



## MACROECONOMIC POLICY FRAMEWORKS FOR RESOURCE-RICH DEVELOPING COUNTRIES—ANALYTIC FRAMEWORKS AND APPLICATIONS—SUPPLEMENT 2

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Approved By  
**Siddharth Tiwari,**  
**Carlo Cottarelli,**  
**Olivier Blanchard,**  
**Antoinette M. Sayeh,**  
and **José Viñals**

Prepared by a staff team led by Dhaneshwar Ghura and Catherine Pattillo and comprising Chris Geiregat, Juliana Araujo, Armine Khachatryan, Lyngne Nielsen, Nkunde Mwase, Friska Parulian, Sibabrata Das and Lisa Kolovich (all SPR); Alex Segura-Ubiergo, Santiago Acosta, Nathaniel Arnold, Fuad Hasanov, Takuji Komatsuzaki, Todd Mattina, Kyung-Seoul Min, Marcos Poplawski-Ribeiro, and Christine Richmond (all FAD); Maria Oliva (MCM); Felipe Zanna, Susan Yang, Grace Bin Li, Manzoor Gill, Salifou Issoufou, Rafael Portillo, and Nicola Spatafora (all RES); Javier Arze del Granado, Carol Baker, Thomas Baunsgaard, Felix Fischer, Rodrigo Garcia-Verdu, Mumtaz Hussain, Shawn Ladd, Lamin Leigh, Geoffrey Oestreicher, Gonzalo Salinas, Darlena Tartari Schwegler, Alun Thomas, Juan Treviño, Mauricio Villafuerte, and Irene Yackovlev (all AFR); Byung Kyoon Jang (APD); Dora Iakova and Daniel Rodriguez-Delgado (all WHD); and Hannah Behrendt (World Bank). An interdepartmental advisory group included representatives from the above departments, and Benedict Bingham (APD), Nikolay Gueorguiev (EUR), Rabah Arezki (ICD), Ron Van Rooden (MCD), and Przemek Gajdeczka (WHD). General guidance was provided by Hugh Bredenkamp (SPR), Sanjeev Gupta (FAD), Andrew Berg (RES), Seán Nolan (AFR), and Udaibir Das (MCM). Production assistance provided by Neri Gomes and Nazma Nunhuck (SPR).

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## Abbreviations and Acronyms

AFR	African Department
BEAC	Bank of Central African States
ANS	Adjusted Net Savings
CA	Current Account
CBN	Central Bank of Nigeria
CEMAC	Economic Community of Central African States
CES	Constant Elasticity of Substitution
CGER	Consultative Group on Exchange Rate Issues
DRC	Democratic Republic of Congo
DSGE	Dynamic Stochastic General Equilibrium
ECA	Excess Crude Account
ES	External Sustainability
EU	European Union
FAD	Fiscal Affairs Department
FARI	Fiscal Analysis of Resource Industries Model
FDI	Foreign Direct Investment
FFG	Fund for Future Generations
FSF	Financial Sustainability Framework
GDP	Gross Domestic Product
GFSM	Government Finance Statistics Manual
GNI	Gross National Income
ICRG	International Country Risk Guide
LIC	Low-Income Country
LMIC	Lower-Middle Income Country
MNRW TTF	Managing Natural Resource Wealth Topical Trust Fund
MPIH	Medium Permanent Income Hypothesis
MTFF	Medium-Term Fiscal Framework
NFA	Net Foreign Assets
NOPD	Non-oil Primary Deficit
NRPB	Non-resource Primary Balance
NRW	Natural Resources Windfall
OECD	Organisation for Economic Co-operation and Development
PFM	Public Financial Management
PIH	Permanent Income Hypothesis
PIMI	Public Investment Management Index
PPT	Product Price Targeting
RES	Research Department
RRDC	Resource Rich Developing Country
SEEA	System of Environmental and Economic Account
SNA	System of National Accounts
SSA	Sub-Saharan Africa
SWF	Sovereign Wealth Fund
TFP	Total Factor Productivity
UN	United Nations
VaR	Value-at-Risk
VAT	Value Added Tax
WAVES	Wealth Accounting and the Valuation of Ecosystem
WEO	World Economic Outlook

# I. ANALYTICAL FRAMEWORKS

## A. Uncertainty and Volatility in Natural Resource Revenues—Analytical Considerations<sup>1</sup>

*Two major questions for policymakers in natural resource-rich developing countries (RRDCs) are (i) how much of resource revenues to consume and how to save (invest) the remainder, and (ii) how to cope with the uncertainty and volatility of resource revenues. This chapter offers some analytical background on the second question. Many resource-dependent developing countries must deal with very volatile exports, revenues, and non-resource GDP growth.<sup>2</sup> In the short to medium term, designing policies to cope with that uncertainty and volatility may be a more pressing challenge than dealing with the issue of exhaustibility, especially when there is a relatively long extraction horizon. Uncertainty may relate to how large the resource reserves are, how much will be extracted in a given period, what prices will be on average, and how volatile prices are likely to be in the short term.<sup>3</sup> These factors complicate macroeconomic management and stimulate demand for precautionary mechanisms.*

1. **Large swings in commodity prices deeply complicate resource and macroeconomic management.** Commodity price swings can be large, long-lasting, and asymmetric. Shocks to prices for several commodities may take several years to dissipate, and for commodities like gold, natural gas, and oil they may be permanent (Box 1). It is therefore hard to forecast prices with a reasonable degree of confidence, even over the medium term. These factors also complicate the task of policy makers who wish to assess whether a shock is permanent (warranting adjustment) or temporary (warranting smoothing).
2. **There can also be substantial uncertainty and volatility related to the volume of commodity production and exports.** Production might be disrupted by technical difficulties, accidents, strikes, social and political unrest, and cross-border disputes. Production forecasts may prove too optimistic because of delays in investment or for economic reasons (e.g., drop in international demand, substitution of other commodities). These factors may call for a relatively conservative approach to projecting production volumes. However, in several countries there is also substantial upside risk to production, especially over the longer term. While it is hard to obtain estimates for numerous commodities, with new discoveries and better extraction technologies

<sup>1</sup> Prepared by Chris Geiregat (SPR).

<sup>2</sup> See Chapter 3 in IMF (2012a).

<sup>3</sup> For a discussion, see Collier (2012).

### Box 1. A Few Stylized Facts on Commodity Prices

*Standard policy advice suggests that temporary shocks may be smoothed out while permanent shocks will eventually require adjustment. In practice, policy makers must first interpret the price signals. Shocks to commodity prices are often persistent and cycles asymmetric. Price movements may depend on short- or on longer-term demand and supply factors.*

**Shocks to commodity prices tend to persist for years**, though the length of time varies depending on the commodity. Using price data for 44 commodities, Cashin et al. (2000) find that the shocks were permanent for 9, and for another 17 it took over five years for half the shock to dissipate. For example, price shocks to aluminum and iron ore lasted nearly four years and for zinc up to eight years; for gold, natural gas, and crude oil they were permanent. Hamilton (2009) illustrated the challenges in forecasting crude oil prices when he found that those prices behave like a random walk without drift: starting from an oil price of US\$115 per barrel in 2008:Q1, a 95 percent confidence interval for a forecast a year ahead was US\$62–212. There is also evidence of “supercycles” in commodity prices—cycles that last for several decades. For example, using price data for six metals going back to 1850, Cuddington and Jerrett (2008) found evidence of three supercycles.

**For many commodities price cycles are asymmetric.** Commodity price slumps often last longer than price booms (see Cashin et al. 2002, who studied prices of 36 commodities from 1957:1 through 1999:8). The *WEO* (2012) broadly confirms these findings. Price slumps for aluminum, copper, lead, steel, and uranium last on average 3–3.5 years, and booms on average 2–2.5 years; coal slumps last about 2 years and booms about 1.5. In contrast, periods of price upswings for natural gas and crude oil, which average some 2.5 years, outlast periods of downswings by a few months.

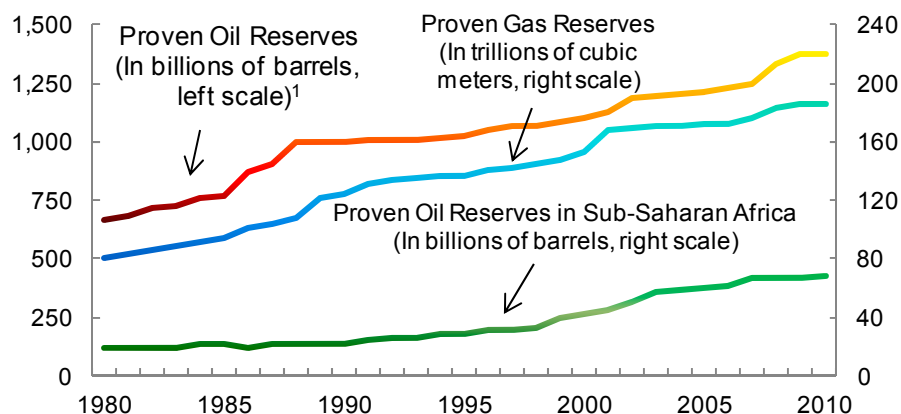
**The source of price swings matters.** Price swings driven by global demand are typically stronger and more persistent than those caused by supply conditions (IMF 2012b).

proven reserves for a number of commodities have been revised upward over time.<sup>4</sup> For example, proven oil reserves in sub-Saharan Africa more than tripled between 1990 and 2010, to nearly 70 billion barrels (Figure 1). Moreover, high prices have made extraction in difficult-to-reach areas economically viable. Since estimates of reserves and extraction may be projected with varying degrees of confidence, there may be merit in using a probabilistic approach to get a sense of possible extraction paths and thus the robustness of baseline projections.

