreign exchange sales? This chapter, therefore, contributes to the making of monetary policy in Nigeria by examining the performance of a small set of alternative monetary policy rules in the face of volatile oil prices, holding other sources of volatility constant.

Two central messages emerge from our analysis. The first is that, when the fiscal response to oil surges significantly alters the path of domestic deficit financing needs, strategies involving significant foreign exchange intervention to offset the incipient nominal exchange rate appreciation deliver less volatile outcomes than those which allow the exchange rate to float freely. This intervention can be achieved by simple rules that match foreign exchange intervention directly to the saving out of the windfall (what we refer to as a buffer-plus-float) or through an explicit exchange rate crawl aimed at keeping the rate of nominal exchange rate depreciation close to the long-run inflation target. Both rules are much more effective at reducing short-run real and nominal volatility than a pure float. Second, judged solely against the narrow criteria of minimizing short-run price, exchange rate and output volatility, the crawl outperforms the buffer-plus-float. However, if, in addition to targeting macroeconomic volatility, the authorities are also concerned to develop the structural performance of domestic finance markets by promoting greater market-based exchange rate determination, the balance tips in favour of the buffer-plus-float.

The second main message is that, in the face of an oil price surge, the conventional case for domestic bond sterilization may be weaker than conventionally thought,
even when the authorities’ foreign exchange rate intervention leads to a growth in domestic liquidity. The reason is that the combination of income growth and a reduction in expected inflation arising from fiscal consolidation serves to increase the demand for domestic money thereby warranting the growth in liquidity arising from the authorities’ accumulation of official net international reserves. Indeed, there may even be a case for ‘reverse sterilization’ where part of the oil windfall is used to buy back domestic debt. This may serve two purposes. First, a debt buy-back serves to crowd in private investment by temporarily lowering the real interest rate. At the same time, a debt buy-back at the beginning of an oil surge creates ‘space’ for the monetary authorities to more effectively manage the end of an oil price surge, especially in circumstances where the fiscal authorities cannot credibly commit to adjusting expenditure immediately as windfall revenue disappears.

Three important caveats apply to our model-based analysis, however. First, the strength of the case for foreign exchange intervention, and against bond sterilization, in the face of oil surges depends intimately on the assumed sensitivity of the private sector’s demand for money to changes in expected inflation, and how heavily it discounts the future. Our simulations attempt to reflect the view that in contemporary Nigeria, especially as reforms in the financial sector begin to take root, portfolio effects appear to be relatively strong. However, these are only model-based assumptions: if in reality the inflation elasticity is low and horizons are short, portfolio effects on the demand for money will weaken, the distinction between alternative exchange rate rules will be less stark, and the case for a debt buy-back less powerful. Second, the analysis reported below is based on a model which de-emphasizes the role of the banking system in the transmission of monetary policy and hence the results do not do justice to the full range of policy instruments available to the Central Bank. Finally, and most importantly, we must reiterate a self-evident truth about monetary policy in Nigeria. With oil revenues constituting such a dominant share of total fiscal receipts, it will always be the case that monetary policy is conducted in the shadow of the fiscal management of oil revenues. Whilst it may be possible for the Central Bank to lean against weak fiscal management in the short run – for example by relying heavily on quantitative controls such as reserve requirements and Central Bank liabilities to mop up excess domestic liquidity – no long-run inflation target can succeed without a supportive fiscal policy. It follows, therefore, that, in the absence of a compatible fiscal policy, monetary policy options will remain heavily proscribed and strongly influenced by concerns about managing unsustainable liquidity growth. Other chapters in this volume address these broader issues of fiscal management directly; given the specific objectives of this chapter, we assume the existence of a broadly coherent fiscal stance.

The remainder of the chapter is structured as follows. Section 6.2 sets the scene by providing a brief sketch of the relevant monetary conditions in contemporary Nigeria. In Section 6.3 we motivate the formal simulation analysis by establishing the
main lines of our argument, and in Section 6.4 we present and discuss the simulation results. Section 6.5 concludes with some brief comments on the question of fiscal credibility.

6.2 Monetary policy objectives and practice in contemporary Nigeria

In recent decades the declared objective of monetary policy in Nigeria has been to attain both price stability and exchange rate stability. The reality has, however, been rather different. Average inflation, which had stood at around 30 per cent per annum from most of the two decades since the 1974–1979 oil price boom, has fallen but has continued to be volatile (Figure 6.1).

Batini (2004) highlights two reasons for Nigeria’s relatively poor historical record on inflation control. The first is a chronic ‘fiscal dominance’ problem which has frequently obliged the Central Bank to finance large and volatile fiscal deficits, and the second is the policy incoherence arising from attempts to satisfy the so-called ‘impossible trinity’ of monetary policy. This holds that, in countries with an open capital account, money supply and exchange rate targets cannot be pursued simultaneously so that, at some point in time, these two objectives will require mutually incompatible policy actions with the consequence that either or both targets will be jeopardized. These tensions between money supply and exchange rate objectives remain so that, while the authorities remain publicly committed to a programme in which broad money growth is the principal anchor, concerns about the path of the exchange rate are rarely far from the surface.²

Greater coherence has emerged in recent years, however, promoted in part by the National Economic Empowerment and Development Strategy (NEEDS) framework. A central pillar of NEEDS has been the development of an oil-price based fiscal rule, endorsed by the federal, state and local governments, under which the windfall oil

Figure 6.1 Inflation 1999–2006 (12-month percentage change in CPI).
Source: International Financial Statistics, IMF.
revenues in excess of a budget reference price are saved. Under this rule, the fiscal stance has improved substantially in the last few years, despite the pressures to spend the large increase in oil revenue. The overall fiscal balance moved from a deficit of around 4 per cent of GDP in 2001 and 2002 to a surplus of roughly the same order of magnitude in 2004 and 2005, while the domestic debt ratio fell by around 5 percentage points of GDP over the same period. The focus on improving fiscal discipline has also underpinned the Fiscal Responsibility Bill (FRB) – under review by the National Assembly at the time of writing – which seeks to establish better coordination of the fiscal policies of federal, state and local governments through formal fiscal rules and enhanced fiscal transparency and accountability, the lack of which has long been a problem in Nigeria (see Box 6.1).

**Box 6.1 Allocation of oil resources and fiscal decentralization in Nigeria**

The allocation of oil resources and fiscal decentralization in Nigeria has long been a topic of much controversy. The present system, embedded in the constitution, allocates a large share of revenues to the state and local governments. In particular, two categories of revenue are shared by the federal, state and local governments. The first consists of oil revenues net of expenditures, called ‘First Charges’, plus tax revenue collected by the federal government on behalf of the federation. This revenue is known as the Federation Account revenue and is allocated according to a rule that has changed over the years. In 2001, the rule allocated 48.5 per cent of the revenue to the federal government, 24 per cent to the state government, 20 per cent to the local government, and 3.5 per cent to special funds. The remaining 4 per cent was originally meant for other purposes but is now reallocated to the three government levels. The second category of revenue, the value added tax, is also collected at the federal level but is allocated to the three levels of government according to a different rule. In 2001, 50 per cent of the revenue was allocated to the local governments, whereas the state and federal governments received 35 per cent and 15 per cent, respectively.

