CHAPTER 10

Managing Oil Revenue Volatility in Nigeria: The Role of Fiscal Policy

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Not since the 1979–80 oil price hikes have oil prices been so high above historical averages for so long. Moreover, available forecasts indicate that this latest price boom, which started in 2000, could persist for another five to seven years beyond the time of writing. This boom presents oil-exporting countries with a unique opportunity to remedy what has been labeled the "resource curse." International evidence suggests this is not an easy challenge: resource-rich countries are characterized by slow or stagnating growth, de-industrialization, low savings, lagging human and physical capital accumulation, and stagnating or declining productivity.

Manzano and Rigobon (2001) have suggested a link between debt problems and slow growth in resource-rich countries, but have not identified the specific channels through which this link operates. Indeed, in spite of their resource wealth, a large number of resource-rich countries remain classified by the World Bank as severely indebted countries with high levels of external debt making them vulnerable to exchange rate fluctuations induced by volatile resource prices.[1] Public indebtedness also tends to be high in oil-exporting countries, and a substantial number of them have run into debt problems (for example, Angola, Chad, Ecuador, Iraq, Mexico, the Russian Federation, Sudan, the República Bolivariana de Venezuela, and the Republic of Yemen), mostly when oil prices were in decline but some even in boom periods. Budina, Pang, and van Wijnbergen (2007) have provided econometric evidence showing that the volatility of

expenditure was increased by debt overhang problems. This evidence suggests that fiscal policy design should pay special attention to downside risk. Debt overhang problems imply that world capital markets become inaccessible at precisely the moment they are needed most.

This chapter focuses on the role of fiscal policy in managing the volatility of oil wealth and its implications for debt and development. We show that Nigeria's fiscal policy has increased volatility beyond that stemming from oil price variance. The chapter uses the lessons from poor management of oil wealth in Nigeria to derive a framework that can be used to assess fiscal sustainability and vulnerability to debt overhang problems in oil-rich countries. To that end, the case of Nigeria, interesting in its own right, is also of wider interest to other oil-rich countries, given the opportunities and challenges presented by the recent oil boom. We use this framework to assess the oil price fiscal rule (OPFR) recently adopted in Nigeria and show that it is not robust against plausible downside risks.

The next section of this chapter distills lessons for macroeconomic management of the oil windfall, emphasizing the challenge of managing volatility in a poor institutional environment. The third section presents a framework for assessing fiscal sustainability and vulnerability to debt overhang problems in oil-rich countries. The fourth section applies this framework to Nigeria, and the final section offers our conclusions. The chapter annex explains the derivation of public debt decomposition dynamics.

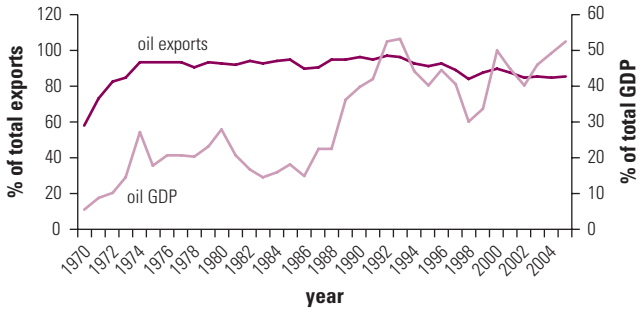
Oil Wealth and the Poor Growth Record: Lessons for the Future

Nigeria discovered oil in 1956 and began to export it in 1958. Since the oil discoveries in the early 1970s, oil has become the dominant factor in Nigeria's economy. Using 1970 as a benchmark, Nigeria gained an extra $390 billion[2] in oil-related fiscal revenue over the period 1971–2005, or 4.5 times 2005 gross domestic product (GDP), expressed in constant 2000 dollars. The sizable oil windfall, of course, presented net wealth and thus additional spending room, but it also has complicated macroeconomic management and led to an extreme dependency on oil—a highly volatile source of income. The share of mining in total GDP increased substantially, representing about a half of GDP in 2005. Oil also accounts for about 90 percent of total exports and approximately four-fifths of total government revenues (see figure 10.1).

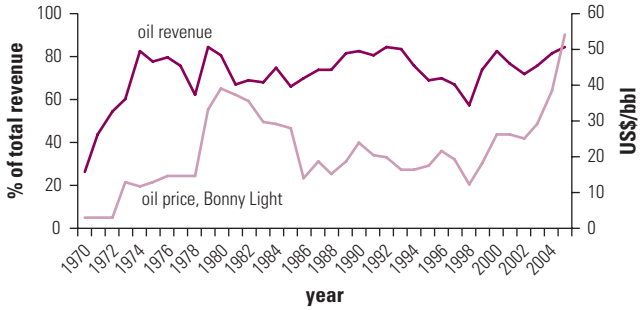
FIGURE 10.1

Indicators of Oil Dependence, Nigeria, 1970–2006

a. Oil dependence



b. Revenue dependence on oil



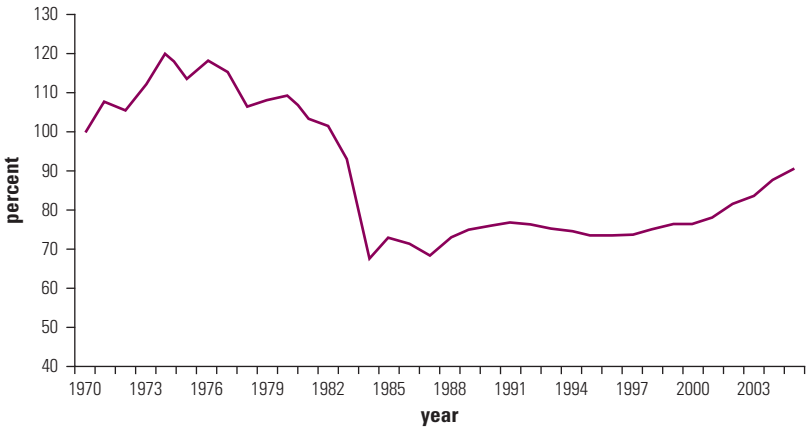
Sources: World Bank 2003; authors' calculations; World Economic Outlook data.

Since the oil discoveries in the early 1970s made Nigeria one of the world's top 10 oil exporters, the Nigerian economy has followed the boom/bust cycles of the world oil market. Yet the many years with oil money have not brought the population an end to poverty nor, at least until recently, have they enabled the economy to break out of what seems like perennial stagnation in the non-oil economy (see figure 10.2).

Is this record the unavoidable consequence of the so-called resource curse, or have misguided policies contributed to slow growth? Traditional among explanations of poor performance in oil-rich countries is the so-called Dutch disease, named after Holland's poor record in managing its natural gas wealth in the 1960s (Corden and Neary 1984; van Wijnbergen 1984a, 1984b). The literature points out that spending out of oil wealth increases demand for nontradables and so draws productive resources into that sector. Because the presumption is that technological progress is faster

FIGURE 10.2

Real Per Capita Income, Nigeria, 1970–2006



Sources: Authors' calculations; World Bank 2003; World Economic Outlook data.

in traded sectors than in nontraded sectors, the explanation of low growth naturally follows. Moreover, if some of the higher growth is related to effects that are not captured directly by private entrepreneurs, such as sectorwide learning-by-doing effects, there is a case for an explicit government-supported economic diversification strategy (van Wijnbergen 1984b).

However, only when oil revenues are temporary and, critically, capital market failures or misguided spending policies cause an associated temporary spending boom does a strong case for industrial diversification emerge. Countries following a permanent income rule, sharing the oil wealth with future generations and smoothing out expenditure into the far future, do not need to face a near future without oil wealth and with depressed economic activity, and therefore have no need to worry about future declines in exchange rates. In such circumstances, there is no clear-cut case in favor of intensified diversification policies after an increase in oil wealth (van Wijnbergen 1984b).