<sup>4</sup> Proven reserves are typically defined as reserves that can be extracted with a high degree of confidence under existing conditions. As technology improves, it is likely that more natural resources can be extracted from existing sources (“reserve growth”). Also, the U.S. Geological Survey in April 2012 released mean estimates for yet *undiscovered*, technically recoverable, oil resources amounting to 565 billion barrels and gas resources amounting to 157 trillion cubic meters.

***Proven reserves of oil and gas have steadily been revised upward with new discoveries and better extraction technologies.***

**Figure 1. Changes in Proven Oil and Gas Reserves<sup>1</sup>**



Source: BP Statistical Review of World Energy, June 2011.

<sup>1</sup>Excludes Canadian oil sands.

3. **Revenue volatility creates a motive to save some of the resource revenues for precautionary reasons.** Prudent policymakers who wish to cope with sharp unwanted and unforeseen swings in resource envelopes may wish to build up a liquidity fund to smooth consumption spending (see Figure 2).<sup>5</sup> Saving for precautionary (prudential) reasons is conceptually different from other motives, such as intergenerational risk aversion (which aims to spread consumption spending over time because of lumpiness in the timing of revenue) and temporary parking of revenue to minimize absorptive capacity disruptions.<sup>6</sup> Conceptually, the optimal size of the liquidity buffer will be larger if revenue volatility is higher and more persistent, and if society dislikes consumption swings more (i.e., is more prudent). Also, the optimal liquidity buffer will be larger when consumption using resource revenue is higher. Consider two countries with similar resource inflows, one where the inflows are short-lived and the other where they are long-lasting. Absent any uncertainty, and other things being equal, the country with short-lived resource inflows optimally will consume relatively little, saving more, and the other will consume relatively much, saving less, of the resource inflows, all for intertemporal smoothing reasons. When there is

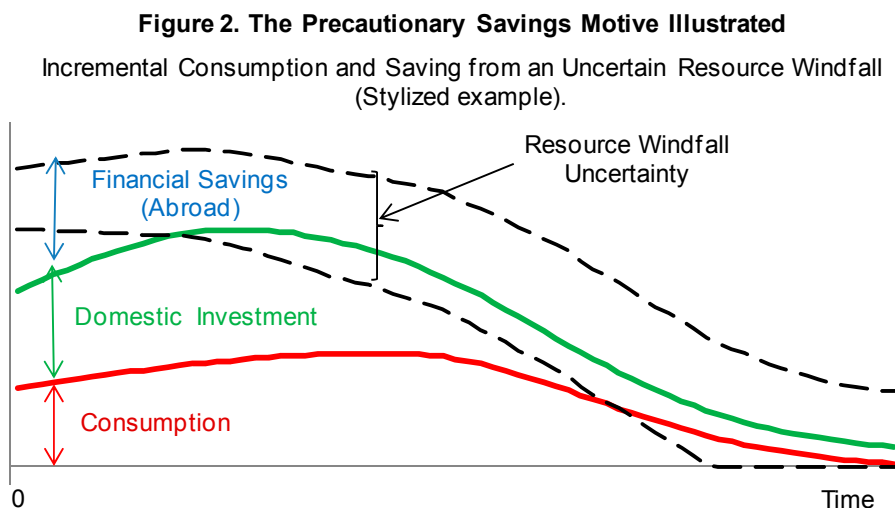
<sup>5</sup> In a strict sense the prudence motive applies to consumption spending. Policymakers may also dislike the impact of volatility on the resource envelope available for domestic investment, especially if the investments have multiyear implementation plans and other financing options are limited.

<sup>6</sup> Technically, risk aversion is captured by the concavity of the utility function while the prudence motive requires convexity of marginal utility—a positive third derivative of the utility function. Not all utility functions exhibit prudence characteristics (an example of a function that displays risk aversion without a prudence motive is quadratic utility).



uncertainty, however, consumption is likely to be more variable in the country with the long-lasting resource windfall, and optimally it will choose to build up a relatively large liquidity buffer.<sup>7</sup>

***Uncertainty about future resource flows may call for cautious spending plans and create a precautionary savings motive.***



4. **Self-insurance for precautionary reasons may be costly, especially in developing countries, which suggests that any impact from volatility needs to be managed rather than totally eliminated.** A number of authors have derived orders of magnitude of precautionary balances for oil producers where persistence in oil prices implies need for a large precautionary buffer. Van der Ploeg (2010) calculates that 3.75–7.5 percent of an oil windfall would need to be saved to cope with unexpected oil price volatility within a single quarter. When the horizon is extended to four years, the precautionary motive suggests that 30–60 percent of an oil windfall be saved. Cherif and Hasanov (2012a) also find sizable precautionary saving by oil exporters, on the order of 30 percent of income.<sup>8</sup> Finally, Bems and Carvalho (2011), using a sample of oil exporters to assess the importance of precautionary motives for the current account, found that the precautionary motive added about 1 percent of GDP (US\$36 billion for the sample) to the current account balance in 2007, with substantial country variation depending on the degree of resource dependency.

5. **In practice, policy makers may wish to build liquidity buffers based on what they consider a tolerable degree of confidence that the buffer will be adequate if there is a tail-risk shock.** A value-at-risk (VaR) or DSGE model-based approach could be used to derive the buffer.

<sup>7</sup> The technical details of this argument are discussed in van den Bremer and van der Ploeg (2012). They also discuss an application to Iraq (large and long-lived oil revenue) and Ghana (small and short-lived oil revenue).

<sup>8</sup> Gelb and Gasmann (2010) use a stylized model to show that countries should contain spending to save abroad more than half of a resource revenue boom, at least at first (and not necessarily for purely precautionary reasons).

These simulation methods make it possible to calculate the required liquidity buffer to absorb a tail-end adverse price shock across a spectrum of price paths over a period of time. Bartsch (2006) assessed a number of fiscal rules for Nigeria, with spending envelopes based on 3–5-year average oil prices, and applied a VaR approach to derive the size required for the liquidity fund. He found that a fund of US\$16–18 billion (75 percent of 2004 revenue) would be tolerable, in the sense of having more than 80 percent confidence that it would not be exhausted within five years. A similar exercise was conducted for the Republic of Congo (see Chapter III.A). With an 8-year moving average oil price rule (5 historical years and 3 years of forward projection), it was found that with a high degree of confidence a stabilization buffer of about 48 percent of non-oil GDP would be needed to avoid depletion within three years. The DSGE model-based approach has a richer economic structure. An application to Angola found that under an aggressive public investment scaling up scenario, a stabilization buffer can still be built, but with a 30 percent probability that the fund is inadequate to prevent future spending cuts (see Chapter III.B and Box 3 in the main paper).

6. **Developing countries might also consider using market-based instruments to manage commodity price volatility.** Countries can enter into over-the-counter forward contracts to lock in prices or hedge price risk with options.<sup>9</sup> While several countries have used market-based hedging instruments—Mexico, for example, has bought put options on oil to insure against a fall in prices—they are probably still under-used by developing countries, including commodity exporters. A number of factors could explain why such instruments are not used more often; for instance, these contracts can be technically complex, costly, hard to communicate to stakeholders, and politically risky.<sup>10</sup>

7. **RRDCs also need to take into account uncertainty about the return on investment.** While capital scarcity calls for ramping up spending for domestic investment, taking into account absorptive capacity constraints, the additional savings required for precautionary purposes will slow the scaling up of investment. In reality, the return on investment is risky, and could even be negative sometimes. Where there is risk aversion, uncertain returns on investments will slow the speed at which investment spending is ramped up; instead, countries will want to invest relatively more in safe assets or to repay debt faster.<sup>11</sup>

8. **When there is both uncertainty and volatility, the approach to natural resource management should be holistic.** Policy makers will need to carefully balance consumption spending and savings when resource revenue flows are uncertain and volatile. Spending can be

<sup>9</sup> These countries could also pursue other insurance-type strategies, such as linking debt to commodity prices or investing in assets with low or negative correlation with commodity returns. For a detailed description of the use of contingent financial instruments, see IMF (2011).

<sup>10</sup> For example, it may be hard to explain to voters that the cost of a long option was justified when it was not exercised or why a revenue windfall is being offset by losses in futures contracts. On the supply side, some investors may be reluctant to enter into hedging deals with sovereigns when they fear that political fallout might induce them to want to renegotiate contracts.

<sup>11</sup> Van den Bremer and van der Ploeg (2012) and Cherif and Hasanov (2012b) discuss how uncertainty coupled with risk aversion and prudence can explain why resource producers can have high savings and low investment rates.

safeguarded by setting aside a liquidity buffer as a precaution. Additional savings can be used to pay down debt, ramp up domestic investment spending, or invest in external financial assets to benefit future generations (for example, when absorptive capacity constraints make it impossible to invest faster).