While a large share of the revenues goes to the state and local governments, the responsibility for consolidated fiscal policy and macroeconomic stability lies at the level of the federal government. At the same time, the local and state governments are allowed to borrow domestically and hold no responsibility for fiscal prudence and macroeconomic stability. As a result, the current institutional structure makes it difficult for the federal government to exert control over the aggregated fiscal policy stance. It is this situation the Fiscal Responsibility Bill (2006) seeks to address by providing for formal fiscal rules aimed at improved coordination of the fiscal policies of federal, state and local governments.
Although the long-term success of the current initiatives remains to be seen, the first important and unprecedented steps have been made towards a sustainable fiscal policy framework. This improved fiscal outlook has immediate consequences for the conduct of monetary policy as well. In the presence of a certain degree of fiscal discipline and a credible money targeting regime, the question arises how the other objective of the Central Bank, exchange rate stability, should be viewed, particularly in the face of volatile oil prices. It is to these issues that we now turn.

6.3 A simple framework for monetary policy analysis

6.3.1 The basic structure

Successful monetary management of volatile oil revenues turns on how this volatility translates into volatility in domestic deficit financing (‘seigniorage’). As we show, this becomes a particularly important issue if fiscal policy is geared towards saving some of the oil windfall, either to reduce reliance on domestic deficit financing or to smooth the profile of government expenditure for a given fiscal stance (or some combination of the two). In such circumstances, simple monetary rules which stabilize the path of domestic financing through more or less exchange rate intervention turn out to have attractive properties. The reason for this is as follows: conventional wisdom concerning the choice of exchange rate regimes suggests that a floating exchange rate regime offers the economy the best protection against real shocks while a fixed (or crawling peg) regime provides better protection against portfolio shocks. The distinctive feature of oil price surges in Nigeria is that, while the originating shock is real, the authorities’ fiscal choices, which alter the path of domestic deficit financing, convert the real shock into a mixed real and portfolio shock thus shifting the balance in favour of a degree of intervention aimed at managing the path of the exchange rate.

We examine the properties of two specific rules which achieve this objective, albeit in different ways. The first, which we refer to as a 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 the oil windfall. This entails initially accumulating oil proceeds as official foreign exchange reserves and then sterilizing the full domestic currency counterpart of non-import spending through foreign exchange sales as it occurs.\(^3\)

The second rule, an 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 this case, foreign exchange intervention responds to the latent pressures coming through the private portfolio choices (between holding domestic and foreign denominated assets)
which, in turn, reflect underlying changes in the supply of domestic liquidity arising from the fiscal intervention.

The simulation results presented later in this chapter are derived from a model based on O’Connell et al. (2006). Although the model itself is quite detailed, its central insights can be derived directly from the basic accounting identities that frame the set of policy choices. The first is the consolidated budget constraint of the public sector which we define in naira terms as

\[
(S_t - T^o_t) - E_t \Delta F_t - DF_t = \Delta H_t + \Delta B_t - \Delta NIR_t,
\]

where \( S_t = (G_t + i^d_t B_{t-1} + E_t i^e_t F_{t-1} - T^o_t) \) is the non-oil overall fiscal deficit before foreign financing, \( G \) is consolidated government expenditure, \( B \) and \( F \) represent domestic and external debt respectively (with domestic and foreign interest rates \( i^d \) and \( i^e \)), \( E \) is the nominal exchange rate, \( T^o_t \) is total non-oil revenue, and \( T^o_t \) windfall revenue from the oil sector. \( DF_t \) is therefore domestic financing of the consolidated public sector deficit. Equation (6.1) states that the fiscal deficit net of oil and any foreign financing is ultimately financed through some combination of the growth in the monetary base (\( \Delta H \)), growth in public sector domestic debt (\( \Delta B \)), and depletion of official net international reserves (\(-\Delta NIR\)).

The left hand side of (6.1) is the traditional province of fiscal policy. The fiscal spending decision determines the overall public sector domestic deficit net of oil proceeds period by period. In what follows we shall ignore the role of official foreign financing of the budget. For Nigeria this is of second-order importance to the overall budget: what really matters is the evolution of the fiscal deficit net of the oil windfall, \( (S_t - T^o_t) \). The domain of monetary policy is then the composition of the right-hand side of (6.1), taking the left hand side as given. Choices over the exchange rate are implemented by the degree to which the monetary authorities target the evolution of official net international reserves. Net of choices over domestic debt issues (\( \Delta B \)), seigniorage (\( \Delta H \)) is the residual financing item which may, of course, be an intermediate policy target.\(^5\)

It may also be the case that the fiscal authority explicitly chooses to run a foreign reserve buffer as part of a strategy to smooth its own expenditure. In this case we can re-define (6.1) as

\[
(S_t - T^o_t) - E_t \Delta F_t + \Delta NIR^C_t = DF_t = \Delta H_t + \Delta B_t - \Delta NIR^C_t
\]

where the superscripts \( G \) and \( C \) denote reserve accumulation decisions exercised by the fiscal and monetary authorities respectively.

These fiscal and monetary choices necessarily feed back onto the evolution of the external balance which can be defined as
\[-\Delta NFA - \Delta NIR = CAD^{oo} - X^o\]  \hspace{1cm} (6.2)

where $CAD^{oo}$ is the non-oil current account deficit, $X^o$ represents net oil proceeds and $NFA$ private net foreign assets, and $NIR = NIR^G + NIR^C$. From (6.2), fiscal and monetary policy choices directly influence the contribution of official reserves to overall current account financing, which, in conjunction with the private sector’s decision on net foreign asset accumulation, determines the extent to which the oil inflow is absorbed into the domestic economy. The private sector’s portfolio choice, in other words their allocation of wealth between domestic bonds ($B$), foreign assets ($NFA$) and domestic assets ($H$), combined with the authorities’ decisions over the supply of domestic liquidity simultaneously determine the real interest rate, inflation expectations and the private capital account response to the oil windfall. These two choices play a central role in shaping the short-run macroeconomic response of the economy to the oil price surge.

### 6.3.2 Formal model structure

The model is a stylized short-run open economy model with currency substitution. On the consumption side, households (characterized here by a representative agent) consume tradable and non-tradable goods, with the composition of expenditure being determined by the real exchange rate, given the parameters governing the elasticity of substitution. Their net financial wealth is held in terms of three assets: domestic government debt, money and foreign currency. Importantly, however, neither the representative household nor the government are fully integrated into world capital markets. Hence, while the private sector can accumulate foreign currency, it does not have direct, unrationed access to world capital markets. Similarly, world capital markets have no appetite for Nigerian government debt. Domestic public debt, on the other hand, is marketed but, given the lack of openness of the official capital account, it is, in effect, non-tradable. These assumptions may not be wholly realistic, but are made to allow for two important features that do characterize the Nigerian economy. The first is that domestic interest rates are not tied down by interest parity conditions but rather will move with supply and demand conditions in domestic markets – which are in turn influenced by fiscal and monetary policy choices – and the second is that the private sector capital account will constitute an important channel for adjustment to oil windfalls.

The private sector’s naira money demand depends on its level of expenditure and the relative opportunity cost of holding domestic or foreign currency. The sensitivity of relative currency demand to these opportunity costs is an increasing function of the elasticity of currency substitution. Holding the nominal interest rate constant, an increase in expected exchange rate depreciation shifts desired portfolios in favour of foreign currency. The higher the elasticity of substitution between domestic and for-
eign money for any given change in relative returns, the stronger the desired portfolio reallocation and therefore the greater the pressure on the nominal exchange rate in response to shocks. We do not have any reliable empirical estimates of the size of this parameter for Nigeria, or indeed for other African countries, and so in this chapter we set this elasticity at around the mid-range values from the evidence on Latin American and other emerging markets. Given the calibration values used in the model, this implies an inflation elasticity of the demand for money of around 0.45.