Nigeria has had periods of excessive spending and periods of underspending, and it started an explicit expenditure smoothing policy in 2004. As long as that policy is maintained, there will be no real Dutch disease problem now or in the foreseeable future. Moreover, there are other difficulties in simply labeling Nigeria as another instance of an oil-rich country (ORC) succumbing to the Dutch disease. In particular, the mechanism

through which high spending out of what, in essence, is a tradable resource leads to low growth is a fight for scarce resources drawing labor and capital out of the traded sector. Budina, Pang, and van Wijnbergen (2007) reviewed Nigeria's growth record and indicated that Dutch disease–style resource pull effects out of the traded sector cannot explain a poor non-oil growth record; instead, they point to the extreme volatility of public expenditure.[3]

Poor Growth Record: The Challenge of Managing Oil Revenue Volatility

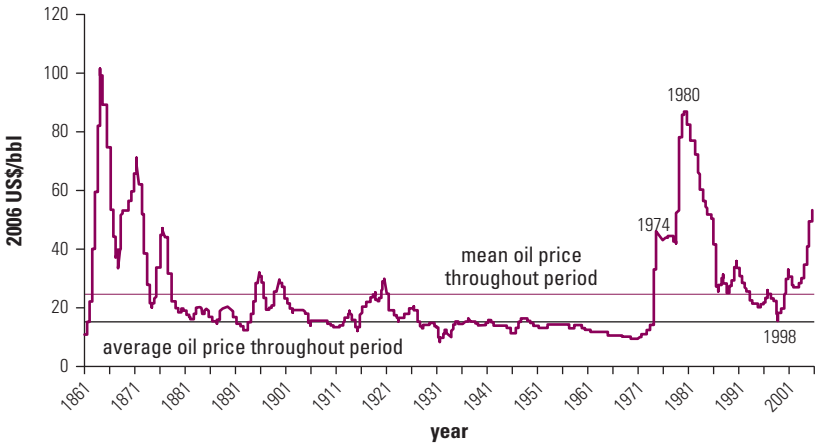
Several empirical studies also have found that oil-abundant countries' output as well as government revenue and expenditure experience higher volatility due to highly volatile commodity prices combined with undiversified revenue and export bases. Commodity prices and revenues from natural resources tend to be volatile, and they may translate into macroeconomic instability and a highly volatile real exchange rate.[4] Volatility can be seen as a tax on investment. Investment requires irreversible decisions because capital, once installed, cannot be moved to other sectors. Highly volatile relative prices discourage the irreversible commitments to specific sectors that capital investment implies (van Wijnbergen 1985). Aghion, Bacchetta, and Ranciere (2006) have shown empirically that high volatility slows down productivity growth by a substantial margin in countries with a relatively underdeveloped financial sector, like Nigeria. In their sample, a 50 percent increase in volatility slows down productivity growth by 33 percent, on average. And there is substantial evidence that ORCs have more volatile economies than non-ORCs (Hausmann and Rigobon 2002).

Vulnerability problems in ORCs—Nigeria, in particular—may well be exacerbated by apparent volatility clustering in addition to regular oil-price uncertainty (see figure 10.3a). This means there is a significant probability of big outliers and clustering of high-volatility periods. High oil-price volatility results in volatile oil revenue streams and, at the same time, increases the equity characteristics of debt: if a debtor often cannot pay in bad years, debt looks more like equity and debt overhang becomes a real problem (see Budina, Pang, and van Wijnbergen 2007). This situation complicates fiscal management, further increases the vulnerability of the ORCs to debt overhang problems, and therefore underscores the implications of high oil-price volatility for fiscal sustainability.

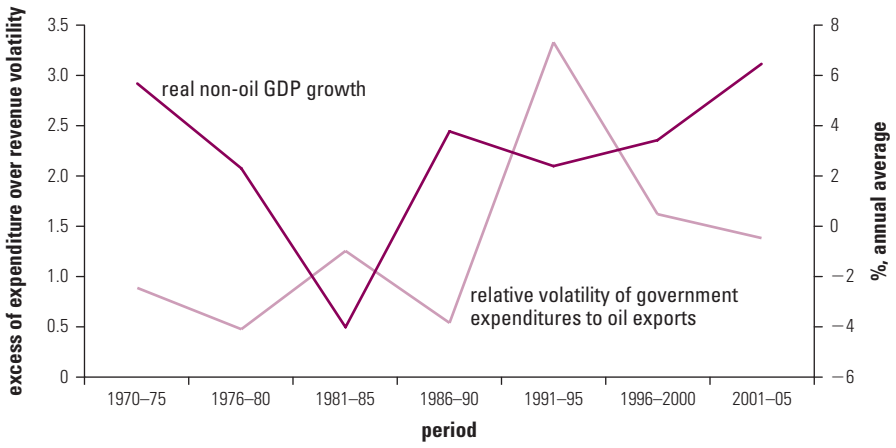
FIGURE 10.3

The Cost of Volatility

a. Oil prices, 1861–2001



b. Volatility and growth



Sources: Authors' calculations; British Petroleum's *Statistical Review of World Energy;* World Bank 2003; World Economic Outlook data.

As illustrated by figure 10.3b, however, fiscal policy has pushed volatility beyond the volatility stemming from variable oil prices; the government itself has become a source of macroeconomic volatility. One plausible explanation for this volatility is the "voracity effect" (see Lane and Tornell 1996). To explain high volatility in ORCs, it has been argued that countries with many interest groups competing for the resource rents are likely to overspend in good years, and underadjust in bad years. Each interest

group tries to overexploit windfall gains in an attempt (at least partially) to offload adjustment costs to others while fully capturing the gains from its lobbying efforts. Federal states like Nigeria are thought to be especially vulnerable to what amounts to an equivalent of overgrazing the commons. An expenditure behavior that leads to overspending in good days and underadjustment in bad days may end up with an economy that has even higher volatility than is to be expected on the basis of the volatility in its revenue streams alone.

There is an alternative, or possibly complementary, explanation of high volatility in ORCs—an explanation that starts from the surprising fact that many ORCs have landed themselves in debt problems, their oil wealth notwithstanding. Borrowing may well have been restricted after the sudden reduction in net resource inflows associated with lower oil prices because lenders fear too much of "project returns" will be diverted to the servicing of old debt, thereby undermining the credit quality of any new debt. This is the classic *debt overhang* problem. Manzano and Rigobon (2001) have suggested a link between debt problems and slow growth in resource-rich countries.

And there is another problem in Nigeria and in many ORCs—the problem of too close a link between public expenditure and volatile current oil income. When oil prices unexpectedly drop, it is often difficult and costly to adjust expenditure downward, although, in fact, the need to do so may be larger than the actual decline in income triggering the need for adjustment in the first place. This is because ORCs, and Nigeria very much so, have a peculiar problem concerning capital market access. Obviously, their need to borrow is lowest when oil prices are high, and is high when prices are low. However, their borrowing capacity is inversely related to their borrowing need because the value of their de facto collateral—oil wealth—also peaks when prices are high and drops when they are low. This perverse link among income shortfalls, declining collateral values, and reduced resource inflows is an obvious recipe for debt overhang problems: new lenders will fear too much of their money will be diverted to service old debt, thereby reducing the value of their claims even if projects financed by the new moneys have a sufficiently high rate of return to service new debt in the absence of old claims outstanding. This is the classic debt overhang problem, triggering a larger need for adjustment than just the current fall in income, as debt repayments coming due cannot be refinanced either. In this way, debt overhang problems raise the costs of

adjustment substantially and explain why volatility of government expenditure in Nigeria has exceeded the volatility of oil prices.

It is important to note that debt overhang problems can arise in countries with relatively little debt; what matters are short-term cash flow needs. So having a modest debt but with all debt coming due in the near future is more damaging than having a much higher debt with amortization smoothly stretched. And the worse the debt service record, the more likely it is there will be a debt overhang problem. The fact that the existing debt was not serviced actually reinforces the argument: debt overhang exists when debt has strong equity characteristics (that is, when it is serviced only in good times) and accordingly trades at a large discount.

The consistent record of repeated rescheduling and continuing arrears since the early 1980s has effectively shut Nigeria out of international capital markets for most of the past two decades.[5] Evidence of this lack of market access is the prohibitive markups that Nigeria would have had to pay on primary issues that can be derived from secondary market information (figure 10.4). It is only after the most recently concluded debt relief agreement that markups have fallen to manageable, although still high, levels.

The combination of exuberance in good years and debt-overhang-induced, draconian adjustment in bad years makes for disastrous non-oil growth records over longer horizons. Nigeria's pre-2000 fiscal policy actually increased expenditure volatility above levels induced by oil prices themselves, constituting an additional tax on non-oil growth. Moreover, the impact of such policies is much exacerbated if coupled with exchange rate policies that do not accommodate upturns and do not adjust to downturns. Real exchange rate adjustments will take place anyhow, but, when not accommodated through nominal adjustments, they will come about through outbursts of inflation in boom periods and prolonged recessions in down periods. And inflation processes have their own overshooting dynamics, leading to larger collapses and deeper recessions than would have occurred if either more orderly appreciation mechanisms had been found or appreciation pressures had been lessened through expenditure smoothing.