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## B. Fiscal Analysis for Resource-Rich Developing Countries<sup>12</sup>

### Fiscal Sustainability Analysis

*This section provides a fiscal sustainability framework for countries with non-renewable natural resources, adapting some simple identities to the realities of resource rich countries.*

9. The overall fiscal balance ( $OB_t$ ) in year  $t$  can be decomposed into resource revenues ( $RT_t$ ) and non-resource revenues ( $NRT_t$ ), primary expenditure ( $E_t$ ), income from the initial stock of financial assets ( $A_{t-1}$ ), and interest payments on the initial stock of liabilities ( $D_{t-1}$ ):

$$OB_t = NRT_t - E_t + RT_t + i_t^a A_{t-1} - i_t^d D_{t-1}, \quad [1]$$

where  $i_t^a$  and  $i_t^d$  are the net interest rates associated with the stock of assets and liabilities, respectively. The overall fiscal balance is also equal to the change in the net financial assets:

$$OB_t \equiv \Delta(A_t - D_t) \quad [2]$$

The non-resource primary balance can then be defined as:

$$NRPB_t = NRT_t - E_t \quad [3]$$

10. Resource-rich countries often run overall fiscal surpluses, which can facilitate the accumulation of substantial financial assets over time, but the NRPB is often in deficit. The law of motion of net financial assets ( $A_t - D_t$ ) is given by:

$$A_t - D_t = NRPB_t + RT_t + (1 + i_t^a)A_{t-1} - (1 + i_t^d)D_{t-1} \quad [4]$$

11. As in other countries, the government's inter-temporal budget constraint requires that the initial stock of net debt equals the present value of the cumulative future primary balances. For countries with exhaustible natural resources, this condition can be disaggregated into: the (i) NRPB and (ii) the resource revenue (accruing only for a fixed period of time,  $N$ , which is a function of the reserve horizon). Assuming for simplicity that all assets and liabilities are discounted at the same constant rate  $i$ , after imposing the no-Ponzi game condition,<sup>13</sup> this can be expressed as:

$$A_{t-1} - D_{t-1} = - \sum_{s=t}^{\infty} \frac{NRPB_s}{(1+i)^{s-t+1}} - \sum_{s=t}^N \frac{RT_s}{(1+i)^{s-t+1}}. \quad [5]$$

<sup>12</sup> Prepared by Alex Segura-Ubiergo, Marcos Poplawski-Ribeiro, Christine Richmond, Santiago Acosta, and Mauricio Villafuerte (all FAD).

<sup>13</sup> The no-Ponzi game condition (also called the transversality condition) essentially means that the government does not service its debt (principal and interest) by issuing new debt on a regular basis. See Escolano (2010).

12. Equation 5 describes the inter-temporal budget constraint consistent with fiscal sustainability. It states that the stabilization of net wealth is a function of the present discounted value of future NRPB and the present discounted value of future resource revenues. Net wealth is stabilized when the present discounted value of future resource revenues is equal to the present discounted value of future non-primary balance deficits (or future non-primary balances, with a negative sign).

13. The assets the government holds in the form of natural resources can be viewed financially as the present value of the future path of resource revenue (the “resource wealth”). Thus, the net wealth ( $W_{t-1}$ ) of the government at the end of period  $t - 1$  is given by the net financial assets accumulated by the end of period  $t-1$  ( $A_{t-1} - D_{t-1}$ ), plus the present value of the natural resources asset in the ground ( $V_{t-1}$ ). Hence, the following identity:

$$W_{t-1} \equiv A_{t-1} - D_{t-1} + V_{t-1} = - \sum_{s=t}^{\infty} \frac{NRPB_s}{(1+i)^{s-t+1}}, \text{ where } V_{t-1} \equiv \sum_{s=t}^N \frac{RT_s}{(1+i)^{s-t+1}}. \quad [6]$$

These definitions imply that  $V_t = (1 + i)V_{t-1} - RT_t$  and  $W_t = (1 + i)W_{t-1} + NRPB_t$ . [7]

14. From this framework, the change in the government’s wealth in nominal terms is determined by the NRPB and the net return on the previous period’s wealth. This can be decomposed into the returns on financial assets and on the natural resources in the ground, minus the interest payment on debt:

$$\Delta W_t = (NRT_t - E_t) + (A_{t-1} + V_{t-1} - D_{t-1})i. \quad [8]$$

15. The change in government wealth can also be presented as a share of nominal non-resource GDP,  $Y_t$ , which can be defined as  $Y_t = Y_{t-1}(1 + \gamma_t)$ . Nominal GDP growth can be decomposed into baseline growth  $\gamma_t^{base}$  plus a potential growth premium in response to frontloaded investment  $\gamma_t^{premium}$ , such that:

$$\gamma_t = \gamma_t^{base} + \gamma_t^{premium}. \quad [9]$$

16. Equation [9] is useful to consider the impact of higher investment on growth and the effect on fiscal sustainability (see below).

The associated ratio of non-resource primary balance to non-resource GDP is defined as:

$$nrpb_t = \frac{NRT_t}{Y_t} - \frac{E_t}{Y_t}. \quad [10]$$

17. where  $nrpb$  is the NRPB simply expressed as a percent of non-resource GDP. All remaining variables can also be redefined as ratios to non-resource GDP. Hence, the change in government wealth is determined by the NRPB (relative to non-resource GDP) and the growth-adjusted return

on net assets. Interest and growth rates can be stated in nominal ( $i, \gamma$ ) or real ( $r, g$ ) terms. Assuming a constant non-resource growth rate gives<sup>14</sup>:

$$\Delta w_t = nrpb_t + (a_{t-1} + v_{t-1} - d_{t-1})\lambda, \text{ where } \lambda = \frac{i-\gamma}{1+\gamma} = \frac{r-g}{1+g}. \quad [11]$$

18. The intertemporal budget constraint can therefore be restated in percent of non-resource GDP:

$$nrpb_t^* = nrt_t - e_t = \lambda(d_{t-1} - a_{t-1} - v_{t-1}), \text{ for } \Delta w_t = 0. \quad [12]$$

### The PIH-Based Rule

19. There are many alternative paths for the NRPB that are fiscally sustainable, i.e., satisfy the no-Ponzi game condition.<sup>15</sup> A simple, but restrictive, path is the benchmark provided by the permanent income hypothesis (PIH), which assumes constant net wealth starting immediately (in real terms, or as a percent of non-resource GDP, or in real per capita terms).

20. To be sustained for an infinitely long period, the annual level of the primary balance should be equal to the return on net wealth, adjusting for inflation; the notional real return on wealth is the real interest rate ( $\tilde{r} = \frac{i-\pi}{1+\pi}$ ), where  $\pi$  is the constant long-term inflation rate.

21. The following rule is therefore consistent with keeping the real NRPB constant: ( $NRPB_t = -\tilde{r}W_{t-1}$ ), where  $NRPB_t$  and  $W_{t-1}$  are now expressed in real terms. Alternative (more restrictive) benchmarks could be to keep real spending constant per capita or constant as a share of non-resource GDP.

### The Modified PIH (MPIH) with Scaling up of Capital Spending

The PIH framework can be modified to accommodate scaling up of public investment.

22. The modified PIH assumes that government front-loads investment spending above the baseline forecasts by  $I'_t$  until the last year of investment front-loading, year  $F$  (e.g.,  $F = 2018$ ). The additional front-loaded capital spending could be financed by “saving” less natural resource revenue during the scaling up period. In this case, the accumulation of financial assets ( $A_t$ ) would be lower during the scaling up period than in the baseline. The higher capital spending would also directly reduce the NRPB during the front-loading years, in line with the scaling up period by the amount of  $I'_t$ .

<sup>14</sup> For simplicity, we assume that growth-adjusted interest rates are positive (i.e., either  $i - \gamma > 0$  or  $r - g > 0$ ). Moreover, to derive equation 12 we use the fact that  $w_t = a_t + v_t - d_t$ , and that in the long run the GDP deflator and the CPI are the same.

<sup>15</sup> When net wealth is assumed to remain constant the no-Ponzi game condition is automatically satisfied.

23. Two additional assumptions characterize this simple fiscal framework. First, in order to assess the government's intertemporal spending choice, the potential growth premium in response to the front-loaded investment is assumed to be equal to zero, i.e.,  $\gamma_t^{premium} = 0$ . Second, over the long run (e.g., year  $T$ ), the level of financial wealth from this front-loaded investment scenario ( $W'_T$ ) has to be equal to the level from the usual PIH fiscal framework:

$$W'_T = W_T, \text{ where } T > F. \quad [13]$$

24. These two assumptions together imply that the front-loaded investment has to be fully compensated by a fiscal adjustment in the medium term (spread over  $T - F$  years). This adjustment would directly increase the NRPB and generate an extra accumulation of financial wealth  $A'_T$  during the period  $F$  to  $T$ . Hence, the level of financial wealth after year  $T$  would be the same for the two alternative fiscal paths.

25. In other words, the future value of the total front-loaded investment spending (and related decrease in the NRPB) in year  $T$  has to be equal to the future value of the total fiscal adjustment (increase in the NRPB in the same year). In terms of financial wealth ( $W$ ), this can be represented by:

$$\sum_{s=t}^T I'_s (1+i)^{s-t+1} = \sum_{s=t}^T A'_s (1+i)^{s-t+1}, \text{ where } I'_s, A'_s \geq 0. \quad [14]$$

26. The MPIH approach provides an *ex ante* measure of possible future fiscal adjustment needs if the scaling up of investment does not have an impact on growth. It does not imply that policy makers explicitly believe that scaling up will not have an impact on growth. Rather, it assumes that given the uncertainty of higher investment on growth, policy makers should not incorporate this impact *ex ante* in their medium-term plans. It therefore provides a future fiscal adjustment path in a worst case scenario where higher public investment has no impact on growth and hence provides a measure of the potential implications for future fiscal adjustment (see simulation below).