Output consists of three forms: a non-tradable good, oil, and non-oil tradable output; although, for Nigeria, this third component represents a relatively small share of total production. Prices for tradable goods (on the production and consumption sides) are determined in world markets, while for non-tradables we allow for some price stickiness (Calvo, 1983).

The model is designed to consider issues of short-run volatility rather than longer-term response to sustained oil price surges. Hence, as we describe below, we examine the response of the economy to only the temporary component of oil price movements. The model does not concern itself with the medium-term evolution of the economy in response to sustained oil price increases. Specifically, we do not consider the supply-side response to the oil windfall. Thus, the volume of tradable output is fixed, although the sticky-price assumption means non-tradable output is demand determined.

6.3.3 Oil shocks and policy responses
We use this model to examine the properties of alternative responses to oil price volatility holding constant all other sources of short-run macroeconomic volatility. In reality, the relevant volatility is in the value of oil proceeds which combine variations in production and exports with variations in the world price for Nigerian oil. In the interests of simplicity, however, we assume that the volume of oil output is constant and that all volatility arises from variations in the oil price. To focus attention on short-run volatility we represent the evolution of the oil price in terms of the following first-order autoregression:

\[
(p_{oil} - \tilde{p}_{oil})_t = \gamma_0 + \gamma_1(p_{oil} - \tilde{p}_{oil})_{t-1} + \epsilon_t
\]

(6.3)

where \( p_{oil} \) is the log of the world price for Nigerian Forcados crude oil in constant US dollars, and \( \tilde{p}_{oil} \) represents a smoothed stochastic trend estimated using the Hodrick–Prescott filter. The key estimated parameters are \( \hat{\epsilon}_t \), the size of the oil shock relative to trend, and \( \hat{\gamma}_1 \), its persistence over time. Equation (6.3) is estimated on quarterly data from 1980(Q1) to 2005(Q4). The fitted trend and residual are shown in Figure 6.2. From the estimation we obtain a mean price shock of approximately 12.5 per cent and a persistence parameter of approximately 0.65. Given the share of
oil in total government revenue, this translates into a revenue shock of just under 3.7 per cent of total revenue per quarter.

Other parameters calibrating the model to the key structural characteristics of the Nigerian economy are based on data for the period 2000–2004 so as to reflect the structure of the economy prior to the most recent oil price surge. Details of these parameters are provided in Appendix Table 6.A1.

### 6.3.4 Fiscal and monetary rules

Our fiscal and monetary policy rules abstract from much of the detail of institutional structures in Nigeria but are sufficiently rich to reflect the principal macroeconomic choices confronting fiscal and monetary authorities. Given our concern with domestic financing we focus on the consolidated budget. On the revenue side we treat all non-oil sources of revenue as constant so that oil revenue is the only source of revenue volatility. Choices are more varied on the expenditure side. First, we assume the fiscal authorities can choose either to fully spend the oil revenue windfall or to save some portion of it. Specifically when oil revenues move above their long-run mean, a portion of the increase may be devoted to reducing the government’s domestic financing needs; this we refer to as the deficit-reducing (dr) component of the windfall. In the experiments reported below, we allow this saving to account for up to a quarter of the windfall. Second, and in addition, the fiscal authorities may also run an explicit fiscal reserve programme aimed at smoothing the path of government expenditure relative to the path of the windfall. This may be for conventional con-
sumption-smoothing reasons or to avoid short-run ‘construction boom’ effects. This expenditure smoothing is achieved through direct reserve accumulation on the part of the fiscal authorities through the operation of a ‘reserve account’. In the face of an oil surge the government spends each period a constant fraction, $\mu$, of the balance in the reserve account which consists of the opening balance in the account plus the windfall revenue accruing during the period:

$$g_t = \mu W_t = \mu [W_{t-1} + (1 - dr)\tau^o_t]$$  \hspace{1cm} (6.4)

where $g_t$ is government expenditure, $\tau^o_t$ is the revenue value of the oil windfall, $dr$ is the proportion of the windfall devoted to reducing the domestic deficit, and $W_t$ is the reserve account. As $\mu \to 1$ the profile of expenditure matches that of the windfall. In the simulations reported below we fix $\mu = 0.5$. Given the estimated persistence of the oil price shock of 0.65, the half-life of the typical shock is just over one year, with 82 per cent of the windfall being received within four years. With $\mu = 0.5$, the half-life of spending is just over two years with only 68 per cent of the windfall being spent within four years. A value of $\mu = 0.25$ would increase the half-life of spending to almost four years. From a financing perspective, smoothing is different from deficit reduction since eventually the full value of the oil windfall is translated into spending. Smoothing alters the time-profile of spending and domestic deficit financing but not the present value; deficit reduction alters the present value. In terms of the simulations reported below, it is the latter that has the stronger impact on the path of domestic financing and hence the dynamics of inflation and the exchange rate.

The third dimension of expenditure choices concerns the composition of spending. We distinguish three alternatives. At one extreme – our reference simulations – we represent spending as consisting of a direct transfer to household by means of lump-sum transfers; this is, in effect, a version of the mechanism discussed by Sala-i-Martin and Subramanian (2003) with spending decisions out of the oil windfall fully aligned with the private sector’s preferences, including their desire to smooth consumption inter-temporally. At the other extreme we assume simple allocation rules under which public spending at the margin is allocated on a current-income basis between tradable and non-tradable goods. Under this characterization we consider the propensity to spend out of the windfall (net of any deficit reduction) to be unity and spending to be allocated between tradable to non-tradable goods in the ratio of 0.15 to 0.85.

These three fiscal settings provide the background to the monetary policy rules. In its current form our model is relatively simple and, in particular, does not afford an explicit role for the banking system. This means, amongst other things, that the full range of monetary policy instruments, particularly the use of reserve requirements or statutory deposit instruments and other quantity-based instruments, cannot be investigated. Hence monetary policy choices centre on the Central Bank’s transactions in
foreign exchange and in government securities. Foreign exchange interventions can be summarized in the following reaction function:

$$\Delta z_{t-1} = -z_1 \cdot \hat{E}_t + z_2 \cdot dr \cdot \tau_t^0 - z_3 \cdot (z_{t-1} - z_0),$$

(6.5)

where $z_0$ is the initial steady-state level of official reserves under the management of the Central Bank and $\hat{E}_t$ the rate of depreciation of the nominal exchange rate. The parameters $z_1$ and $z_3$ govern the degree of commitment to the steady-state rate of crawl, which is tied down by the long-run inflation rate, and the speed with which intervention is eventually unwound. As $z_1 \to \infty$ and $z_3 \to 0$, the regime approaches a predetermined crawl. 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.\(^8\) The term $z_2$ allows the Central Bank to tie foreign exchange sales directly to the time path of windfall-induced government spending. A policy of $z_2 = 1$ and $z_1 = 0$ corresponds to the buffer-plus-float strategy in which the Central Bank sells the oil revenue proceeds in the precise amount required to finance the domestic currency value of windfall-induced spending, while the $dr$ component is then accumulated as reserves. Lower values of $z_2$ induce smaller foreign exchange sales and greater reserve accumulation, implying faster expansion of the monetary base, other things being equal.\(^9\)

In addition, the Central Bank can engage in open market operations in the domestic bond markets. Bond operations are described by the following reaction function:

$$p_t \Delta b_t^p = b_1 \Delta j_t + b_2 \cdot dr \cdot \tau_t^0 + b_3 \cdot p_t (\bar{b}^p - b_{t-1}^p),$$