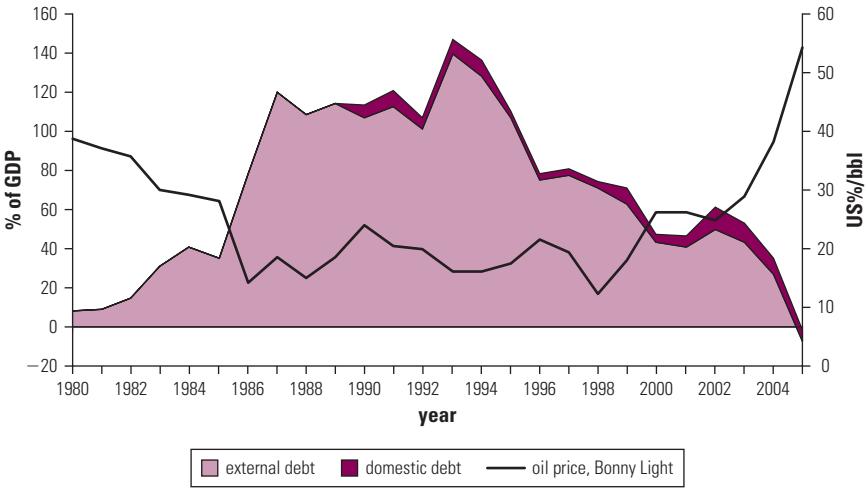
Lessons for the Future

Nigeria's checkered past has important lessons for the future, lessons that should be heeded if the upturn since 2004 is to be more than just a demand-driven upturn foreboding another crash once prices fall again.

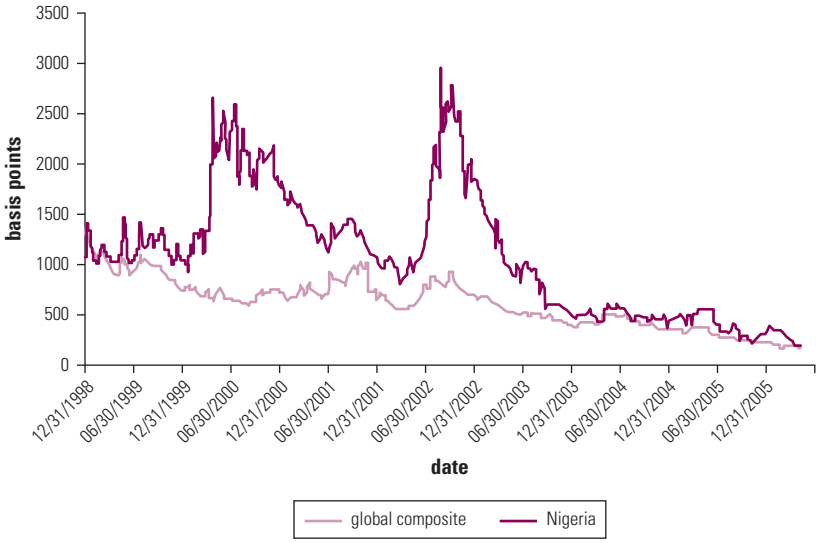
FIGURE 10.4

Net Public Debt-to-GDP Ratio and Risk Premium on External Debt

a. Oil price and net public debt



b. EMBI global stripped spreads



Sources: International Monetary Fund and World Bank staff reports; Data provided by JPMorgan.

As discussed in Budina, Pang, and van Wijnbergen (2007), Nigeria's pre-2000 record of fiscal policy actually increased expenditure volatility rather than reduced it, which led to a series of boom/bust cycles and slowed down non-oil growth.

Moreover, the authors found empirical evidence showing that debt overhang problems also contributed to volatility. They also found evidence of voracity effects that exacerbated expenditure volatility prior to 1984. With the exception of the years leading up to the 1984 crisis, spending in upturns has not been excessive (although perhaps not smoothing volatility enough either), but adjustment in downturns has been harsh as access to capital markets dried up at the very moment it was needed most—when oil prices slumped.

The point is brought out most clearly by the experience of the 1980s and confirmed by the econometric analysis presented. In the beginning of the 1980s, oil prices were substantially higher than they are now in real terms, and predictions of a secular rise in prices abounded, just as some now predict $60+ oil for years to come. Yet a downturn in the West triggered a collapse from which (real) prices have still not recovered. Nigeria followed the optimists' advice then and continued spending, only to find out that capital markets would not accommodate such policies; subsequent adjustment exceeded the decline in oil revenues as short-term debt coming due could not be rolled over. A classic case of debt overhang resulted, and breaking out of it required a new oil boom and substantial debt relief.

Volatility is harmful to economic growth, a problem that is especially relevant in resource-rich countries because of the extremely high volatility of their income streams. Nigeria's experience suggests that managing income volatility to isolate expenditure from it as much as possible is the main challenge in resource-rich economies. Nigeria's experience so far also indicates that managing volatility in a poor institutional environment is especially difficult, thus stressing the need for institutional reform.

Lessons from Nigeria's poor growth record suggest that ORCs, particularly Nigeria, are subject to much bigger vulnerability problems than other countries because of oil price uncertainty and possible volatility clustering (figure 10.3a).

The lesson should be clear. Planning on long-run expenditure commitments low enough to be met from much lower oil revenues than currently projected on the basis of recent price developments is the only way to ensure sustainability and avoid another debt overhang–induced decade of misery. This means non-oil deficits geared toward a sustainable overall

balance based on oil prices in a range of $25–35 a barrel. The importance of complementing the OPFR with such a non-oil deficit policy should be clear: putting money aside with one hand but borrowing on the side with the other to sustain incompatible overall deficits makes the OPFR totally ineffective.

Of course, windfall gains in excess of that price range do not need to be carried over exclusively in the form of foreign exchange; physical capital is also a way of sharing wealth with future generations. But no investment projects should be undertaken that cannot be entirely financed from already accumulated and ring-fenced oil fund assets, and whose recurrent costs cannot be met within the long-run sustainability constraints just outlined. Otherwise, the capital market problems that Nigeria will undoubtedly face again during future downturns will make fiscal policy a source of volatility and low growth. Moreover, Nigeria's extraordinarily poor record on public investment productivity suggests substantial improvements are necessary in the institutional infrastructure for project analysis, selection, and implementation before strategies of transforming oil wealth in improvements of public infrastructure should be considered, however necessary such improvements may be.

The second lesson concerns exchange rate management. Unless public expenditure completely smoothes over oil revenue fluctuations, and no private spending boom is triggered, the real exchange rate will have to appreciate when oil prices rise. Not accommodating through nominal exchange rate flexibility implies that high domestic inflation becomes unavoidable. It is unfortunate that, once started, inflation is often difficult to stop, even if pressure for appreciation falls away. The ensuing overvaluation of the real exchange rate then will trigger unemployment and the necessity of overly harsh downward adjustments later on, once a crisis has brought down a then overvalued nominal rate. Thus, a cautious move toward more exchange rate flexibility, coupled with expenditure restraint to reduce pressure toward real appreciation, will be essential if Nigeria wants to avoid the boom/bust cycles of the past.

The extent to which exchange rates will rise with rising oil prices is directly related to the degree to which the government succeeds in smoothing out expenditure levels through the use of an oil fund facility. If such a facility is used, only structural upshifts in oil income require real exchange rate adjustment.

Assessing Fiscal Sustainability in Oil-Rich Countries

Many ORCs, recently including Nigeria, have attempted to use oil funds and/or fiscal rules to de-link public expenditure from volatile oil revenue and to accumulate large foreign exchange reserves/oil fund assets to lower vulnerability to financial crises and debt overhang problems. Experience has shown that high current oil income is in no way a guarantee that these countries will not have to face crisis circumstances at times in future. Thus, managing fiscal risks from oil revenue uncertainty is a key challenge facing policy makers in ORCs. This section proposes an analytical framework for assessing the sustainability of fiscal strategies in ORCs.

Any framework needs to go beyond the routine consistency checks that form the bread and butter of fiscal sustainability analysis (FSA).[6] First of all, doing an FSA in the presence of an oil fund rule requires explicit incorporation of non-oil deficit rules to make the oil fund a meaningful exercise.[7] This requires modifying the government budget constraint and the resulting public debt dynamics equation to isolate the impact of oil on public finances and to reflect the special features of oil discussed above.

The first step in such an approach is to create a baseline scenario of the likely future time path of the oil producer's net financial asset position, using the flow budget constraint equation. This baseline uses the flow budget equation to update future net financial assets as a share of GDP, based on macroeconomic projections of key determinants of public debt dynamics, such as growth, inflation, projected primary surpluses, and interest rates, as well as our projections for the oil fiscal revenues, which involve projections or assumptions of remaining oil reserves, the future rate of oil extraction, future oil prices, and taxation regimes. As mentioned above, customizing the forward looking approach to ORCs requires modifying the government budget constraint and the resulting public debt dynamics equation to isolate the impact of oil on public finances and to reflect the special features of oil.

Once the baseline scenario is created, the next step requires checking the vulnerability of the net debt/net asset dynamics to key debt determinants and, most important, to sudden drops in oil prices. The sensitivity checks to low oil prices are especially important, given the large uncertainty surrounding future oil prices, high oil price volatility, and possible volatility clustering.