### **Fiscal Sustainability Framework (FSF) for Resource-Rich Countries**

27. This approach allows for a stabilization of net wealth at lower levels than with the PIH or MPIH framework. Higher investment is assumed to have a positive impact on growth,  $\gamma_t^{premium} > 0$ , which generates higher non-resource revenues ( $\tau'_t$ ), but also leads to an increase in operation and maintenance expenditures ( $\sigma$ ). Both variables affect the  $NRPB_t$ , but the key feature is that this framework allows for a fiscally sustainable level of financial wealth that is lower than in the PIH or MPIH. The specific stabilizing target for net wealth (and the time horizon by which it is to be achieved) is country-specific since it involves estimating the interactions between government spending needs and non-resource growth.<sup>16</sup> As a percent of non-oil GDP, wealth evolves before

<sup>16</sup> In addition to the growth impact as well as recurrent and replacement costs of additional public investment.

being stabilized according to the law of motion described by equation 14. Once wealth is finally stabilized at year  $F$ , the associated constant non-resource primary balance is given by

$$nrpb = -\frac{1-\gamma}{1+\gamma} w_{F-1}.^{17} \quad [15]$$

28. Hence, in the FSF, the following effects are to be expected:

- An increase in public investment will have a positive impact on non-resource GDP growth through  $\gamma^{premium} > 0$ . The higher non-resource GDP growth rate will lower the growth-adjusted asset return. Using equation 15, and assuming no debt and positive  $a$  and  $v$ , if  $(i - \gamma) > 0$ , then  $nrpb^* < 0$ . On the other hand, if  $(i - \gamma) < 0$ , then  $nrpb^* > 0$ . In all cases where investment increases growth, the wealth-stabilizing NRPB will increase for a given nominal or real interest rate.
- Non-resource tax collections will also increase if growth is higher. The fiscal impact will depend on the non-resource tax ratio/effort,  $NRT_t = \tau Y_{t-1} (1 + \gamma^{base} + \gamma^{premium})$ . For a given size of the net wealth-stabilizing NRPB, higher growth will allow for a higher primary expenditure path.
- Higher investment is likely to be associated with higher operation and maintenance expenditures ( $\sigma$ ), worsening the  $NRPB_t$ .

29. Two important differences between the MPIH and the FSF are therefore worth noting:

- The FSF allows for a positive impact of investment on growth  $\gamma^{premium} > 0$ , but also on tax collection, and on operation and maintenance spending ( $\sigma$ ).
- In contrast with the MPIH, the FSF wealth is stabilized at a lower level after the front-loaded investment, ( $W'_F < W_F$ ). This new level,  $W'_F$ , is computed using the usual PIH framework (present value of remaining natural resources assets) after  $F$  periods of front-loaded investment,  $(V_F = \sum_{s=F+1}^N \frac{RT_s}{(1+i)^{s-F}})$ .
- Since financial wealth is allowed to decrease in this framework, the implicit adjustment path of fiscal variables can be smoother than with either the PIH or the MPIH framework. The intuition behind this framework is that instead of accumulating higher financial savings, the country has accumulated higher physical assets that also provide a fiscal return.

<sup>17</sup> This approach for assessing fiscal sustainability is followed in the application of the framework to the Republic of Congo.



## Practical Considerations in Selecting Fiscal Anchors

30. This section analyzes some of the key issues discussed in this section from a practitioner’s point of view. It uses a stylized example of a resource-rich country and simulates the effects of alternative fiscal rules. These simulations are generated with an Excel-based template developed by the Fiscal Affairs Department (FAD) of the IMF in consultation with other departments. Using a series of data inputs, this template generates simulations of fiscal policy dynamics. It is designed to help IMF teams and country authorities analyze the tradeoffs associated with alternative fiscal rules. Visualizing these trade-offs in practice and assessing the implications of alternative assumptions and scenarios can help inform policymakers about the best fiscal anchors given country-specific circumstances. These templates are still in an experimental phase and will evolve further during the second phase of this project.

31. The stylized example uses an RRDC with a non-oil sector growing at a constant annual rate of 3 percent in real terms and contributing about 20 percent of non-oil GDP to government revenues. The oil revenue share accruing to the government is assumed to be a constant 50 percent. Inflation is constant at 5 percent a year, while the average real rate of return on financial assets is assumed to also be 5 percent. For the sake of simplicity, the country has no outstanding liabilities when the framework/rule is initiated.

32. The exercise has two parts. The first analyzes long-term sustainability, assuming that the resource horizon is 35 years and that production of natural resources rises steadily from 2012 to 2029. The objective of this part is to simulate three alternative ways of computing fiscal sustainability benchmarks:

- *Traditional PIH*, where the NRPB remains constant over time and is financed with the rate of return on accumulated financial assets plus the net present value of projected resource revenues;
- *The modified PIH (MPIH)*, which allows for a scaling up of public investment during 5 years, but requires substantial fiscal adjustment to offset the initial scaling up and satisfy the inter-temporal budget constraint; and
- *The Fiscal Sustainability Framework (FSF)*, which incorporates the impact of higher public investment on growth, and non-resource revenues and, hence, generates a fiscally sustainable path that is consistent with a lower level of financial wealth. As noted above, the FSF requires a higher NRPB than the PIH because the steady state level of financial wealth over the long-term is lower, but since part of the resource wealth has been transformed into physical assets, growth and non-resource revenues are higher; so this is also consistent with a higher level of expenditures.

33. The second part of the exercise analyzes trade-offs in the operation of different short-to-medium-term fiscal rules. It looks at the effects of different price-based rules targeting a zero percent structural primary balance as a percent of non-resource GDP. A higher/lower primary

balance can be targeted in countries that want to increase or decrease the level of financial savings over time. The exercise simulates how these rules would have performed in the past, using the evolution of oil prices for the past 40 years and showing how they would have performed in terms of smoothing out volatility and generating different levels of financial assets. It also simulates how the interaction of a price-based rule with a long-term sustainability benchmark can be implemented in practice and shows a comparison between the primary balance target and the accumulation of financial savings over time.

34. The country presented in this exercise is precisely at the boundary of the resource revenue horizon and hence could either have started with an NRPB rule associated with a sustainability benchmark, or with a price-based rule calibrated to take into account sustainability issues. The precise implication of these issues requires working with several fiscal rules at the same time. For example, where countries confront exhaustibility issues, this could take the form of an NRPB rule to maintain sustainability. In other countries a price-based rule could be used to smooth out volatility but calibrated in a way that ensures sustainability (i.e., higher structural primary balance target or using “prudence” in setting long-term prices, or both). This would also affect the path for the NRPB.

### Assessing Long-Term Sustainability in Practice

35. Long-term sustainability should be assessed through the use of a PIH, MPIH, or FSF (see technical description above). The importance of this step is a function of the length of the resource horizon. Sustainability benchmarks are more relevant the shorter the estimated reserve horizon. A simple practical rule of thumb would involve the following steps.

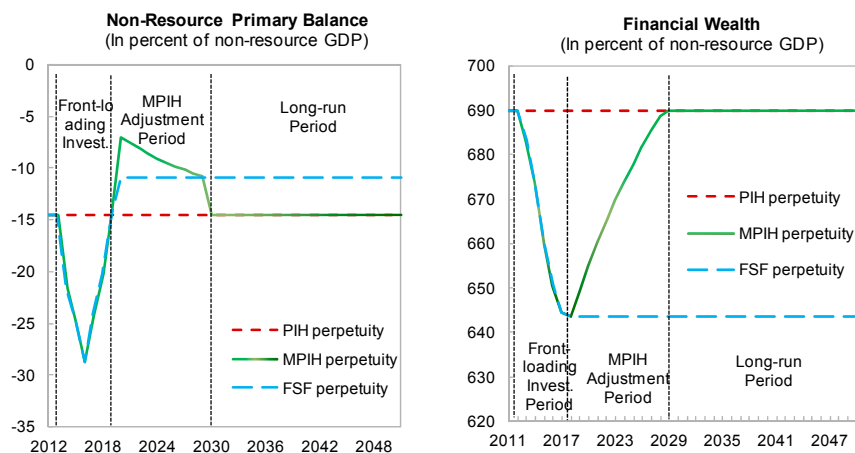
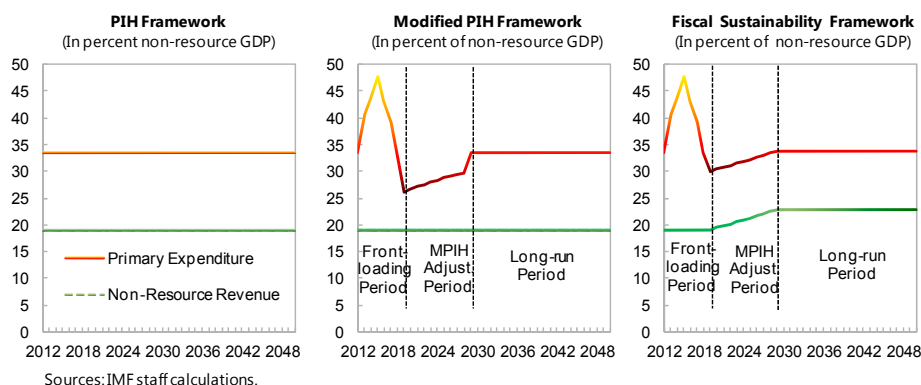
- *Compute the PIH sustainability benchmark.* This benchmark is given by the NRPB that stabilizes net financial wealth over the long run ( $NRPB_t = -\tilde{r}W_{t-1}$ ). This is an indication of the non-resource primary deficit that could be maintained indefinitely once resource wealth is exhausted.<sup>18</sup> Figure 3 compares the three frameworks for a stylized country in which oil reserves last until 2046. In this example, the present value of oil wealth ( $V_{t-1} \equiv \sum_{s=t}^N \frac{RT_s}{(1+i)^{s-t+1}}$ ) at the end of 2010 corresponds to 679 percent of non-resource GDP.<sup>19</sup> Assuming again a constant real interest rate of 5 percent and a constant real growth rate of non-resource GDP of 3 percent, the *nrrpb\** consistent with the PIH sustainability benchmark is equal to -14.3 percent of non-resource GDP, as shown by the red dashed line in the first chart of Figure 3. Figure 4 shows the paths for primary expenditure and non-resource revenue for all three fiscal frameworks. With the PIH, the constant *nrrpb\** combined with an assumption of constant non-resource revenue at 19 percent of non-resource revenues, stabilizes primary expenditure permanently at 33.3 percent of non-resource GDP.

<sup>18</sup> Note that once resource wealth has been exhausted the NRPB will be equal to the primary balance.

<sup>19</sup> The assumed nominal interest rate on this example is 10.25 percent.