(6.6)

where $j$ denotes the sum of reserves under the management of the fiscal authorities ($W$) and the Central Bank itself ($z$). For $b_1 > 0$, bond operations are used to offset a portion of the impact of foreign exchange intervention on the monetary base, while for $b_2 > 0$ with $z_2 = 1$, intervention is used to sterilize the effect of the accumulation of reserves against the savings of government, whereas a strategy of $b_2 > 0$ with $z_2 = 1$ represents a reverse sterilization or debt buy-back operation.\(^10\)

Both foreign exchange operations and bond operations are unwound over time, at rates determined by $z_2$ and $b_2$. These ensure that reserves eventually return to their original steady-state level, so that oil windfalls are ultimately fully absorbed regardless of the values of $z_1$, $z_2$ 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.
6.4 Results

6.4.1 Core results: impulse response functions

We begin by presenting a simple set of reference runs against which later analysis can be evaluated. Table 6.1 reports the impulse response functions for a one-time positive shock to the oil price under three alternative exchange rate rules. In doing so, we emphasize the effect of fiscal saving. In the first case, reported in panels A and B, we assume that the proceeds of the oil windfall are fully spent – but not ‘overspent’ – as and when they arrive. Government expenditure therefore follows, naira for naira, the rise and fall in oil revenues over the duration of the shock. In this base case, government spending is in the form of direct transfers to the representative private agent. In the second case, reported in panels C, D and E, we assume that the fiscal authorities use one quarter of the windfall revenue to reduce the demands on domestic deficit financing. In the context of equation (6.1) therefore, panels A and B correspond to the case where \( DF \) is unchanged, at least directly, while panels C, D and E correspond to the case where \( DF \) falls.

Two preliminary points should again be stressed. First, the model is stationary. The oil price shock is temporary and the economy reverts eventually to its initial equilibrium. Second, and related, the exchange rate regime is neutral in the long-run even though each has different short-run implications and different implications for the out-of-steady-state volatility of the economy. These are design choices allowing us to focus on short-run, day-to-day, monetary management issues. But they mean that we do not engage with issues of the medium-term response to persistent surges in the oil price, including questions of optimal oil extraction, investment behaviour, the long-run fiscal stance, and hence movements in the long-run equilibrium real exchange rate. All these features are subsumed in our ‘steady state’ equilibrium.

With these ideas in place, we can turn to what our results do say. The first substantive point from Table 6.1 is that when the oil revenue is fully spent, and spent in line with optimal private sector consumption smoothing considerations (panels A and B), the real adjustment is relatively modest: the real exchange rate appreciates by between 4.3 and 5.5 per cent on impact while consumption rises by between 3.5 and 4 per cent on impact before adjusting smoothly to its original steady state level. The contrast is on the nominal side: under the float, the real exchange rate appreciation is achieved by a combination of a nominal exchange rate appreciation (of around 4 percentage points on impact) and an initial fall in inflation (of around 1 percentage point). Under the crawl, by contrast, given the stability of the nominal exchange rate relative to its steady state path, the appreciation requires a small transitory increase in inflation of around 2.3 per cent. In other respects there are no significant differences between the two adjustment paths: in both cases they describe an efficient adjustment to a temporary positive shock, with both consumption \( (C) \) and the current account
balance \((ca)\) rising and the real interest rate falling on impact and adjusting relatively smoothly back towards their equilibrium values.

Matters change when the fiscal authorities choose to use some of the proceeds of the windfall to reduce the domestic financing requirement of the budget deficit. This fiscal adjustment has two effects. The first is that the stronger savings response strengthens the real exchange rate appreciation. But, second, the change in the fiscal stance entails a sharp contraction in base money which, in turn, induces a drop in expected inflation and increases the demand for domestic money relative to foreign currency, depending of course on the strength of the inflation elasticity of the demand for money. Under a floating exchange rate, however, this shift in the private sector’s portfolio – away from foreign currency and towards domestic – occurs against a background where the Central Bank does not intervene to alter relative supplies of domestic and foreign currency: the entire portfolio adjustment must therefore take place through the nominal exchange rate. As panel C indicates, the nominal exchange rate appreciation required to facilitate the desired portfolio adjustment is greater than the real appreciation required to absorb the windfall. As a result, both the nominal and real exchange rates overshoot which, with sticky prices, means that the non-traded goods sector experiences a sharp demand-switching recession.

The contrast with strategies that involve greater intervention is sharp. In terms of smoothing short-run volatility, of inflation, the exchange rate, output and interest rates, an aggressive crawl dramatically outperforms the clean float in this instance (panel D). In part this is because the intervention allows the desired portfolio adjustment to take place through quantity rather than price adjustment but, more importantly, because the intervention serves to limit the deviation of expected inflation from its long-run value and hence forestalls the short-run portfolio switching that so dominated outcomes under the float. How large this distinction is between a pure float and a crawl depends crucially on the underlying elasticity of demand for money with respect to expected inflation.

In practice, both the pure float and the aggressive crawl are polar extremes. In the final panel of Table 6.1 we consider a useful benchmark case which we refer to as a buffer-plus-float. In this instance, the monetary authorities accumulate reserves against that proportion of windfall allocated for deficit reduction but otherwise maintain a floating exchange rate regime. This strategy, which probably comes closer to actual practice than either of the other two rules, does not target the path of the exchange rate directly as in the crawl, and hence exhibits rather more inflation and exchange rate volatility, but nonetheless attacks the principal source of the volatility under the pure float, namely the sharp short-run contraction in base money growth brought about by the fiscal saving decision. Under this rule, however, intervention is significantly less aggressive than required to stabilize the path of the nominal exchange rate and inflation so that out-turns, for the parameters used here, lie somewhere closer to the float than the crawl.
Table 6.1  Impulse responses to a 12.5 per cent positive shock to oil prices

<table>
<thead>
<tr>
<th>Period (quarters)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil revenue (% of total revenue)</td>
<td>3.70</td>
<td>2.41</td>
<td>1.57</td>
<td>1.02</td>
<td>0.66</td>
<td>0.43</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Panel A: Clean float, oil windfall fully spent

<table>
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<tr>
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<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>−1.06</td>
<td>−0.96</td>
<td>−1.53</td>
<td>−1.64</td>
<td>−1.52</td>
<td>−1.31</td>
<td>−0.09</td>
</tr>
<tr>
<td>Nominal exchange rate(^b)</td>
<td>−4.10</td>
<td>−0.94</td>
<td>−1.16</td>
<td>−1.20</td>
<td>−1.09</td>
<td>−0.93</td>
<td>−0.06</td>
</tr>
<tr>
<td>Real exchange rate(^b)</td>
<td>−5.53</td>
<td>−5.49</td>
<td>−4.83</td>
<td>−4.03</td>
<td>−3.24</td>
<td>−2.59</td>
<td>−0.13</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>−1.10</td>
<td>−1.20</td>
<td>−1.19</td>
<td>−1.06</td>
<td>−0.89</td>
<td>−0.73</td>
<td>−0.04</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>0.54</td>
<td>0.17</td>
<td>0.04</td>
<td>−0.02</td>
<td>−0.04</td>
<td>−0.05</td>
<td>−0.01</td>
</tr>
<tr>
<td>Current account</td>
<td>1.72</td>
<td>0.62</td>
<td>0.05</td>
<td>−0.22</td>
<td>−0.33</td>
<td>−0.34</td>
<td>−0.03</td>
</tr>
<tr>
<td>Private spending</td>
<td>4.05</td>
<td>3.53</td>
<td>2.96</td>
<td>2.39</td>
<td>1.89</td>
<td>1.46</td>
<td>0.07</td>
</tr>
<tr>
<td>Official reserves</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Panel B: Crawl, oil windfall fully spent