Before going into the details, we should consider one important point. To ensure consistency among debt stocks, deficits, and revenue from seigniorage, it is necessary to consolidate the general government accounts with the central bank's profit and loss account (Anand and van Wijnbergen 1988, 1989). Otherwise, seigniorage, an important source of revenue in most developing countries will not show up in the budget dynamics, and debt may be mismeasured by failing to take into account assets held by the central bank.[8] This is especially important if the savings from current oil revenues are deposited at the central bank. Public sector foreign debt is then measured net of the (net) foreign asset holdings of the central bank and net of the assets of the oil fund, if those are deposited outside the central bank. Similarly, deficits and the ensuing liabilities for the state may be seriously mismeasured if the quasi-fiscal deficit of the central bank is excluded. Such mismeasurement is a major shortcoming of the recent International Monetary Fund approach to sustainability (IMF 2002, 2003). Similarly, if the oil fund is set up as an extrabudgetary fund, then one should consolidate the oil fund operation in the general budget. This consolidation may be especially important if the fund is authorized to undertake expenditure outside the consolidated budget.

After that consolidation, increases in net public debt (that is, measured net of the net foreign assets, public debt holdings of the central bank, and oil fund assets) can be decomposed in various contributing factors, which, in turn, can be linked to the macroeconomic projections available. By switching to ratios to GDP, public debt dynamics can be broken down into several components: (1) the primary non-oil fiscal deficit net of seigniorage revenues; (2) growth adjusted real interest rate payments on domestic debt; (3) the real cost of external borrowing, including capital gains and losses on net external debt due to changes in the real exchange rate; and (4) oil fiscal revenue, which is often the most important way of financing a non-oil deficit in countries highly dependent on oil. This can be expressed in the following formula:[9]

$$d = (f - \sigma) + (r - g)b + (r^* + \hat{e} - g)(b^* - nfa^*)e - Roil + OF \qquad (10.1)$$

where d is the net public debt-to-GDP ratio (that is, measured net of the net foreign assets, public debt holdings of the central bank, and oil fund assets); the OPFR is captured by the projections for the non-oil primary deficit as a share of GDP, f; g is the real GDP growth rate; r is the real interest rate on domestic debt, r^* is the real interest rate on external debt; e is

the real exchange rate, $\frac{EP^*}{P}$ with obvious definitions of variables; and *Roil* refers to projected oil fiscal revenues (at projected World Economic Outlook [WEO]/Development Prospects Group oil prices).

Furthermore, given the oil price uncertainty and the possibility of volatility clustering, many ORCs have introduced fiscal/oil fund rules that aim at stabilizing the oil revenue flow to the budget, using a conservatively chosen budget reference price. In what follows, we are referring to a so-called reference price rule, whereby all revenues due to actual prices in excess of this reference price are diverted to an oil fund. Commensurately, revenue shortfalls due to prices falling short of the reference price can be met from the oil fund.

After adding and subtracting the oil revenue evaluated at the reference price from the right-hand side of equation (10.1), we get

$$d = (f - Roil_{REF} - \sigma) + (r - g)b + (r^* + \hat{e} - g)(b^* - nfa^*)e - (r^* + e - g)oa^*e - (Roil - Roil_{REF}) + OF \quad (10.2)$$

In equation (10.2), $Roil_{REF}$ stands for oil revenue evaluated at a reference price, whereas *Roil* is the oil revenue evaluated at the projected WEO price. We assume that the excess of actual oil revenues over the reference revenues evaluated at the budget reference price and the interest earned on the stock of oil assets are saved in a ring-fenced oil fund. This results in the following two equations, one for the dynamics of the oil fund *oa* and one for public debt:

$$oa^* = (r^* - \hat{e} - g)oa^*e + (Roil - Roil_{REF}) \quad (10.3)$$

$$d = (f - Roil_{REF} - \sigma) + (r - g)b + (r^* + \hat{e} - g)(b^* - nfa^*)e - oa^* + OF \quad (10.4)$$

As can be seen from equation (10.4), the net public debt-to-GDP ratio can increase as a result of larger non-oil primary deficits, *f*, net of the revenue from seigniorage; it also can grow as a result of "automatic debt dynamics," which are determined by the difference between the real interest rate and the real growth rate. If a large share of public debt is denominated in foreign currency, the public debt-to-GDP ratio also can change because of capital gains/losses due to real exchange rate fluctuations. It also includes a catchall term, *OF* (other factors). OF collects residuals due to cross-product terms arising because of the use of discrete time data[10] and the impact of debt-increasing factors that, in a perfect accounting world, would be included in deficit measures but, in the real world, are not

included. Examples are contingent liabilities that actually materialize, such as the fiscal consequences of a bank bailout, one-off privatization revenues, and so on. Of course, if countries borrow in more than one foreign currency (for example, dollars and euros or yen), more than one foreign debt stock should be kept track of in an analogous manner.

The modified public debt dynamics equation (10.4) also isolates the impact of oil on public finances. In particular, it reflects the following major changes. First, it renders transparent the fact that a substantial share of fiscal revenues is derived from oil; the primary fiscal deficit (noninterest spending minus revenues) is replaced with the non-oil primary deficit, isolating net oil revenues evaluated at reference price as a financing flow, $Roil_{REF}$. Second, the change in net debt-to-GDP ratio now also accounts for fiscal savings out of oil, accumulated in a ring-fenced oil fund, *oa*–dot*.[11] Third, given the higher volatility of the oil fiscal revenue, the uncertainty about the net debt trajectory for ORCs is likely to be much higher; hence, fiscal sustainability assessment should pay much more attention to the issues of uncertainty and risk.

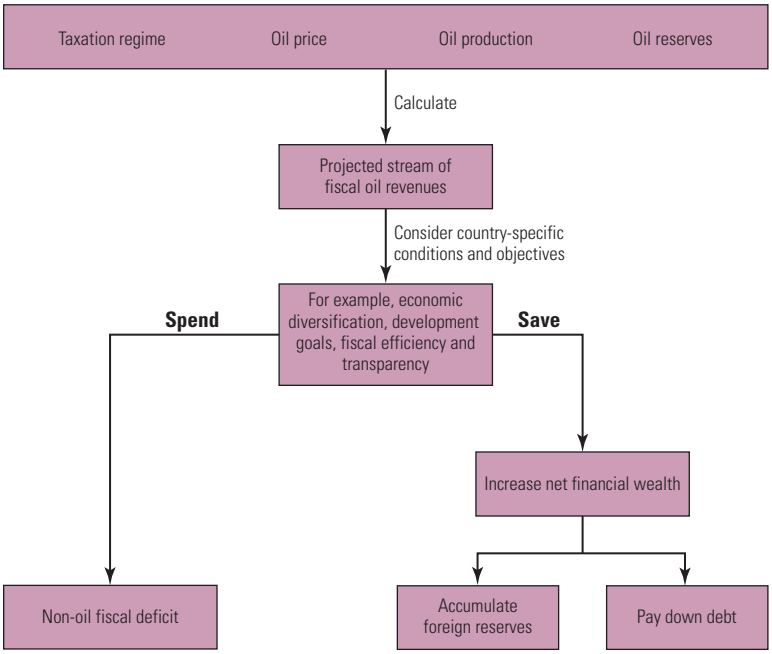
A simplified scheme of the proposed practical framework, which also accommodates a fiscal strategy for de-linking public expenditure from current oil revenue, is presented in figure 10.5. As shown in the figure, besides the traditional automatic debt dynamics, the path of (gross) public debt depends on the projected stream of oil-related fiscal revenues, the level and the trajectory of the non-oil deficit, and the targeted level of foreign exchange reserves (the oil fund).

The fiscal sustainability tool presented in Budina, Pang, and van Wijnbergen (2007), has been extended along the lines of figure 10.5 and incorporates the oil fund rule used in Nigeria, as in many other resource-rich countries.

Note that the implementation of such an OPFR is especially relevant for mature oil producers with a relatively constant oil extraction profile, so it is oil price volatility that matters most. This rule might need to be modified for countries with new oil discoveries (such as Azerbaijan), which might find that they can suddenly and substantially raise the non-oil deficit. Whereas the same considerations—such as absorptive capacity, impact on real exchange rate and non-oil economy, and intergenerational equity—apply, the relative emphasis would be different, with absorptive capacity becoming much more important. For countries where oil is running out (such as Yemen), the emphasis on the non-oil economy and diversification should

FIGURE 10.5

Steps in Conducting Fiscal Sustainability Analysis for ORCs



Source: World Bank 2006.

receive more prominence. Finally, it is also important to stress that, to be meaningful at all, such an OPFR should be complemented with targets for the non-oil deficit. Putting money aside with one hand but borrowing on the side with the other obviously would make the OPFR ineffective.