- *Assess the fiscal implications of a modified PIH (MPIH) scenario.* This step estimates the inter-temporal trade-off between a short-term increase in spending and future fiscal adjustment needs. Fiscal adjustment needs will be such that the future value of the financial wealth in year  $T = 2028$  after the start of the front-loaded investment period is equal to the financial wealth level with the usual PIH ( $W'_T = W_T$ ), where  $W'_T$  is the level of financial wealth following a fiscal path with an initial front-loading of investment followed by fiscal adjustment (see section I, C2 above). In the example below, an MPIH scenario allows for an increase in annual capital spending equivalent to 7.9 percent of non-resource GDP on average for the 5 years. The period of front-loaded investment then needs to be compensated by an annual improvement in the NRPB of 5.4 percent of non-resource GDP on average, smoothed over 10 years. The path for the NRPB under the MPIH is given by the solid green line in the first chart of Figure 3. For the financial wealth to be the same in both the MPIH and PIH after  $T$  periods, the future value of the cumulative increase in investment during the front-loading period has to be equal to the future value of adjustment after  $T$ . This strategy maintains wealth constant after year  $T = 2028$ . Figure 4 shows a similar path for the NRPB with an initial increase owing to the investment front-loading and then an adjustment returning to the PIH level of 33.3 percent of non-resource revenues after  $T = 2028$ . Table 1 also reports the average values of revenues and spending under the three frameworks.
- *Consider the fiscal implications of an FSF scenario.* This involves the calculation of the new (lower) financial wealth value in the FSF scenario assuming a positive impact of front-loaded investment on growth. The precise impact of higher public investment on growth is difficult to measure. However, one can make an assumption of the growth impact and compute the new stable financial wealth after the front-loaded investment, such that ( $W'_T < W_T$ ). This exercise is shown by the blue dashed lines in Figure 3. After the period of front-loaded investment, a new PIH exercise is performed for the remaining oil wealth and financial assets accumulated at that point, but taking into account the growth impact of the additional public investment. Assuming a permanent additional effect of 1 percent on real growth and a reduction in the positive value of  $r - g$ ,<sup>20</sup> after the front-loading investment period  $F = 2018$ , the new lower wealth level becomes 633 percent of non-oil GDP and the  $nrrpb^*$  is stabilized at the lower deficit of -10.9 percent of non-resource GDP. As Figure 4 shows, the primary expenditure path depends on the multiplier effects of the front-loaded investment on the economy. For this exercise, the assumption is that the fiscal multiplier becomes larger than 1 just after the front-loaded investment and returns to its steady state level equal to 1 in the long run. This way, even if the  $nrrpb^*$  is lower in the FSF than in the PIH, the level of primary expenditure can be the same or even higher depending on the additional growth impact of public investment and the multiplier of the economy, given that this will increase non-resource revenues. A final computation could be finding the interest-growth rate differential that allows to be the same as in the PIH model.

<sup>20</sup> The growth impact is based on the amount of planned public investment and on its estimated elasticities in non-resource GDP growth (see Tabova and Baker, 2012).

**Figure 3. Fiscal Sustainability Frameworks for Resource-Rich Countries: Non-Resource Primary Balance and Financial Wealth**

**Figure 4. Fiscal Sustainability Frameworks for Resource-Rich Countries: PIH, Modified PIH, and FSF**

**Table 1. Average Fiscal Variables Under the Fiscal Sustainability Frameworks**

	PIH			MPIH			FSF		
	Scaling up	Adjustment	Steady state	Scaling up	Adjustment	Steady state	Scaling up	Adjustment	Steady state
Non-resource revenue	19.0	19.0	19.0	19.0	19.0	19.0	19.0	20.6	22.7
Total Primary Expenditure	33.3	33.3	33.3	41.1	27.9	33.3	41.1	31.5	33.6
Current Spending	29.9	29.9	29.9	29.9	27.9	29.9	29.9	29.9	29.9
Capital Spending	3.3	3.3	3.3	11.2	0.0	3.3	11.2	1.6	3.7
Non-resource primary balance	-14.3	-14.3	-14.3	-22.1	-8.9	-14.3	-22.1	-10.9	-10.9

Source: IMF staff estimates.

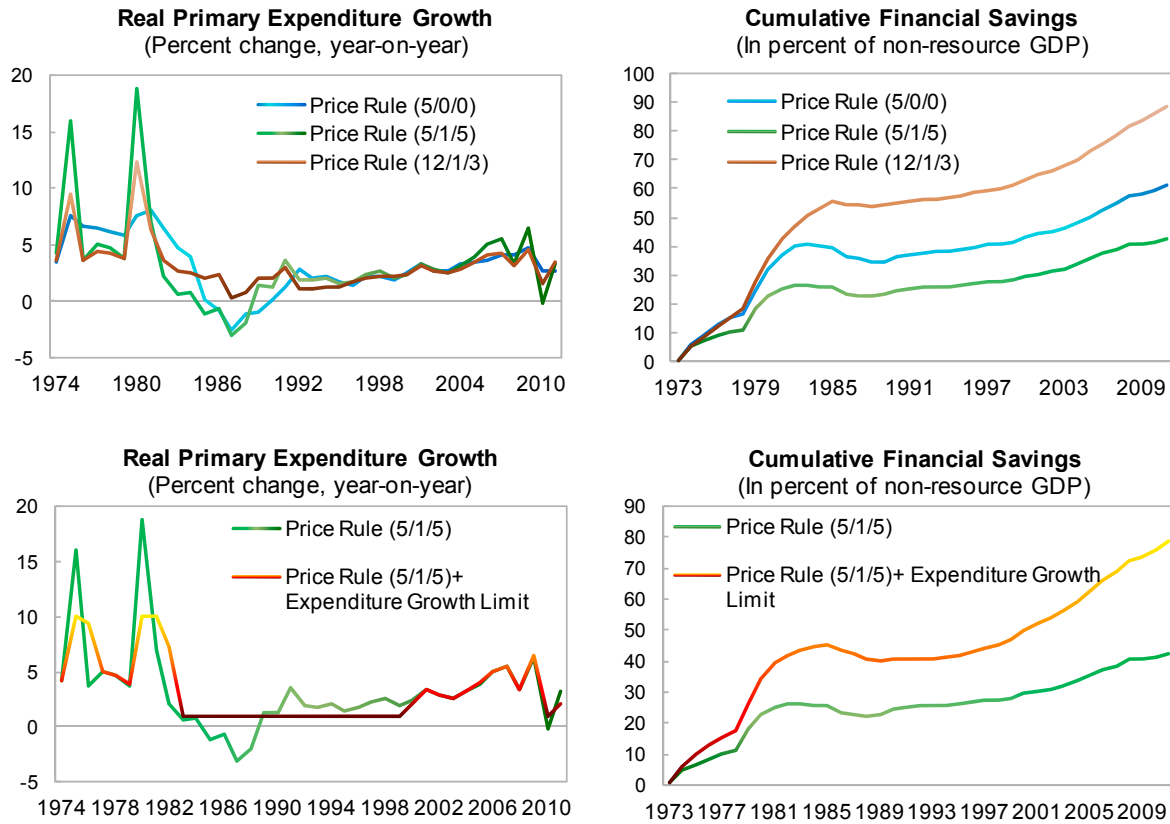
## Dealing with Price Volatility

36. We assume in this simulation that a price-based rule has been chosen (i.e., structural primary balance rule with price smoothing). As the main fiscal rule, this approach would be more appropriate for countries with relatively long reserve horizons. This rule is also more helpful in practice when resource dependence is high and thus the use of the NRPB in a fiscal rule becomes less politically attractive due to the difficulties of communicating large negative numbers to the public. Figure 5 shows the performance of alternative price rules in terms of smoothing out volatility, both when used in isolation and when combined with an expenditure growth rule. Figure 6 shows how a price-based rule could be combined with a long-term sustainability benchmark, and how the choice of structural balance target generates higher, or lower, financial buffers. Possible steps could include:

- *Calibrate the rule based on past historical experience and the desired policy objective (higher or lower financial savings).* In this example (Figure 5), we illustrate the trade-offs available to a country that has decided to use a price-based rule using different computation formulas. The country would start by observing how different calibrations of the price-based rule smooth out volatility and generate fiscal buffers. In this case, a rule based on a long moving average of resource prices (the black line in panel 1) does the best in terms of expenditure smoothing but generates a relatively high level of financial savings (panel 2). This may be more or less appropriate depending on whether the country is using this rule just to smooth out short-term volatility or, like Chile, also to generate financial savings over time. A rule with a combination of past and future expected prices (red line) generates more volatility but would be consistent with less financial savings. The key trade-off is between volatility and the level of financial savings. To be sure, given the uncertainty about the future path of resource prices, past performance provides only limited guidance. The intent, however, is to have a mechanism to make simulations about the implications of alternative choices.
- *Decide whether a complementary rule is needed to further smooth out volatility.* Where avoiding volatility and fiscal procyclicality is the most important objective, an expenditure growth rule can be used in combination with the price-based rule. Figure 5 (Panel 3) shows how the use of the expenditure growth rule manages to smooth out expenditure to a much greater degree. However, in such cases where commodity prices rise for a long period, the use of this rule may be conducive to higher savings than desired (panel 4) consistent with sustainability concerns.
- *Assess trade-offs in managing volatility and sustainability issues.* Price-based rules can also be visualized in combination with long-term sustainability benchmarks. Figure 6 (Panels 1–3) simulate a price-based rule under different paths for the evolution of resource prices. Following price-based rules could result in expenditure paths far from those suggested by the sustainability-focused benchmarks, suggesting that investment scaling up plans may need adjustment or implying a drawdown of wealth. Panel 1 assumes high oil prices, which leads to deficits substantially higher than those implied by the sustainability benchmark. Panel 2 assumes very low oil prices over the next 20 years, which indicates that investment scaling up

would happen just at the time when price rules suggest a reduction in deficits. Panel 3 presents a more favorable scenario, with oil prices evolving in such a way that the price-based rule balance follows the sustainability benchmark relatively closely. Panel 4 simulates different levels of financial savings for a given price-based rule, under alternative structural primary balance targets. The results suggest that small changes in the target can have large impacts on savings