<table>
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<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>2.26</td>
<td>0.08</td>
<td>−0.48</td>
<td>−0.68</td>
<td>−0.76</td>
<td>−0.78</td>
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</tr>
<tr>
<td>Nominal exchange rate(^b)</td>
<td>−0.15</td>
<td>−0.17</td>
<td>−0.22</td>
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<td>−0.38</td>
<td>−0.45</td>
<td>−0.44</td>
</tr>
<tr>
<td>Real exchange rate(^b)</td>
<td>−4.38</td>
<td>−4.84</td>
<td>−4.36</td>
<td>−3.67</td>
<td>−2.98</td>
<td>−2.38</td>
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</tr>
<tr>
<td>Real interest rate</td>
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<td>−1.01</td>
<td>−0.99</td>
<td>−0.91</td>
<td>−0.78</td>
<td>−0.65</td>
<td>−0.05</td>
</tr>
<tr>
<td>Non-tradable output</td>
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<td>0.20</td>
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<td>0.01</td>
<td>0.00</td>
<td>−0.01</td>
<td>−0.01</td>
</tr>
<tr>
<td>Current account</td>
<td>1.95</td>
<td>0.81</td>
<td>0.18</td>
<td>−0.13</td>
<td>−0.27</td>
<td>−0.31</td>
<td>−0.07</td>
</tr>
<tr>
<td>Private spending</td>
<td>3.69</td>
<td>3.18</td>
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<td>2.22</td>
<td>1.79</td>
<td>1.42</td>
<td>0.13</td>
</tr>
<tr>
<td>Official reserves</td>
<td>2.02</td>
<td>0.42</td>
<td>0.72</td>
<td>1.09</td>
<td>1.14</td>
<td>0.99</td>
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Table 6.1 Continued

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<th>Period (quarters)</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel C: Clean float, oil windfall partially spent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>-12.94</td>
<td>-4.49</td>
<td>-3.73</td>
<td>-2.98</td>
<td>-2.32</td>
<td>-1.78</td>
<td>-0.08</td>
</tr>
<tr>
<td>Nominal exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-17.41</td>
<td>-3.56</td>
<td>-3.01</td>
<td>-2.38</td>
<td>-1.82</td>
<td>-1.37</td>
<td>-0.06</td>
</tr>
<tr>
<td>Real exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-8.14</td>
<td>-6.45</td>
<td>-5.22</td>
<td>-4.14</td>
<td>-3.22</td>
<td>-2.46</td>
<td>-0.12</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-1.10</td>
<td>-1.46</td>
<td>-1.32</td>
<td>-1.10</td>
<td>-0.89</td>
<td>-0.70</td>
<td>-0.04</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>-0.55</td>
<td>-0.19</td>
<td>-0.15</td>
<td>-0.14</td>
<td>-0.12</td>
<td>-0.09</td>
<td>-0.01</td>
</tr>
<tr>
<td>Current account</td>
<td>1.49</td>
<td>0.51</td>
<td>0.03</td>
<td>-0.19</td>
<td>-0.28</td>
<td>-0.29</td>
<td>-0.03</td>
</tr>
<tr>
<td>Private spending</td>
<td>4.15</td>
<td>3.63</td>
<td>2.93</td>
<td>2.31</td>
<td>1.78</td>
<td>1.36</td>
<td>0.06</td>
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<tr>
<td>Official reserves</td>
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<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
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<tr>
<td><strong>Panel D: Crawl, oil windfall partially spent</strong></td>
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</tr>
<tr>
<td>Inflation</td>
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<td>-1.01</td>
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<td>-1.88</td>
<td>-1.96</td>
<td>-1.95</td>
<td>-1.10</td>
</tr>
<tr>
<td>Nominal exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.89</td>
<td>-1.25</td>
<td>-1.46</td>
<td>-1.58</td>
<td>-1.65</td>
<td>-1.68</td>
<td>-1.07</td>
</tr>
<tr>
<td>Real exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-3.73</td>
<td>-4.15</td>
<td>-3.78</td>
<td>-3.23</td>
<td>-2.69</td>
<td>-2.21</td>
<td>-0.36</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-0.97</td>
<td>-0.85</td>
<td>-0.82</td>
<td>-0.74</td>
<td>-0.64</td>
<td>-0.53</td>
<td>-0.05</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>0.73</td>
<td>0.19</td>
<td>0.06</td>
<td>0.01</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

<sup>a</sup> Impulse responses are reported as percentage points for inflation, the nominal and real rates and the interest rate. All other variables are measured as percentage point devations from steady state values. See Appendix Table 6.A1.

<sup>b</sup> An increase in the nominal and real exchange rate indices denotes a depreciation.
<table>
<thead>
<tr>
<th></th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current account</td>
<td>2.18</td>
<td>1.03</td>
<td>0.36</td>
<td>0.01</td>
<td>-0.17</td>
<td>-0.25</td>
<td>-0.10</td>
</tr>
<tr>
<td>Private spending</td>
<td>3.22</td>
<td>2.76</td>
<td>2.35</td>
<td>1.96</td>
<td>1.61</td>
<td>1.31</td>
<td>0.21</td>
</tr>
<tr>
<td>Official reserves</td>
<td>12.24</td>
<td>5.35</td>
<td>3.13</td>
<td>1.94</td>
<td>1.06</td>
<td>0.39</td>
<td>-1.03</td>
</tr>
</tbody>
</table>

**Panel E: Buffer plus float, oil windfall partially spent**

<table>
<thead>
<tr>
<th></th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>-5.44</td>
<td>-2.84</td>
<td>-2.31</td>
<td>-3.55</td>
<td>-2.69</td>
<td>-2.02</td>
<td>-0.08</td>
</tr>
<tr>
<td>Nominal exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-7.49</td>
<td>-2.61</td>
<td>-1.98</td>
<td>-2.95</td>
<td>-2.18</td>
<td>-1.61</td>
<td>-0.06</td>
</tr>
<tr>
<td>Real exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.45</td>
<td>6.44</td>
<td>5.27</td>
<td>4.18</td>
<td>3.24</td>
<td>2.48</td>
<td>0.12</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-1.61</td>
<td>-1.49</td>
<td>-1.30</td>
<td>-1.09</td>
<td>-0.88</td>
<td>-0.69</td>
<td>-0.04</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>-0.08</td>
<td>-0.09</td>
<td>-0.10</td>
<td>-0.08</td>
<td>-0.16</td>
<td>-0.11</td>
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</tr>
<tr>
<td>Current account</td>
<td>1.45</td>
<td>0.52</td>
<td>0.04</td>
<td>-0.19</td>
<td>-0.27</td>
<td>-0.28</td>
<td>-0.03</td>
</tr>
<tr>
<td>Private spending</td>
<td>4.37</td>
<td>3.61</td>
<td>2.89</td>
<td>2.28</td>
<td>1.76</td>
<td>1.34</td>
<td>0.06</td>
</tr>
<tr>
<td>Official reserves</td>
<td>7.72</td>
<td>2.32</td>
<td>1.87</td>
<td>1.23</td>
<td>0.80</td>
<td>0.52</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<sup>a</sup> Impulse responses are reported as percentage points for inflation, the nominal and real rates and the interest rate. All other variables are measured as percentage point deviations from steady state values. See Appendix Table 6.A1.