The second extension to regular FSA is the incorporation of uncertainty. So far we have assumed deterministic paths for the variables underlying the debt dynamics, as spelled out in equations (10.1) and (10.3). Given that there is uncertainty attached to projections of variables such as interest and growth rates, exchange rate developments, and so on, how sensitive are the results to a given shock in any of the variables used as input in the exercise? One way to address these uncertainties is to introduce *stress tests* to deal with specific risks. In a stress test, a set of sensitivity tests to the baseline scenario is conducted, assuming that the underlying variables swing away from their means by one or two standard deviations. Stress tests are a useful sensitivity check, but they have their limitations. In particular, they are incomplete because they ignore the endogenous interactions between input variables, and so are not a substitute for a full

macroeconomic model–based analysis. But their merit is that they significantly reduce computational complexity and data requirements, and still give meaningful insights about the sensitivity of the model results to exogenous shocks. The most important sensitivity analyses include stress tests with respect to oil prices, real interest rates on domestic and foreign public debt, real output growth, primary balance, and (changes in) the real exchange rate.[12] The purposes of the various alternative scenarios are to facilitate a discussion of key vulnerabilities of the economy and to ensure more realistic fiscal sustainability assessments. In addition, the framework used allows for a fully specified crisis scenario, whereby the fiscal rule is compromised and a country is hit by a severe negative oil price shock.

In the light of Nigeria's recent debt overhang problems (Budina, Pang, and van Wijnbergen 2007), the fiscal rule should aim for long-run expenditure commitments low enough to be met from much lower oil revenues than are currently projected on the basis of recent price developments. Periods with low oil prices are also periods of difficult capital market access for Nigeria. A cautious approach would be to use as reference price a range of $25–35, the long-term average of the (real) price of oil (see figure 10.3a).

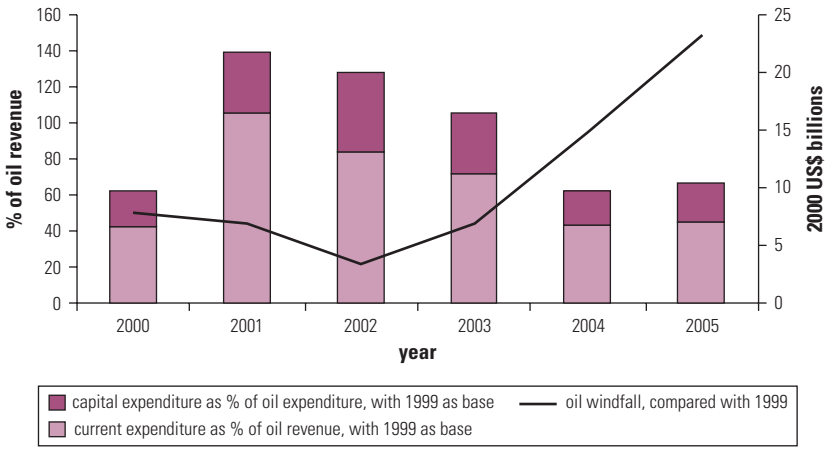
Oil Wealth, the OPFR, and Sustainability of Public Debt

Despite its long history of poor economic performance, Nigeria appeared to be experiencing an economic turnaround that began in 2000. Real non-oil GDP grew at an annual average rate of 5.9 percent during 2000–05; together with the significant oil windfall, that growth has more than doubled GDP per capita in current U.S. dollars over the same period. Is this a structural shift toward sustained high growth or just a temporary, demand-induced boom due to an unanticipated jump in oil prices? Has fiscal policy been able to dampen the impact of oil revenue volatility and to lower vulnerability of the economy to debt overhang?

The adoption of an oil price–based fiscal rule in the 2004 and 2005 budgets has been an important step in the implementation of Nigeria's fiscal reform agenda. This rule is designed to link government spending to some notion of a long-run oil price, thereby de-linking government spending from current oil revenues. This action should both lower the volatility of public expenditure and lead to the saving of at least part of the current oil windfall receipts. Indeed, contrary to earlier responses to steep increases

FIGURE 10.6

Benchmarking Marginal Propensity to Spend out of the Oil Windfall, 2000–05



Sources: International Monetary Fund staff reports; World Economic Outlook data; authors' calculations.

in oil revenues, Nigeria has accumulated sizable foreign exchange reserves, external debt has almost disappeared (also because of the recent Paris Club debt deal), and the consolidated government budget registered strong and increasing surpluses.

To check whether there is any change in the spending pattern, we present the share of annual increments in public expenditure (with respect to their 1999 level) as a share of the incremental oil windfall (with respect to the 1999 level of oil revenues) for each year (figure 10.6). Indeed, there seems to be a change in Nigeria's spending pattern before and after 2004, the year when the OPFR was implemented.[13]

In what follows, we will check whether the recently implemented OPFR is robust enough to lower the vulnerability of Nigeria to potential negative shocks to key debt determinants, and we will show that if the fiscal rule is compromised, a negative oil price shock is likely to have severe consequences for the net asset position.

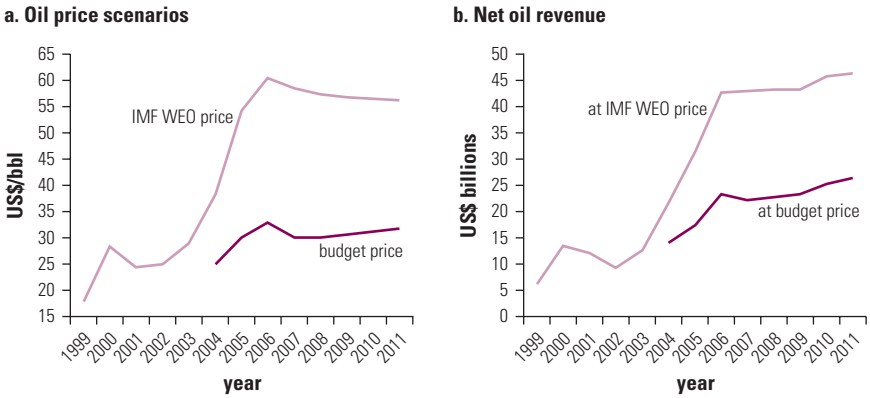
Impact of Adherence to the OPFR on Net Asset Position

This section uses public debt dynamics to create a baseline projection of future trends in the net public debt-to-GDP ratio, utilizing existing

macroeconomic projections.[14] The base case scenario for public debt dynamics assumes continued commitment to implementation of the oil price fiscal rule over the projection period. It is not surprising that public debt dynamics are particularly sensitive to assumptions about projected and budget reference oil prices, which determine the net oil revenues and acceptable level of non-oil deficits. As we have seen, the cost of oil price forecasting errors is asymmetric, with the cost of overpredicting being far greater than the cost of underpredicting. To account for this feature, the annual budgets for 2004 and 2005 were built on rather conservative budget reference oil prices. Looking forward, budget reference price is assumed to be roughly constant at slightly above $30 per barrel, despite expectations that oil prices will stay at their current high levels for the projection period (figure 10.7a). Fiscal projections also assume that non-oil tax collection will improve, leading to higher non-oil taxes (an increase of about 3 percentage points of GDP). Public expenditure is assumed to increase by less than the increase in the non-oil tax revenues, so that the entire non-oil deficit is being financed by the oil revenues calculated at the conservative budget reference price. As a result, the non-oil deficit to non-oil GDP ratio is expected to decline from about 41 percent in 2005 to slightly above 36 percent in the medium term, which is consistent with maintaining real wealth over the long run. Finally, using the WEO

FIGURE 10.7

Scenarios for Oil Price and Net Oil Revenue, 1999–2011



Source: International Monetary Fund staff projections.

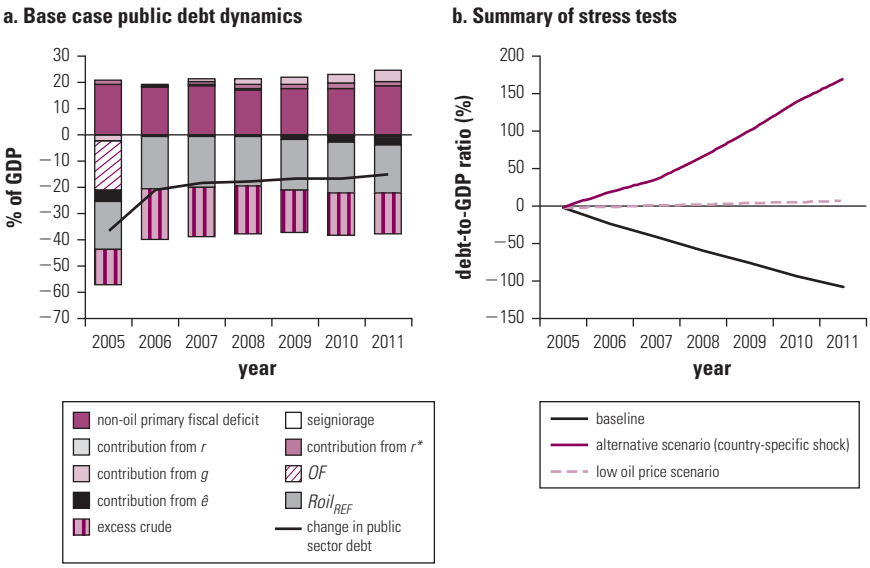
Note: IMF = International Monetary Fund; WEO = World Economic Outlook.

projections, oil prices are assumed to hover above $60 a barrel, which implies substantial savings out of oil revenues (figure 10.7b).