**Figure 5. Expenditure and Savings Outcomes Under Various Price Rules<sup>1</sup>**

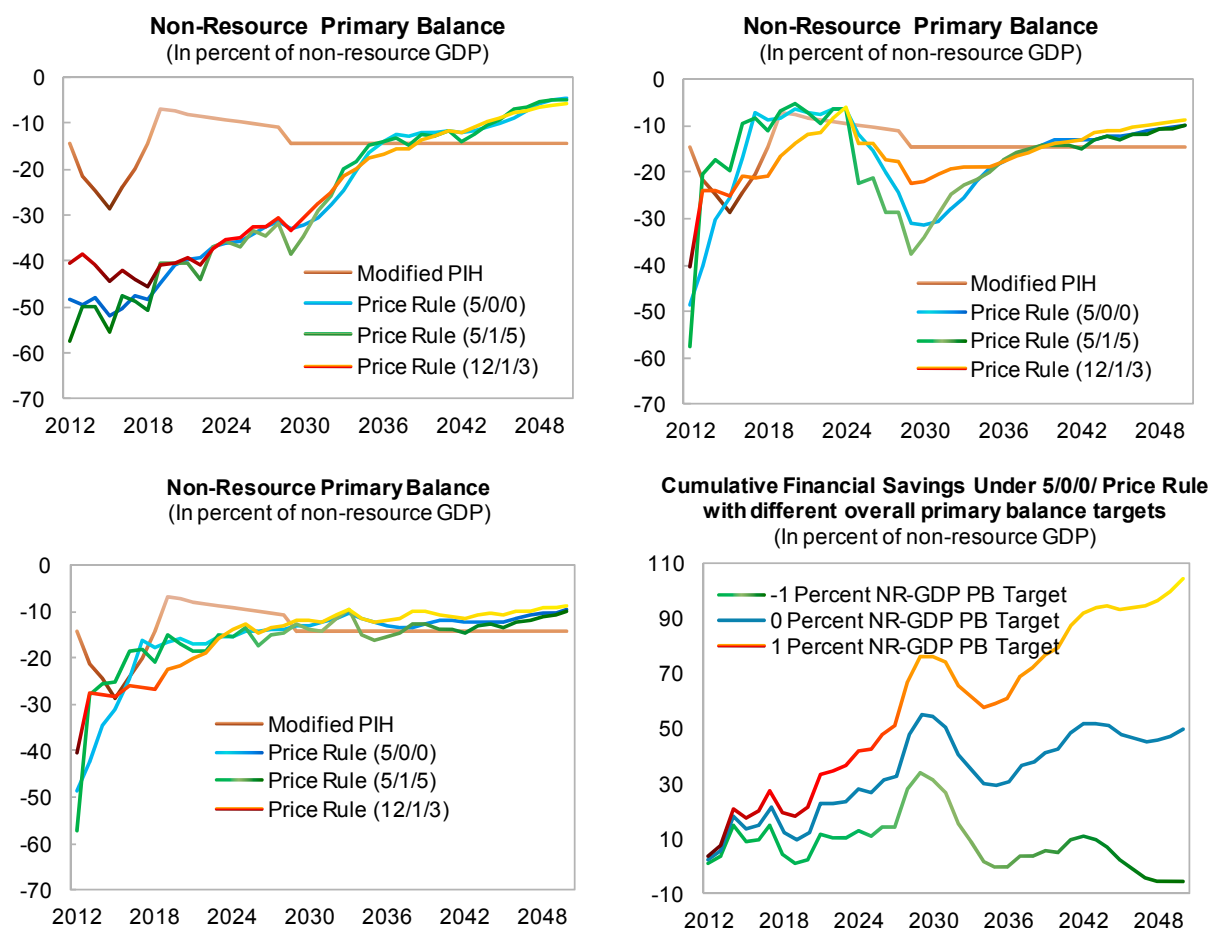


Source: IMF staff estimates.

<sup>1</sup> The numbers associated with the price rules correspond to the number of years in the past, present, and future used in the smoothing calculation. For example, the “12/1/3” rule uses 12 years of past prices, the current year price, and a 3-year projection for the calculation.

over time and indicate the need to reassess existing targets periodically.

**Figure 6. Volatility and Sustainability Under Various Fiscal Rules<sup>1</sup>**



Source: IMF staff estimates.

<sup>1</sup> The numbers associated with the price rules correspond to the number of years in the past, present, and future used in the smoothing calculation. For example, the “12/1/3” rule uses 12 years of past prices, the current year price, and a 3-year projection for the calculation.

## Priorities for Public Financial Management in Resource-Rich Countries

37. **While PFM requirements are broadly the same across countries, certain dimensions need to be emphasized in the resource-rich countries** (see also <http://blog-pfm.imf.org> and Dabán, Sánchez, and Héris, 2010).

38. **Forecasting resource revenues.** Forecasting revenue flows that are large, volatile, and uncertain require capacity and appropriate tools. The complexity of tax or other fiscal arrangements also complicates revenue forecasting—progressivity in taxation could also increase volatility. Forecasting frameworks would ideally have the following features:

- *Bottom-up forecasts.* Revenue forecasts that build on individual extraction projects better capture the evolving revenue path over the life of the project and any project-specific fiscal terms. A prudent approach is only to include proven reserves in the revenue forecasts
- *Aggregation of individual project forecasts.* Revenue forecasts from individual projects need to be integrated into an aggregate resource revenue forecast for the medium term fiscal frameworks.
- *Capacity for sensitivity analysis.* The revenue forecasting framework should allow for sensitivity analysis and alternative scenarios under different assumptions regarding price, costs, and volume.

39. **Medium-term budget planning.** A medium-term orientation to budget planning would help to ensure that natural resource revenues are utilized in a sustainable manner. Key components are

- *Medium-term fiscal framework (MTFF).* The budget should be underpinned by an MTFF with forecasts for broad fiscal aggregates for revenues and expenditures. The MTFF should be formulated in line with a fiscal rule.
- *Medium-term budget and expenditure frameworks.* Aggregate expenditure forecasts need to be translated into disaggregated expenditure ceilings including the investment program. The level of disaggregation could initially be done with less granularity, focusing on larger expenditure categories before moving toward component programs.

40. **Investment appraisal, selection, and implementation.** Countries need to ensure they have the capacity to efficiently appraise, select, and implement public investment, including public-private procurements, so they can overcome absorption constraints that would otherwise prevent productive scaling up of capital and investment spending. The following components are essential (Rajaram et al., 2010):

- *Investment plan integrated with the budget,* including medium-term expenditure plans and budget ceilings. Where a country faces absorption and capacity constraints, the investment plans and ceilings should provide a gradual path for scaling up investment rather than large changes.
- *Project appraisal, selection, and implementation.* A clear process is needed to appraise project proposals, which also requires developing sector expertise in key infrastructure areas. Capacity for executing and overseeing projects needs to be enhanced. This also requires having in place rules-based and transparent procurement procedures (including competitive bidding).
- *Ex-post evaluation.* A process needs to be in place for an objective evaluation of the selection and implementation of projects to ensure that lessons of both success and failure can be applied to strengthen future project planning and implementation.



- *Multiyear funding for investment projects.* For large investment projects, it is important to fully account for the full costs of project implementation, which may extend over several years. Likewise, recurrent costs also need to be factored in.

41. **Transparency.** The integrity of resource revenue utilization depends upon the transparency, quality, and timeliness of government accounting and reporting. Best practice guidance is available in the *Fiscal Transparency Manual* and the *Guide on Resource Revenue Transparency* (IMF, 2007).

### Additional Fiscal Indicators

42. **In light of the unique policy challenges faced by resource-rich countries, the fiscal policy framework needs to be based on a multiple indicator approach.** Focusing exclusively on conventional indicators, such as the overall and primary balances, would result in incomplete and potentially misleading conclusions about the sustainability of public finances and the impact of fiscal policy on the economy. In addition to the NRPB discussed above, the following indicators can be considered:

43. **The overall (or primary) balance, common in countries without natural resources, measures the change in net financial assets.** This indicator provides a measure of related fiscal vulnerabilities as well as net financing needs in the event of declines in resource revenue. However, this indicator can often be procyclical in resource-dependent countries: with rising resource revenues, a fiscal expansion (increase in spending) can be masked by an improving overall balance. At the same time, a persistently negative overall fiscal balance in a resource-rich country would have to be assessed carefully, as it would imply, under certain conditions, that the country is continuously increasing its net debt.

44. **Other complementary indicators might be the current balance (which excludes public investment); the domestic balance (which excludes resource revenues and the import content of government expenditures); and the break-even resource price.**

- The *current balance*,<sup>21</sup> which is equivalent to public savings, is a useful measure of the budgetary resources available for public investment (i.e., net acquisition of non-financial assets). It therefore indicates the maximum amount of public investment that could be executed without incurring an overall fiscal deficit. The *non-resource current balance* is similar but excludes resource revenues. A practical drawback of these indicators is that they do not provide a clear anchor for fiscal policy. They also ignore difficulties in classifying current and capital expenditure, which leads to incentives for creative accounting.
- The *domestic balance* can be helpful in assessing short-term demand pressures that can give rise to inflationary concerns. When the domestic balance deteriorates, the demand for domestic goods increases, so an abrupt deterioration of this indicator (for example, when a large

<sup>21</sup> The current balance is equivalent to the gross operating balance in the GFSM 2001 Manual.

expansion of public investment does not have a large import content) could indicate limited absorptive capacity for scaling up. However, this indicator is even more difficult to compute than the current balance because data on the import content of government spending is often not readily available.