<sup>b</sup> An increase in the nominal and real exchange rate indices denotes a depreciation.
Exactly where this outcome lies is less important than the implications, two of which are worth stressing. The first is that the outcome is consistent with well-established views about efficient exchange rate responses to shocks which focus on the superiority of flexible exchange rates to current account (real) shocks and fixed or crawling rates to portfolio shocks. Although the originating shock in this case is a current account, terms-of-trade, shock, macroeconomic volatility stems from a portfolio shock arising from the change in expected inflation and seigniorage requirements. To the extent that the intervention element of the buffer-plus-float goes some way to smoothing the impact of deficit reduction choices on the path for future seigniorage requirements, the otherwise disruptive portfolio adjustment is allowed to take place more smoothly.

The second point is that, while the buffer-plus-float may not be quite as effective as the aggressive crawl in terms of limiting short-run instability, it is nonetheless consistent with another objective of the Central Bank, namely to promote a more market-based integrated foreign exchange rate. The buffer-plus-float strategy commits the Central Bank to intervene with respect solely to that portion of the oil windfall that is saved but to observe a float with respect to all other sources of volatility and, more specifically, to sterilize the liquidity injections arising from the spending out of the windfall through foreign exchange sales (that is, a float).

6.4.2 Extending the analysis

The results in Table 6.1 provide a valuable background which allows us to focus on some key aspects of the problem. In what follows, however, we consider a slightly wider range of policy options but in the interests of clarity we report only the most salient results. In doing so we forgo the detailed examination of the impulse response functions presented in Table 6.1 and report instead the volatility of the variables of interest.11

We start by considering two particular variations of the fiscal response. First we assume that the spending patterns out of the windfall are heavily biased towards non-tradable goods. Second, and possibly in response to this, we assume that the fiscal authorities seek to smooth the profile of aggregate spending relative to the windfall. Since it may not be reasonable to assume that this occurs at all levels of government, the degree of smoothing that can be achieved is taken to be relatively moderate. In particular we assume that pressures to spend mean that smoothing falls some long way short of a rule which would tie consumption to the permanent income arising from the windfall.

Spending and smoothing

Table 6.2 summarizes the effects of altering these fiscal choices where in this case, rather than focusing on the profile of a single shock, we report the implied analytical standard deviations from the simulated model. Comparing panel B with panel
A, two features stand out. The first is that the higher is the propensity to spend on non-tradables, the greater is the volatility in the real exchange rate, regardless of the nominal exchange rate regime. Although not reported in the table, the impact appreciation of the real exchange rate is almost twice as large as shown in Table 6.1. This differential behaviour is only partly related to the assumption that government has a stronger baseline preference for non-tradables per se. Rather it reflects the difference between ‘rule-based’ characterization of public expenditure and the extent to which this differs from the private sector’s spending decisions which entail an efficient alteration of the composition of spending, both inter-sectorally and inter-temporally in response to a temporary income windfall. A similar pattern of response emerges even if we assume that the public sector’s spending at the margin is biased towards the tradable sector. The message, therefore, is that rule-based ‘myopic’ public spending behaviour generates higher real exchange rate volatility than if the spending decision out of the windfall were handled by an optimizing private sector representative agent. The second feature of panel B is that the switch in demand at the margin towards non-tradables eases the up-front deflationary pressure that otherwise is present in Table 6.1 and hence reduces the inflation and nominal exchange rate volatility. Hence the benefits of intervention relative to the float are somewhat weakened although, as the evidence from the last three columns suggests, the pressures arising from the portfolio adjustment when the windfall is partly used for deficit reduction remain significant.

Aggregate expenditure smoothing on the part of the fiscal authorities also eases the pressure on monetary policy and narrows the gap between the exchange rate rules (Table 6.2, panel C). However, given the modest degree of smoothing considered in our experiments these effects are not dramatic and certainly not sufficient on their own to remove the instability caused by the effect of latent pressures for portfolio adjustment.

**Bond sterilization and debt buy-backs**

When exchange rate rules embody intervention it is common practice to consider issues of bond sterilization. The logic is simple: intervention implies a growth in net foreign assets relative to the counterfactual and hence, other things being equal, a growth in base money. This is certainly the case in debates on managing aid inflows (see, for example, IMF 2005a) and would appear to be a perennial concern in Nigeria (IMF 2005b). However, as Table 6.1 indicates, when an oil windfall is accompanied by a significant fiscal savings response, base money actually contracts in nominal terms relative to the counterfactual. The conventional rationale for bond sterilization does not seem quite so relevant here since non-sterilized intervention delivers a smooth path for base money as well as delivering a fair degree of stability in inflation and the exchange rate. Indeed as the first two columns of Table 6.3, panel A, indicate, additional bond sterilization, in this case equivalent to 50 per cent of the intervention,
### Table 6.2  Standard deviations under alternative fiscal and monetary rules: responses to a 12.5 per cent shock to oil prices

<table>
<thead>
<tr>
<th>Period (quarters)</th>
<th>Windfall fully spent</th>
<th>Windfall partially spent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Float</td>
<td>Crawl</td>
</tr>
<tr>
<td><strong>Panel A: Standard deviations from Table 6.1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>3.76</td>
<td>3.54</td>
</tr>
<tr>
<td>Nominal exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.90</td>
<td>2.14</td>
</tr>
<tr>
<td>Real exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.24</td>
<td>9.94</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>2.70</td>
<td>2.39</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>0.58</td>
<td>0.81</td>
</tr>
<tr>
<td>Current account</td>
<td>1.97</td>
<td>2.24</td>
</tr>
<tr>
<td>Private spending</td>
<td>7.20</td>
<td>6.66</td>
</tr>
<tr>
<td>Official reserves</td>
<td>0.00</td>
<td>3.31</td>
</tr>
<tr>
<td><strong>Panel B: Expenditure biased towards non-tradables</strong></td>
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<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>4.89</td>
<td>5.93</td>
</tr>
<tr>
<td>Nominal exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.94</td>
<td>0.76</td>
</tr>
<tr>
<td>Real exchange rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>19.87</td>
<td>19.57</td>
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<sup>a</sup> Standard deviations measured as percentage points.

<sup>b</sup> An increase in the nominal and real exchange rate indexes denotes a depreciation.
<table>
<thead>
<tr>
<th></th>
<th>Float</th>
<th>Crawl</th>
<th>Float</th>
<th>Crawl</th>
<th>Buffer plus float</th>
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<td>3.54</td>
<td>14.93</td>
<td>6.87</td>
<td>9.22</td>
</tr>
<tr>
<td>Nominal exchange rate</td>
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<td>18.40</td>
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<td>10.93</td>
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<tr>
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<td>13.28</td>
<td>8.86</td>
<td>10.91</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>2.70</td>
<td>2.39</td>
<td>2.87</td>
<td>2.01</td>
<td>3.09</td>
</tr>
<tr>
<td>Non-tradable output</td>
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<td>0.81</td>
<td>0.64</td>
<td>0.76</td>
<td>0.40</td>
</tr>
<tr>
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<td>1.70</td>
<td>2.55</td>
<td>1.77</td>
</tr>
<tr>
<td>Private spending</td>
<td>7.20</td>
<td>6.66</td>
<td>7.18</td>
<td>5.93</td>
<td>7.27</td>
</tr>
<tr>
<td>Official reserves</td>
<td>0.00</td>
<td>8.63</td>
<td>0.00</td>
<td>16.65</td>
<td>8.43</td>
</tr>
</tbody>
</table>