In addition, the base case scenario assumes that, under good policies and reforms, the non-oil GDP grows at about 5 percent, underpinned by a strong growth in the non-oil sector (on average, 6 percent over the projection period). External debt-to-GDP ratio is assumed to remain roughly constant—at around 4 percent as a ratio to GDP, with a very low real interest rate on external debt reflecting Nigeria's low-income status. The annual average real interest rate on domestic debt during the projection period is assumed to be somewhat lower (6 percent), accounting for the ample liquidity and increased savings from oil. The base case also assumes a broadly constant real exchange rate, which once again reflects the relatively prudent fiscal stance under the current assumption that high oil prices will prevail. Furthermore, to check the robustness of the baseline scenario to shocks, we also perform a battery of stress tests, as elaborated below. Results from the baseline scenario and the most important stress tests are summarized in figure 10.8.

FIGURE 10.8

Debt Dynamics and Stress Tests, 2005–11



Source: Authors' calculations.

As can be seen in figure 10.8a, if the oil prices remain at their present very high levels (around $60+ a barrel at time of writing), and if the current OPFR is adhered to, fiscal sustainability is not going to be an issue in Nigeria for many years to come. Following the OPFR would lead to a very fast accumulation of foreign assets: at the end of the projection period, the net asset position will reach 100 percent of GDP! Sizable oil assets accumulation is the chief reason for this favorable debt dynamics. Of course, the strong initial position (as a result of the combination of the Paris Club debt relief and the high oil prices) also helps.

Although the baseline scenario looks rather optimistic, history shows that key determinants of public debt dynamics are highly volatile and subject to external shocks. The fiscal sustainability framework checks the credibility of baseline projections with alternative scenarios (historical scenario, no policy change, alternative country-specific scenario, and low oil price scenario) and bound tests, which are used to assess the behavior of the public debt ratio in the event of temporary shocks on key parameters. Although all the stress tests are presented in table 10.1 for the sake of completeness, the baseline scenario is quite robust to most of the stress tests—including historical, no policy change, and the bound tests. The most important vulnerability of the baseline scenario relates to an unanticipated oil price drop, which is illustrated by the low oil price scenario and by the alternative country-specific scenario (see figure 10.8b and table 10.1). Hence, we concentrate our further discussion on these two scenarios.

As demonstrated by Nigeria's past, the role of fiscal policy in minimizing the impact of oil wealth volatility on the economy by delinking public expenditure from volatile oil revenues is crucial if debt overhang and associated low growth are to be avoided. To check the robustness of the OPFR, we also project the net public debt dynamics on the assumption of a negative permanent oil price shock during the projection period. In particular, we assume that the oil price would permanently drop to a constant $25 a barrel in real terms, which is the oil price observed on average during 1986–99. At the same time, the non-oil deficit trajectory remains unchanged because it is bounded by the reference price of oil, which remains as in its baseline level of around $30 a barrel, or somewhat higher than the

TABLE 10.1

Net Public Debt: Stress Test Results, 2006–11

Percent of GDP

	2006	2007	2008	2009	2010	2011
Baseline scenario	−23.7	−41.8	−59.7	−76.3	−93.2	−108
Alternative scenarios						
A1. Key variables are at their historical averages in 2006–11	−24	−42	−59	−76	−100	−122
A2. No policy change (constant primary balance) in 2006–11	−24	−3.0	−1.7	1.2	−20	−36
A3. Alternative country-specific scenario, modeling a country-specific shock	18	35	65	100	138.3	169.6
A4. Low oil price scenario, 2006–11	−1.0	1.2	2.1	3.5	4.8	7.2
Bound tests						
B1. Real interest rate is at historical average plus two standard deviations in 2005 and 2006	−21.0	−32.2	−52.4	−71.6	−95.1	−113
B2. Real GDP growth is at historical average minus two standard deviations in 2005 and 2006	−22.3	−38.2	−54.1	−69.3	−84.4	−98.3
B3. Primary balance is at historical average minus two standard deviations in 2005 and 2006	−2.5	−12.6	−41.8	−56.9	−71.8	−85.1
B4. Combination of 1–3 using one standard deviation shocks	−15.9	−26.6	−44.1	−60.1	−76.3	−90.7
B5. One time 30 percent real depreciation in 2005	−27.8	−43.3	−57.7	−70.3	−82.8	−93.0
B6. 10 percent of GDP increase in other debt-creating flows in 2005	−14.4	−34.5	−54.6	−73.8	−93.0	−111

Source: Authors' calculations.

projected oil price. Whereas this scenario will result in net outflows from the oil stabilization fund, given the strong initial net asset position and the adherence to the OPFR, Nigeria would be able to survive a sizable negative oil shock of at least five years' duration without requiring dramatic fiscal adjustment and with only modest debt accumulation. This is good news for the fiscal rule and indicates that it is robust enough to withstand a sizable negative oil shock. Of course, if the duration of the shock is much longer (beyond the five-year projection period that we assumed here), this policy rule may need to be reconsidered to avoid over-borrowing.

Robustness Check of the OPFR

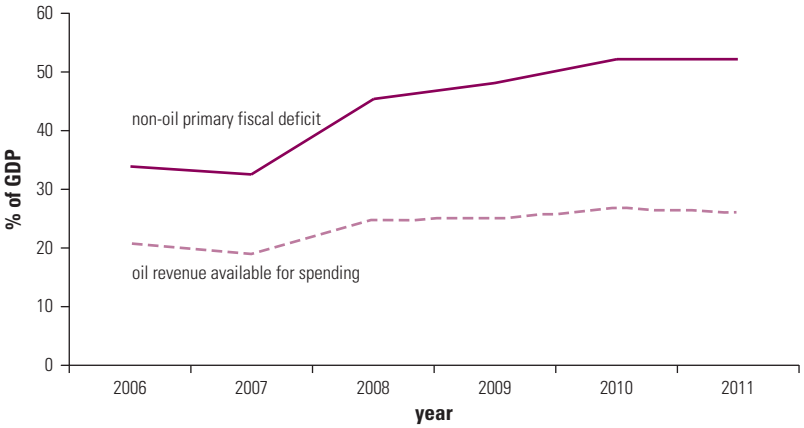
To explore the consequences of abandoning the fiscal policy rule, we have constructed an alternative scenario where OPFR is compromised by assuming a much higher budget reference price of oil ($60 a barrel), although, in reality, oil prices would drop permanently to a constant $25 a barrel. In other words, we performed a *robustness check* to see what would be the implications if history repeats itself and Nigeria experiences a shock similar to the one in the mid-1980s. Specifically, this scenario assumes that the government will passively spend its oil revenues, which are estimated on the assumption that current high oil prices ($60 a barrel) will continue to prevail during the projection period, while oil prices actually return to their historical level ($25 per barrel in real terms).

As a result, non-oil deficits will expand drastically, while the oil revenue available for deficit financing will turn out to be much lower than expected. Under such a policy, Nigeria will exhaust its oil fund assets in 2006, after which sizable financing gaps will emerge (shown in figure 10.9 as the difference between projected non-oil primary deficits and oil revenues).

The options available to the government are then to borrow or, more likely when external funds dry up, to print money and see inflation

FIGURE 10.9

Financing Gap in the Alternative Scenario, 2006–11



Source: Authors' calculations.

reemerge. Given debt overhang problems for ORCs after price downturns, this situation most likely would lead to confidence crises, credit rationing by external capital markets, sizable depreciation, rapid increases in real interest rates, hyperinflation, and deep recession—the end result of which would be unsustainable levels of public debt only five years after the Paris Club debt agreement. This simulation thus stresses the importance of the fiscal policy rule and the conservative reference price chosen to underpin it. Both are necessary to impart sufficient robustness to Nigeria's macroeconomic policies. Guessing wrong can be very expensive if high oil prices fail to materialize.

Conclusions

This chapter has focused on the role of fiscal policy in managing the volatility of oil wealth and its implications for debt and development. It uses the lessons from poor management of oil wealth in Nigeria to derive a framework that could be used to assess fiscal sustainability and vulnerability to debt overhang problems in ORCs. Whereas Nigeria is an interesting example in its own right, many issues that are familiar from other countries show up here too, making the case of wider interest.