- The *break-even resource price*, which is the price at which the overall balance will be zero, can also be used in resource-rich countries to determine the short-term vulnerability of public finances to lower resource prices. It does not take into account any financial savings the country may need to deal with shocks, but a constantly rising break-even price would suggest that the budget is becoming increasingly vulnerable to declines in resource prices.

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## C. Managing Natural Resource Revenues: A Dynamic Stochastic General Equilibrium Framework<sup>22</sup>

45. Dynamic stochastic general equilibrium (DSGE) models are increasingly being used to analyze the effects of macroeconomic policy.<sup>23</sup> Besides being applied to short-term issues, they have also been used to evaluate policies with longer-term implications.<sup>24</sup> Based on Berg et al. (forthcoming), this section introduces a DSGE framework for assessing fiscal strategies for managing natural resource revenues. It focuses on the scaling up of public investment in developing countries using volatile resource income.

### Specification of the Model

46. The model is a small open real economy that has a closed private capital account. The government cannot borrow in international financial markets but can save externally by holding financial assets.<sup>25</sup> To allow for the low quality of public institutions and governance, it builds in public investment inefficiency and absorptive capacity constraints, which cause substantial waste in producing public capital. The model also features learning-by-doing externalities in production of traded goods to capture potential Dutch disease from spending large amounts of foreign exchange.

### Households

47. A representative household chooses composite consumption,  $c_t$ , and labor,  $l_t$ , to maximize expected utility,

$$E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{1}{1-\sigma} (c_t)^{1-\sigma} - \frac{\kappa}{1+\psi} (l_t)^{1+\psi} \right], \quad (1)$$

subject to the budget constraint:

$$(1 + \tau_t^c)c_t + b_t = (1 - \tau_t^l)w_t l_t + R_{t-1}b_{t-1} + \Omega_t^T + \Omega_t^N + s_t rm^* + z_t. \quad (2)$$

$\sigma$  and  $\psi$  are the inverses of the elasticity of intertemporal substitution for consumption and labor supply;  $\kappa$  is the disutility weight on labor;  $w_t$  is a real wage index;  $\tau_t^c$  and  $\tau_t^l$  are consumption and labor tax rates;  $rm^*$  is remittances in units of foreign consumption (denoted by \*);  $z_t$  is government

<sup>22</sup> Prepared by Susan Yang (RES).

<sup>23</sup> Examples include the Swedish Central Bank (Adolfson et al., 2007); the IMF (Kumhof et al., 2010); the European Central Bank (Smets et al., 2010); and the Federal Reserve Board (Edge et al., 2010).

<sup>24</sup> For example, Berg et al. (2010) study the medium-term effects of scaling up aid, and Buffie et al. (2011) evaluate the debt sustainability of scaling up public investment.

<sup>25</sup> These simplifying assumptions are meant to capture the credit constraints faced by many developing countries.

transfers;  $s_t$  is the real exchange rate, the price of the foreign consumption basket relative to the domestic; and  $\Omega_t^T$  and  $\Omega_t^N$  are profits from traded and from non traded goods. The only financial asset a household can hold is domestic government bonds,  $b_t$ ;  $R_t$  is the domestic gross real interest rate.

Composite consumption,  $c_t$ , consists of non traded and traded goods, combined in a CES (constant elasticity of substitution) basket. The price of one unit of composite consumption is

$$1 = \varphi(p_t^N)^{1-\chi} + (1 - \varphi)(s_t)^{1-\chi}, \quad (3)$$

where  $p_t^N$  is the relative price of non traded goods to composite consumption,  $\chi$  is the intratemporal elasticity of substitution, and  $\varphi$  is the degree of home bias. Assuming the law of one price holds for traded goods,  $s_t$  is also the relative price of traded goods.

Total labor input of a household is

$$l_t = \left[ \delta^{-\frac{1}{\rho}} (l_t^N)^{\frac{1+\rho}{\rho}} + (1 - \delta)^{-\frac{1}{\rho}} (l_t^T)^{\frac{1+\rho}{\rho}} \right]^{\frac{\rho}{1+\rho}}, \quad (4)$$

where  $l_t^T$  and  $l_t^N$  are labor supplied to the traded and to the non traded sectors;  $\delta$  is the initial labor share in the non traded sector; and  $\rho$  is the elasticity of substitution.<sup>26</sup>

### Non-resource Production Sectors

48. The economy consists of three production sectors: a non traded goods sector, a non-resource traded goods sector, and a natural resource sector (denoted by  $O$ ). As the vast majority of resource output in developing countries is exported, in the model resource output is solely for exports.

A representative goods firm, non traded or traded, produces using the technology,

$$y_t^j = z_t^j (k_{t-1}^j)^{1-\alpha^j} (l_t^j)^{\alpha^j} (K_{t-1}^G)^{\alpha^G}, \quad j \in \{N, T\}, \quad (5)$$

where  $z_t^j$  is sector-specific total factor productivity (TFP);  $K_t^G$  is public capital; and  $\alpha^G$  is output elasticity with respect to public capital.

Private capital evolves by the law of motion,

<sup>26</sup> To simplify model specification, resource production does not employ labor because most extraction industries are capital-intensive in reality.

$$k_t^j = (1 - \delta^j)k_{t-1}^j + \left[ 1 - \frac{\kappa^j}{2} \left( \frac{i_t^j}{i_{t-1}^j} - 1 \right)^2 \right] i_t^j, \quad j \in \{N, T\}, \quad (6)$$

where  $\kappa^j \geq 0$  governs investment adjustment costs.

A representative firm maximizes its net-present-value profit weighted by the marginal utility of households ( $\lambda_t$ ),

$$E_t \sum_{t=0}^{\infty} \beta^t \lambda_t \underbrace{\left[ (1 - \iota)(p_t^j y_t^j) - w_t^j l_t^j - i_t^j + \iota p_t^j Y_t^j \right]}_{\equiv \Omega_t^N \text{ or } \Omega_t^T}, \quad j \in \{N, T\}, \quad (7)$$

subject to (6). Note that  $p_t^T = s_t$ , and  $\iota$  captures distortion that discourages firms in developing countries from investing and hiring further;  $\iota$  acts like an implicit tax on firms but the revenues collected remain in the private sector; and  $Y_t^j$  denotes the aggregate output of nontraded or traded goods.

Following van Wijnbergen (1984), TFP in the traded goods sector is subject to learning-by-doing externalities in the form of

$$\log z_t^T = \rho_{zT} \log z_{t-1}^T + d \log y_{t-1}^T. \quad (8)$$

Non traded TFP is assumed to be constant:  $z_t^N = z^N, \forall t$ .

### Resource Production Sector

49. The model takes the world price of a resource commodity as given and assumes that  $p_t^{O*}$  follows a random walk,<sup>27</sup>

$$\log p_t^{O*} = \log p_{t-1}^{O*} + \varepsilon_t^{pO}, \quad (9)$$

where  $\varepsilon_t^{pO} \sim i.i.d. N(0, \sigma_{pO}^2)$  is the resource price shock.

To simplify resource production, resource capital in the model is financed by foreign direct investment (FDI), which follows an AR(1) process,

$$\log FDI_t^* = \rho_{FDI} \log FDI_{t-1}^* + \varepsilon_t^{FDI}, \quad (10)$$

<sup>27</sup> Using 1970 to 2008 data, Hamilton (2009) estimated that the real oil price follows a random walk without a drift.

where  $\varepsilon_t^{FDI} \sim i.i.d. N(0, \sigma_{FDI}^2)$  is the FDI shock.

Resource capital evolves according to

$$K_t^O = (1 - \delta^O)K_{t-1}^O + FDI_t^*. \quad (11)$$

Resource output is produced by the technology

$$Y_t^O = z_t^O (K_{t-1}^O)^{\alpha^O}, \quad (12)$$

where  $z_t^O$  is resource TFP. It also follows an AR(1) process,

$$\log z_t^O = \rho_{zo} \log z_{t-1}^O + \varepsilon_t^{zo}, \quad (13)$$

where  $\varepsilon_t^{zo} \sim i.i.d. N(0, \sigma_{zo}^2)$  is the resource TFP shock.

Resource production is subject to royalties at a rate of  $\tau_t^O$  and profit taxes at a rate of  $\tau^{div}$ . Because intermediate inputs in resource production are omitted here, the profit is calculated as

$$\Omega_t^{O*} = (1 - \tau_t^O) p_t^{O*} Y_t^O. \quad (14)$$

Resource taxes paid each period are

$$T_t^O = s_t [\tau_t^O p_t^{O*} y_t^O + \tau^{div} \Omega_t^{O*}]. \quad (15)$$

## Fiscal Policy

50. One main policy issue for a resource-abundant country is how to allocate resource revenues among saving and spending options. The model considers the options of external saving in a resource fund ( $F_t^*$ ), public investment ( $G_t^I$ ), government consumption ( $G_t^C$ ), and transfers to households ( $Z_t$ ).<sup>28</sup>

Let  $ES_t$  be external savings from resource revenues and  $C_t$  and  $L_t$  be aggregate consumption and labor. The government's flow budget constraint can then be written as

$$ES_t = \underbrace{\tau_t^C C_t + \tau_t^L w_t L_t}_{\text{non-resource taxes}} + T_t^O + s_t r^* \rho_F F_{t-1}^* - p_t^G (G_t^C + G_t^I) - Z_t - (R_{t-1} B_{t-1} - B_t), \quad (16)$$

<sup>28</sup> An option not considered here is to lower tax rates.

where  $r^*$  is the constant net foreign interest rate, and  $p_t^G$  is the relative price of government purchases.<sup>29</sup>

The evolution of a resource fund is

$$F_t^* = \rho_F F_{t-1}^* + ES_t^*, \quad (17)$$

where  $ES_t^* \equiv \frac{ES_t}{s_t}$  is external savings in units of foreign consumption.