**Panel B: Expenditure biased towards non-tradables**

<table>
<thead>
<tr>
<th></th>
<th>Float</th>
<th>Crawl</th>
<th>Float</th>
<th>Crawl</th>
<th>Buffer plus float</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>4.89</td>
<td>5.93</td>
<td>10.58</td>
<td>7.23</td>
<td>8.03</td>
</tr>
<tr>
<td>Nominal exchange rate</td>
<td>2.94</td>
<td>0.76</td>
<td>16.19</td>
<td>5.13</td>
<td>12.36</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>19.87</td>
<td>19.57</td>
<td>19.87</td>
<td>15.95</td>
<td>17.49</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>1.21</td>
<td>0.92</td>
<td>1.20</td>
<td>0.79</td>
<td>1.12</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>1.89</td>
<td>2.29</td>
<td>0.50</td>
<td>1.85</td>
<td>0.96</td>
</tr>
<tr>
<td>Current account</td>
<td>1.99</td>
<td>1.93</td>
<td>1.72</td>
<td>2.31</td>
<td>1.68</td>
</tr>
<tr>
<td>Private spending</td>
<td>3.29</td>
<td>3.18</td>
<td>4.09</td>
<td>3.34</td>
<td>3.85</td>
</tr>
<tr>
<td>Official reserves</td>
<td>0.00</td>
<td>8.63</td>
<td>0.00</td>
<td>16.65</td>
<td>8.43</td>
</tr>
</tbody>
</table>

**Panel C: As Panel B with fiscal smoothing**

<table>
<thead>
<tr>
<th></th>
<th>Float</th>
<th>Crawl</th>
<th>Float</th>
<th>Crawl</th>
<th>Buffer plus float</th>
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</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>2.24</td>
<td>3.82</td>
<td>12.57</td>
<td>6.36</td>
<td>7.68</td>
</tr>
<tr>
<td>Nominal exchange rate</td>
<td>3.89</td>
<td>0.97</td>
<td>17.33</td>
<td>5.36</td>
<td>8.55</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>18.42</td>
<td>17.97</td>
<td>18.46</td>
<td>14.86</td>
<td>9.07</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>0.95</td>
<td>1.05</td>
<td>1.14</td>
<td>0.96</td>
<td>1.49</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>0.64</td>
<td>1.11</td>
<td>0.58</td>
<td>0.98</td>
<td>0.24</td>
</tr>
<tr>
<td>Current account</td>
<td>2.76</td>
<td>2.73</td>
<td>2.29</td>
<td>2.91</td>
<td>2.26</td>
</tr>
<tr>
<td>Private spending</td>
<td>2.96</td>
<td>2.92</td>
<td>3.84</td>
<td>3.16</td>
<td>3.91</td>
</tr>
<tr>
<td>Official reserves</td>
<td>0.00</td>
<td>7.98</td>
<td>0.00</td>
<td>17.27</td>
<td>8.43</td>
</tr>
</tbody>
</table>

*a* Standard deviations measured as percentage points.

*b* An increase in the nominal and real exchange rate indices denotes a depreciation.
Table 6.3  Standard deviations and impulse responses with bond sterilization: responses to a 12.5 per cent shock to oil prices

<table>
<thead>
<tr>
<th></th>
<th>Windfall fully spent</th>
<th>Windfall partially spent</th>
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<tbody>
<tr>
<td></td>
<td>Crawl</td>
<td>Crawl with debt buyback</td>
</tr>
<tr>
<td>Inflation</td>
<td>3.27</td>
<td>9.04</td>
</tr>
<tr>
<td>Nominal exchange rate(^{b})</td>
<td>1.94</td>
<td>8.31</td>
</tr>
<tr>
<td>Real exchange rate(^{b})</td>
<td>9.91</td>
<td>9.07</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>2.28</td>
<td>2.36</td>
</tr>
<tr>
<td>Non-tradable output</td>
<td>0.78</td>
<td>0.84</td>
</tr>
<tr>
<td>Current account</td>
<td>2.30</td>
<td>2.29</td>
</tr>
<tr>
<td>Private spending</td>
<td>6.60</td>
<td>6.24</td>
</tr>
<tr>
<td>Official reserves</td>
<td>5.93</td>
<td>7.78</td>
</tr>
<tr>
<td>Public debt</td>
<td>6.19</td>
<td>40.13</td>
</tr>
</tbody>
</table>

\(^{a}\) See Tables 6.1 and 6.2.  
\(^{b}\) Debt buyback equivalent to 50 per cent of the saving out of the oil windfall.
### Panel B: Impulse response functions with reverse sterilization

<table>
<thead>
<tr>
<th>Period (quarters)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil revenue (% of total revenue)</td>
<td>3.70</td>
<td>2.41</td>
<td>1.57</td>
<td>1.02</td>
<td>0.66</td>
<td>0.43</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Crawl, oil windfall partially saved, no sterilization [Table 1, Panel D]**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>1.15</td>
<td>-1.01</td>
<td>-1.66</td>
<td>-1.88</td>
<td>-1.96</td>
<td>-1.95</td>
<td>-1.10</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>-3.73</td>
<td>-4.15</td>
<td>-3.78</td>
<td>-3.23</td>
<td>-2.69</td>
<td>-2.21</td>
<td>-0.36</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-0.97</td>
<td>-0.85</td>
<td>-0.82</td>
<td>-0.74</td>
<td>-0.64</td>
<td>-0.53</td>
<td>-0.05</td>
</tr>
<tr>
<td>Private spending</td>
<td>3.22</td>
<td>2.76</td>
<td>2.35</td>
<td>1.96</td>
<td>1.61</td>
<td>1.31</td>
<td>0.21</td>
</tr>
</tbody>
</table>

**Crawl, oil windfall partially saved, reverse sterilization**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>-0.06</td>
<td>-1.67</td>
<td>-2.06</td>
<td>-2.09</td>
<td>-1.99</td>
<td>-1.83</td>
<td>-0.58</td>
</tr>
<tr>
<td>Real exchange rate</td>
<td>-4.17</td>
<td>-4.24</td>
<td>-3.97</td>
<td>-3.44</td>
<td>-3.05</td>
<td>-2.61</td>
<td>-0.38</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-0.31</td>
<td>-0.38</td>
<td>-0.53</td>
<td>-0.57</td>
<td>-0.56</td>
<td>-0.51</td>
<td>-0.03</td>
</tr>
<tr>
<td>Private spending</td>
<td>3.76</td>
<td>3.22</td>
<td>2.75</td>
<td>2.06</td>
<td>1.78</td>
<td>1.51</td>
<td>0.33</td>
</tr>
</tbody>
</table>

a, b See Tables 6.1 and 6.2.
c Debt buyback is equivalent to 50 per cent of the saving out of the oil windfall.
delivers a marginal reduction in real exchange rate volatility but at the cost of somewhat higher price, exchange rate and interest rate volatility. Public debt management for the purpose of sterilization, therefore, does not appear to have substantial gains.

Looked at from the other side, however, this analysis suggests that there may be important gains to reverse sterilization in such circumstances. As the lower panel of Table 6.3 shows, our simple short-run model suggests that a debt buy-back may lead to a marginally stronger short-run real exchange rate appreciation but this is set off against a lower real interest rate trajectory over the lifetime of the shock. With no explicit modelling of the supply side of the economy, the real interest rate in this model serves solely as the relative price between present and future consumption. The lower path for the real interest rate therefore serves to ‘tilt’ consumption towards the present. However, in a medium model in which investment figures, the same profile represents an incentive to invest. The debt buy-back in this instance corresponds directly to the proposal advanced by Collier and Gunning (2005) and discussed in Chapter 2.