Nigeria's poor record with managing oil revenue volatility has important lessons for the future, lessons that should be heeded if the upturn since 2004 is to be more than just a demand-driven upturn foreboding another crash once prices fall again. The combination of exuberance in good years and debt-overhang-induced, draconian adjustment in bad years makes for disastrous non-oil growth records over longer horizons. Volatility is harmful to economic growth—a problem that is especially relevant in resource-rich countries because of the extremely high volatility of their income streams. Furthermore, the challenge of managing volatility is even greater in a poor institutional environment.

In particular, Nigeria's pre-2000 record of fiscal policy shows two things: (1) Nigeria's own policies increased rather than smoothed volatility, and (2) volatility of expenditure in Nigeria was further increased by debt overhang problems. Debt overhang problems mean that world capital markets become inaccessible at the very moment they are needed most. This

suggests that fiscal policy design should pay special attention to downside risk.

The point is brought out most clearly by the experience of the 1980s. In the beginning of that decade, oil prices where substantially higher than they are now in real terms, and predictions of a secular rise in prices abounded, just as some now predict $60+ oil for years to come. Yet a downturn in the West triggered a collapse from which (real) prices have still not recovered. Nigeria followed the optimists' advice then and continued spending, only to find that capital markets would not accommodate such policies; subsequent adjustment exceeded the decline in oil revenues as short-term debt coming due could not be rolled over. A classic case of debt overhang resulted, and breaking out of it required a new oil boom and substantial debt relief.

Experience has shown that high current oil income does not guarantee that these countries will face no crisis circumstances in future times. Thus, managing oil revenue volatility is a key challenge facing policy makers in oil-rich countries. Many oil-rich countries, recently including Nigeria, have attempted to use oil funds and/or fiscal rules to de-link public expenditure from volatile oil revenue and to accumulate large foreign exchange reserves/oil fund assets to lower vulnerability to financial crises and debt overhang problems.

Adopting an OPFR in the 2004, 2005, and 2006 budgets has been an important step in improving fiscal discipline since 2004, and Nigeria has been able to accumulate sizable foreign exchange reserves, while net public debt virtually disappeared. We have applied a framework for fiscal sustainability to check how robust the newly established OPFR is under different oil price assumptions. First, we used public debt dynamics to create a baseline projection of future trends in the net public debt-to-GDP ratio, using existing macroeconomic projections. Second, given the uncertainty surrounding public debt dynamics, we conducted various sensitivity tests on baseline public debt dynamics, emphasizing the importance of oil price volatility. Finally, we formulated a country-specific alternative scenario whereby fiscal rule is compromised and a country is hit by a severe negative oil price shock, which serves as a robustness check and accounts for oil price uncertainty and volatility.

Assuming that oil prices remain at their present very high levels of around $60+ per barrel, and that Nigeria adheres strictly to its

OPFR (resulting in non-oil deficits geared toward sustainable balance based on oil prices in a range of $25–35), the fiscal rule is sufficiently robust and the country could weather a substantial oil price drop during the projection period without a substantial impact on its net public debt.

However, the fiscal reforms record is still mixed: during the past three years, 2004–06, the non-oil deficit (expressed as a ratio to non-oil GDP) increased rapidly, and the off-budget deficit items of several percentage points indicate that signs of slippage are appearing. To see the impact of a full loss of fiscal control, we assumed that the reference price is increased back to $60 a barrel, or the OPFR is abandoned, while Nigeria is hit by a severe downturn in the international oil prices. Under such a scenario, large financing gaps will emerge throughout the projection period, leading to a rapid exhaustion of the oil savings. The government then has two available options: to borrow or, more likely when external funds dry up, to print money and watch inflation reemerge. Given ORCs' vulnerability to debt overhang problems following price downturns, this scenario probably will lead to a crisis of confidence, the rationing of credit by external capital markets, sizable depreciation, swift increases in real interest rates, hyperinflation, and deep recession. As a result, there will be unsustainable levels of public debt only five years after the debt agreement reached with the Paris Club.

The overall conclusion should be clear. The only way to avoid another debt overhang problem is to plan expenditure levels and commitments low enough to avoid a crisis if and when oil prices come down to earth again and revenues fall. This implies non-oil deficits based on oil prices in a range of $25–35.

Nigeria recently started to adhere to an oil price–based fiscal rule, introduced more exchange rate flexibility, and improved various aspects of the public investment process. But there are clear dangers of slippage: non-oil deficits have been above safe levels, particularly if off-budget commitments and arrears are taken into account. Those signs of slippage need to be reversed. And, finally, Nigeria's poor public investment performance makes it clear that reform of the public investment process, including anticorruption measures, should remain at the top of the policy agenda. Only if the reform process is brought back on track and maintained in the years to come is there a chance that Nigeria's oil wealth will turn from a curse into a blessing.

Annex: Derivation of Public Debt Decomposition Dynamics

The first section of this annex lists and defines the variables used in the debt decomposition, and the second section derives the debt decomposition equation.

Set of Variables

1. $D_t = B_t + e_t B_t^* - e_t NFA_t^*$: public sector net debt.
2. B_t: domestic debt in local currency units (LCUs).
3. B_t^*: foreign debt in dollar terms.
4. NFA_t^*: net foreign assets in dollar terms.
5. e_t: end-of-period (*eop*) exchange rate, LCU/$.
6. M_t^{bop}: monetary base at the beginning of period in time t (or monetary base *eop* at $t - 1$).
7. i_t^d: domestic interest rate paid over the period $(t - 1, t)$.
8. i_t^f: foreign interest rate paid on foreign debt and reserves on the period $(t - 1, t)$.
9. i_t^l: London interbank offered rate paid on net foreign assets of the central bank on the period $(t - 1, t)$.
10. $P_{t,AV}$: average consumer price index level for period t.
11. $\pi_{t,AV} = (P_{t,AV} - P_{t-1,AV})/P_{t,AV}$: average consumer price inflation in the year t.
12. $\pi_t^* = (P_t^* - P_{t-1}^*)/P_t^*$, where P_t^* is the average U.S. consumer price index.
13. Y_t: real GDP in period t in LCUs.
14. g_t: $(Y_t - Y_{t-1})/Y_t$: real GDP growth rate in the year t.
15. $s_t = (e_t - e_{t-1})/e_{t-1}$.
16. $\hat{e}_t = (1 + s_t)^*(1 + \pi_t^*)/(1 + \pi_t) - 1$: rate of change in the bilateral real exchange rate (LCUs per $1) $e_t P_t^*/P_t$, where + denotes real depreciation, and − denotes real appreciation.

17. Small letters, d_t, b_t, b^*_t, and nfa^*_t denote ratios of *Dt*, *Bt*, *Bt**, and *NFAt** to GDP.

18. $\sigma_t = (M^{bop}_{t+1} - M^{bop}_t)/P_tY_t$: seigniorage revenue.

19. $Roil_{tREF}$, $Roil_t$: net oil revenue evaluated at the budget reference prices, respectively, on projected WEO oil prices.

20. *OA**: oil fund assets.

21. OF_t: other exogenous factors of public debt accumulation that may increase or decrease the outstanding stock of net public debt, such as privatization receipt or recognition of contingent liabilities.

Public Debt Decomposition Equation

In ORCs, a substantial share of fiscal revenues is derived from exhaustible natural resources (oil and gas, referred to simply as "oil"). Hence, we break total tax revenue to *Tt* (non-oil taxes) and *OTt* (oil-related taxes). Oil-related taxes are defined as oil revenues evaluated at the reference price assumed in the government budget, net of oil-related expenditure and transfers. Furthermore, net debt is now defined as domestic treasury debt to private sector and external public debt, net of the central bank's net foreign assets and net of the oil assets, assuming that those are separate from net foreign assets.

$$\begin{aligned} D_t = B_t + e_t \cdot B^*_t - e_t \cdot NFA^*_t - e_t \cdot OA^*_t = (G_t - T_t - OT_t) \\ - (M^{bop}_{t+1} - M^{bop}_t) + (1 + i^d_t) \cdot B_{t-1} + (1 + i^f_t) \cdot e_t \cdot B^*_{t-1} \\ - (1 + i^l_t) \cdot e_t \cdot NFA^*_{t-1} - (1 + i^l_t) \cdot e_t \cdot OA^*_{t-1} + OF_t \end{aligned} \tag{10.5}$$

Converting all the variables in ratios to GDP and defining lowercase variables as uppercase variables in percent of GDP yields

$$\begin{aligned} d_t = b_t + b^*_t - nfa^*_t - oa^*_t = (g_t - t_t - Roil_t) - \sigma_t \\ + \frac{(1 + i^d_t) \cdot b_{t-1}}{(1 + g_t) \cdot (1 + \pi_t)} + \frac{(1 + i^f_t) \cdot (1 + s_t) \cdot b^*_{t-1}}{(1 + g_t) \cdot (1 + \pi_t)} \\ - \frac{(1 + i^l_t) \cdot (1 + s_t) \cdot [nfa^*_{t-1} + oa^*_{t-1}]}{(1 + g_t) \cdot (1 + \pi_t)} + of_t \end{aligned} \tag{10.6}$$

The next step involves converting all the variables in real terms. To do that, it is also necessary to multiply and divide the last two terms of the

right-hand side by $(1 + \pi_t^*)$ and group the real exchange rate components in $(1 + \hat{e}_t)$:

$$d_t = b_t + b_t^* - nfa_t^* - oa_t^* = (g_t - t_t - Roil_t) - \sigma_t + \frac{(1 + i_t^d) \cdot b_{t-1}}{(1 + g_t) \cdot (1 + \pi_t)} + \frac{(1 + i_t^f) \cdot (1 + \hat{e}_t) \cdot b_{t-1}^*}{(1 + g_t) \cdot (1 + \pi_t^*)} - \frac{(1 + i_t^l) \cdot (1 + \hat{e}_t) \cdot [nfa_{t-1}^* + oa_{t-1}^*]}{(1 + g_t) \cdot (1 + \pi_t^*)} + of_t \quad (10.7)$$

Finally, to represent changes in net public debt, it is necessary to subtract d_{t-1} from equation (10.7):

$$\Delta d_t = (g_t - t_t - Roil_t) - \sigma_t + \frac{(i_t^d - \pi_t) \cdot b_{t-1}}{(1 + \pi_t) \cdot (1 + g_t)} - \frac{g_t}{(1 + g_t)} b_{t-1} + \frac{(i_t^f \cdot (1 + \hat{e}_t) - \pi_t^*) \cdot b_{t-1}^*}{(1 + \pi_t^*) \cdot (1 + g_t)} + \frac{\hat{e}_t \cdot b_{t-1}^*}{(1 + \pi_t^*) \cdot (1 + g_t)} - \frac{g_t}{(1 + g_t)} \cdot b_{t-1}^* - \left(\frac{(i_t^l \cdot (1 + \hat{e}_t) - \pi_t^*)}{(1 + \pi_t^*) \cdot (1 + g_t)} + \frac{\hat{e}_t}{(1 + \pi_t^*) \cdot (1 + g_t)} - \frac{g_t}{(1 + g_t)} \cdot \right) [nfa_{t-1}^* + oa_{t-1}^*] + of_t \quad (10.8)$$

Given the uncertainty surrounding future oil prices and the possibility of high-volatility periods, this framework introduces the so-called reference price rule, which aims to stabilize the oil revenue flow to the budget, using a conservatively chosen budget reference price. According to this rule, all revenues in excess of this reference price are saved in an oil fund; revenue shortfalls due to prices falling short of the reference price are financed using the accumulated oil fund's assets. To model this rule, $Roil_{REF}$, the oil revenue evaluated at the reference price is added and then subtracted from the right-hand side of equation (10.8) to get equation (10.9):

$$\Delta d_t = (g_t - t_t - Rroil_t) - \sigma_t - \frac{g_t}{(1 + g_t)} \cdot d_{t-1} + \frac{(i_t^d - \pi_t) \cdot b_{t-1}}{(1 + \pi_t) \cdot (1 + g_t)} + \frac{(i_t^f \cdot (1 + \hat{e}_t) - \pi_t^*) \cdot b_{t-1}^* e_{t-1}}{(1 + \pi_t^*) \cdot (1 + g_t)} - \frac{(i_t^l \cdot (1 + \hat{e}_t) - \pi_t^*) \cdot [nfa_{t-1}^* + oa_{t-1}^*] e_{t-1}}{(1 + \pi_t^*) \cdot (1 + g_t)} + \frac{\hat{e}_t \cdot (b_{t-1}^* - nfa_{t-1}^* - oa_{t-1}^*) e_{t-1}}{(1 + \pi_t^*) \cdot (1 + g_t)} - [Roil_t - Roil_{REFt}] + of_t \quad (10.9)$$

Next, it is assumed that the excess of actual oil revenue over the reference revenue evaluated at the budget reference price, and the interest earned on the stock of oil assets, are saved in a ring-fenced oil fund:

$$\Delta oa^*_t = \left[\frac{(i^l_t \cdot (1 + \hat{e}_t) - \pi^*_t)}{(1 + \pi^*_t) \cdot (1 + g_t)} + \frac{\hat{e}_t}{(1 + \pi^*_t) \cdot (1 + g_t)} - \frac{g}{1 + g} \right] oa^*_{t-1} + [Roil_t - Roil_{REFt}] \tag{10.10}$$

Using (10.10), equation (10.9) can be rewritten as

$$\Delta d_t = (f_t - Rroil_t) - \sigma_t - \frac{g_t}{(1 + g_t)} \cdot d_{t-1} + \frac{(i^d_t - \pi_t) \cdot b_{t-1}}{(1 + \pi_t) \cdot (1 + g_t)} + \frac{(i^f_t \cdot (1 + \hat{e}_t) - \pi^*_t) \cdot b^*_{t-1} e_{t-1}}{(1 + \pi^*_t) \cdot (1 + g_t)} - \frac{(i^l_t \cdot (1 + \hat{e}_t) - \pi^*_t) \cdot nfa^*_{t-1} e_{t-1}}{(1 + \pi^*_t) \cdot (1 + g_t)} + \frac{\hat{e}_t \cdot (b^*_{t-1} - nfa^*_{t-1}) e_{t-1}}{(1 + \pi^*_t) \cdot (1 + g_t)} - \Delta oa^* + of_t \tag{10.11}$$

According to equation (10.11), change in net public debt in percent of GDP is determined by the non-oil primary deficit, oil revenues at budget price, seigniorage revenue, the real interest rate growth differential, capital gains (losses) on net debt from real exchange rate appreciation (depreciation), accumulation of oil assets, and other factors.

Notes

1. Manzano and Rigobon (2001) attributed the resource curse to a "debt overhang" with its origins in the 1970s when oil prices were high and oil-rich countries used commodities as collateral to take on excessive debt. A collapse in oil prices in the 1980s left those countries with no ability to service their debts.
2. A billion is 1,000 millions.
3. The World Bank (2003) also ranked Nigeria as the third most volatile economy in terms of trade volatility (out of 90 developing countries) and the fourth in terms of (real) exchange rate volatility (out of 84 developing countries) during the 1961–2000 period.
4. See also Devlin and Lewin (2005) for a discussion of managing oil booms and busts in developing countries.
5. In 1982 and 1983, Nigeria accumulated trade arrears for the first time. It has been running arrears on its external debt ever since, and the bulk of the

increase of its external debt since the mid-1980s has reflected not so much new lending as converted past commercial debt arrears. Nigeria's arrears on external debt have been rescheduled in successive agreements with the London Club (1984, 1987, 1989, and 1992) and the Paris Club (1986, 1989, 1991, 2000, and 2005). The last Paris Club debt reduction agreement, which was reached in October 2005, has brought significant external debt relief. For more details on this agreement, see IMF (2005).

6. See Burnside (2005) for a good overview of the traditional Word Bank approach.
7. See Davis, Ossowski, and Fedelino (2003) for a discussion of fiscal policy formulation in ORCs, and see Baunsgaard (2003) for a discussion of possible fiscal rules for Nigeria.
8. For debt decomposition derivation in discrete time, see the annex to this chapter.
9. Note that, to simplify the exposition, we present a continuous time formula. As shown in the chapter annex, however, in the fiscal sustainability analysis we use discrete time formulas for deriving public debt dynamics. A similar debt decomposition formula also has been used in World Bank (2005).
10. For an elaboration, see annex A.1 in Bandiera et al. (2007).
11. Ring-fenced oil funds can be successful only if complemented with a rule that limits the non-oil deficit or public debt. Otherwise, the government will accumulate assets in the oil fund while borrowing, so the net asset position may even deteriorate because the cost of borrowing is typically higher than the interest earned on oil fund assets.
12. For a more detailed description of all the stress tests, see Bandiera et al. (2007).
13. The share of the oil windfall that has been spent more than doubled in 2001, relative to 2000, and was quite high in 2002 and 2003; but there seems to be a substantial drop in 2004 and 2005, the years of the OPFR implementation.
14. For more detailed information on this tool, see Budina, Pang, and van Wijnbergen (2007) and Bandiera et al. (2007). All the assumptions underpinning the fiscal sustainability calculations in the base case are derived from the IMF projection framework.

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