Using a temporary oil windfall to finance a debt buy-back may be attractive for other reasons. Buffie et al. (2006) consider the analogous case using (part of) an aid surge to finance a domestic debt buy-back in circumstances where government commitments to reduce public spending once the aid inflow has passed are less than fully credible. A fear of higher future domestic deficits reduces the private sector’s willingness to increase its current demand for money and increases its incentives to resort to capital flight, thereby unwinding the benefits from the aid inflow. In these circumstances, a debt buy-back provides the government extra time to adjust expenditure as the boom passes since the Central Bank can resell the bonds in the future to control the temporary growth in domestic credit to government that will occur if the fiscal authorities struggle to realign expenditures with the new lower level of aid. The debt buy-back by the Central Bank in anticipation of a future surge in domestic deficit financing thus provides the mechanism to quell the private sector’s pessimistic expectations concerning future financing. A directly analogous situation faces the Central Bank in Nigeria. Oil revenue is volatile and government commitments to fully align expenditure to future revenues are rarely fully credible (even in the presence of institutions such as the FRB). Monetary policy alone cannot solve the credibility problem but, with a suitable degree of fiscal discipline, can help to contain it.

6.5 Conclusions

In the last few years, Nigeria has taken important steps to building solid foundations for effective macroeconomic management of oil revenues. While a coherent monetary policy will always require a compatible fiscal stance, demonstrable success in monetary management in current circumstances when a substantial measure of fiscal
control does prevail can fuel its own virtuous circle, allowing the Central Bank’s de facto independence to be enhanced and inflation expectations to be more firmly anchored in the future.

The credibility of monetary policy must be established across a range of issues and in the face of volatility from a variety of sources. In this chapter, we have focused on one particular aspect of the challenge facing the Central Bank, by examining the properties of a range of alternative strategies for exchange rate intervention and bond sterilization in the face of volatile oil revenues. Our analysis suggests that strategies that stabilize the path of domestic financing for a given fiscal response to the oil windfall have attractive properties relative to a range of conventional alternatives including those involving heavy reliance on bond sterilization and variants of a pure float. This is particularly the case if the fiscal authorities seek to save some portion of the windfall. Efficient alignment can be achieved by simple rules that match foreign exchange sterilization (that is, floating) directly to fiscal spending of the windfall while banking the unspent portion. However, an aggressive crawl aimed at keeping the rate of nominal exchange rate depreciation close to the long-run inflation target (a variant of a real exchange rate target) turns out to be rather more effective at reducing short-run real and nominal volatility. The attractive features of the crawl in this specific instance may, however, be over-sold if, in addition to targeting macroeconomic volatility, the authorities are also concerned to develop the structural performance of domestic finance markets by promoting greater market-based exchange rate determination.

The second main message is that the conventional case for domestic bond sterilization may need to be modified, particularly when a reasonable degree of fiscal discipline is in place. The combination of income growth and a reduction in expected inflation arising from fiscal consolidation serve to increase the demand for domestic money thereby warranting the growth in base money arising from growth in official net international reserves. By contrast, however, there may be a stronger case for reverse sterilization either as a means to stimulate private investment or as a way of providing some insurance against future deficit financing demands.

The research and policy agendas considered in this chapter are far from exhausted. Critically, the results and insights discussed here are model based and, as with all such exercises, are sensitive to underlying assumption. Although we are confident that the assumptions made throughout this chapter are sensible, good practice obviously demands that these be tested for robustness. Notwithstanding, the model used here can be extended in a number of directions as circumstances dictate. For example, it will be useful to examine the robustness of the simple policy rules as financial sector reforms take root and the private sector’s asset demands evolve. Similarly for changes in fiscal structures and policies. The framework can also be readily extended to allow the authorities to be confronted by additional sources of volatility, for
example climate-induced variability in agricultural output. Finally, the model could eventually be modified to reflect operating concerns as the authorities move closer to flexible inflation targeting.

Notes

1 This chapter draws heavily on joint work with Stephen O’Connell, Ed Buffie and Catherine Pattillo (see, for example, Adam et al., 2006, Buffie et al., 2006, and O’Connell et al., 2006). We fully acknowledge our substantial debts to all three but stress that any remaining errors of commission and omission are our own responsibility. We thank participants at the Abuja conference for valuable comments on an earlier draft of this chapter. We also acknowledge the support of the UK Economic and Social Research Council (ESRC) under project RES-156-25-0001 Managing Macroeconomic Risks in Developing Countries: Policies and Institutions.

2 See for example IMF (2004, 2005b) and Central Bank of Nigeria (2006). It is clear from these reports that both the authorities and the IMF have been particularly exercised with the appropriate response to ‘excess’ spending out of oil windfalls and in particular how aggressively the authorities should seek to mop up excess liquidity through the domestic debt market.

3 Direct spending on imports is self-sterilizing and hence has no impact on the domestic deficit financing requirements of government.

4 A version of this model is also described in Adam et al. (2006).

5 We do not distinguish between bank and non-bank holdings of money which precludes a consideration of the role of reserve requirements as an instrument of monetary policy.

6 Nonetheless, these short-run shocks themselves are persistent.

7 Note that since we work with the consolidated budget this is an aggregate rate of fiscal saving and is consistent with differential rates of saving by state and federal levels of government.

8 The intervention equation can also be defined in terms of the real exchange rate. Issues of real exchange rate targeting are important elements in the current discussion.

9 Until the oil revenue is spent the windfall has no impact on seigniorage, because net international reserves and net oil proceeds each change by the same amount. As the windfall revenue 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 the oil windfall corresponds to the non-import component of windfall spending. A buffer-plus-float policy uses foreign exchange sales to sterilize this in full, leaving seigniorage unchanged.

10 An alternative, broadly equivalent, formulation of the sterilization rule would link sterilization directly to the growth rate of domestic liquidity rather than the level of intervention.

11 These volatilities (standard deviations) correspond to the analytical standard deviations of the model variables when the model is subjected to a sequence of oil shocks of the form analysed in Table 6.1. A complete set of results is available on request.
References


Buffie, Edward, Christopher Adam, Stephen O’Connell and Catherine Pattillo, 2006, ‘Fiscal Inertia, Donor Credibility and the Monetary Management of Aid Surges’, mimeo, Department of Economics, Indiana University, Bloomington, IN.


Appendix Table 6.A1  Model calibration values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-tradable share (% private spending)</td>
<td>50.0</td>
</tr>
<tr>
<td>Private spending (% GDP)</td>
<td>77.0</td>
</tr>
<tr>
<td>Official reserves (% GDP)</td>
<td>12.0</td>
</tr>
<tr>
<td>Foreign currency (% GDP)</td>
<td>8.0</td>
</tr>
<tr>
<td>Domestic currency (% GDP)</td>
<td>17.0</td>
</tr>
<tr>
<td>Domestic debt (% GDP)</td>
<td>20.0</td>
</tr>
<tr>
<td>Real interest rate (% per annum)</td>
<td>5.0</td>
</tr>
<tr>
<td>Inflation (% per annum)</td>
<td>10.0</td>
</tr>
</tbody>
</table>

**Implied values**

| Nominal interest rate (% per annum)          | 15.5   |
| Inflation elasticity of money demand         | 0.45   |