51. To center the analysis on different approaches to investing resource revenues, policy specifications here lay out a “spend-as-you-go” approach maintaining a resource fund at the initial low level and a “gradual scaling up” approach with external savings. Both approaches keep consumption and income tax rates constant.

- **The “spend-as-you-go” approach:** In each period the government maintains fixed ratios of government consumption and public investment to resource revenues. Transfers to households adjust to clear the government budget constraint. When resource revenues grow, government purchases and hence non-resource GDP also grow. The feedback effect of more government spending generates higher non-resource tax revenues. Since transfers adjust to clear the budget, the additional non-resource revenues also drive up transfers to households. As government consumption, public investment, and transfers all rise when resource revenues increase, this implies a procyclical policy stance on managing resource revenues.<sup>31</sup>
- **The “gradual scaling up” approach:** The government plans a gradual scaling up path for public investment and government consumption. Public investment is scaled up gradually despite the possibility of a revenue surge—the slow pace makes it possible to shore up a fund to build a stabilization buffer against future resource revenue shocks. Assuming that transfers to households are also kept at the initial level, when a resource fund has insufficient funds to allow continued financing of the predetermined periodic investment, investment expenditures for the period are reduced to maintain a nonnegative value in the resource fund. (This reflects the model’s assumption that the government cannot borrow externally to finance public investment.)

<sup>29</sup> When an analysis focuses on fiscal expansions that are financed not by debt but by resource revenues, debt can be fixed at its initial value. When debt is allowed to vary, fiscal rules in response to debt changes have to be operative to ensure fiscal sustainability.

<sup>30</sup> The model does not have the nominal side of the economy. To capture the loss of real principal value of a resource fund over time due to inflation,  $\rho_F$  is calibrated as the inverse of the gross inflation rate;  $\rho_F < 1$  is required to have a stationary equilibrium.

<sup>31</sup> Other designs of the spend-as-you-go approach can also be analyzed. For example, government consumption and transfers can be kept at the same shares of resource revenues in the initial state, and public investment adjusts to clear the budget.

52. Public investment accumulates as public capital subject to absorptive capacity constraints and investment inefficiency. To model absorptive capacity constraints, public investment expenditure  $G_t^I$  is distinguished from *effective* public investment  $\tilde{G}_t^I$ . Specifically,

$$\tilde{G}_t^I = G_t^I e^{\varepsilon_t^{AC}}, \quad \varepsilon_t^{AC} = -b \left[ \left( \frac{G_t^I}{G^I} - 1 \right)^2 \right], \quad (18)$$

where  $b$  (for bottleneck) governs constraint restrictiveness. When  $\frac{G_t^I}{G^I} > 1$ ,  $b > 0$ , and when  $\frac{G_t^I}{G^I} \leq 1$ ,

$b = 0$ . Also, let  $e$  be the historical investment efficiency. The law of motion of public capital,  $K_t^G$  is

$$K_t^G = (1 - \delta^G)K_{t-1}^G + e\tilde{G}_t^I, \quad 0 < e \leq 1, \quad (19)$$

where  $\delta^G$  is the depreciation rate of public capital.<sup>32</sup>

53. Like private consumption, government purchases are also a CES basket of traded and nontraded goods, but the degree of home bias can be different from that of private consumption. Also, since many resource exporters rely heavily on imports to meet increased government demand, the degree of home bias in addition to government purchases when spending resource revenues can also differ from its original degree.

### **Solution Method, Calibration, Model Applications**

54. The equilibrium system is log-linearized around the initial state of the economy and solved by the method Sims (2001) presented for linear rational expectations models.<sup>33</sup> The starting point of stochastic simulations is to calibrate the model to an initial state that characterizes the average current state of an economy. For strategies for calibrating structural parameters, see Berg et al. (forthcoming).

55. To simulate the macroeconomic effects of different approaches to managing resource revenues, the model takes as given forecasts of resource output and prices. A sequence of the FDI shock or the resource TFP shock is fed into the model to match output forecasts, and a sequence of the resource price shock is fed to match price forecasts. Since any forecast, particularly of resource prices, is bound to be highly uncertain, a confidence band of simulation results can be generated by drawing from the assumed distributions of shock processes. Beyond informing the outcomes of

<sup>32</sup> The rate at which public capital deteriorates can vary. The return on public capital could fall if new investment is not sufficient to replenish depreciated capital. When an investment path is fluctuating, as with the spend-as-you-go approach, the depreciation rate may rise to adversely affect total return on public investment.

<sup>33</sup> The model can also be solved by other methods as included in the Dynare software package.



different fiscal approaches to scale up public investment, the analysis can be used to assess the feasibility of a scale-up plan and whether a sufficient buffer can be built to ensure stability when the resource revenue stream is volatile.

56. Chapter III.B describes how the model can be applied to analyze the macroeconomic effect of different approaches to scaling up public investment in the case of Angola. It also demonstrates how the framework can be used to inform policymakers on the allocation decisions between investing and external savings in an environment of uncertain resource revenue flows.

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## D. Framework for Analyzing Short- and Medium-Term Macroeconomic Management of Resource Windfalls<sup>34</sup>

57. **The management of natural resource windfalls is a central short- to medium-run challenge for policy makers in resource-rich countries.** Resource windfalls are typically large relative to the size of the domestic economy and can generate macroeconomic pressures (e.g., on inflation and the real exchange rate). What distinguishes resource windfalls from other external shocks is that their impact depends directly on the fiscal policy response, because the government is typically the main recipient of resource revenue. This section provides a framework for analyzing how fiscal policy—and its interaction with monetary and exchange rate policy—affects transmission of the windfall to the domestic non-resource economy. It also discusses the implications of various policy mixes for such objectives as macro stability, exchange rate stability, support of private demand, and reserve adequacy; and which policy and country characteristics are likely to matter. Finally, the section draws on the recent experience<sup>34</sup> of Nigeria (Box 2), which illustrates the policy challenges.

### Responses to a Resource Windfall: Fiscal Policy

58. **Fiscal policy is the main impulse through which windfalls influence domestic economic activity.**<sup>35</sup> This impulse is given by the decrease in the non-resource primary balance—the primary fiscal balance excluding resource-related revenues. The response (see Table 2) ranges from spending the whole windfall (Column A), in which case the non-resource deficit increases by the full extent of the resource revenues, to saving the whole windfall (column B), in which case the non-resource deficit—other things being equal—holds steady. Higher public spending on local goods and services will expand the corresponding sectors and could lead to inflationary pressures if the economy has absorptive problems (and conditional on monetary and exchange rate policy, as explained below). On the other hand, saving part of the windfall limits aggregate demand pressures and helps the government to prepare for the post-windfall years.

59. **The fiscal policy response has direct implications for the real exchange rate and perhaps also for the export sector.** Other things being equal, an increase in spending causes the real exchange rate to appreciate because the government is using external resources to increase demand for locally produced goods and services. The appreciation (i) leads to a reallocation of factors of production—away from the exportable sector and toward sectors that produce goods and services for domestic consumption; and (ii) allows private spending to be redirected toward imports. If the export sector should contract, while that would reflect the macroeconomic adjustment to the windfall it might have implications for productivity gains in that sector and perhaps for medium- or long-term growth. Saving part of the windfall limits the equilibrium real appreciation.

<sup>34</sup> Prepared by Juliana Araujo (SPR) and Rafael Portillo (RES).

<sup>35</sup> The macrofiscal impact of a natural resource windfall shares some features with that of an aid windfall. For the interaction of fiscal and reserve policy during aid inflows, see Berg et al. (2007) and Berg et al. (2010).

### Box 2. Nigeria: Short- and Medium-term Macroeconomic Management of Oil Wealth<sup>1</sup>

**The experience of Nigeria illustrates some possible policy mixes.** The episode described can be separated into two distinct periods: the 2004-2008 period is marked by a more successful phase of fiscal, monetary, and exchange rate policy coordination with limited aggregate demand pressures and falling inflation; and the 2008-2010 period coordination of fiscal, monetary, and exchange rate policy was challenged by the aftermath of the global financial crisis and oil price shock.

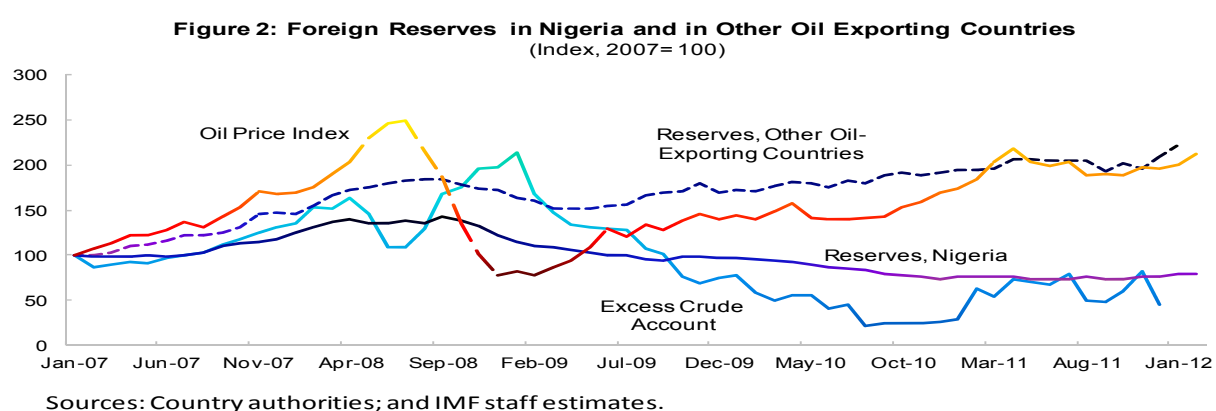
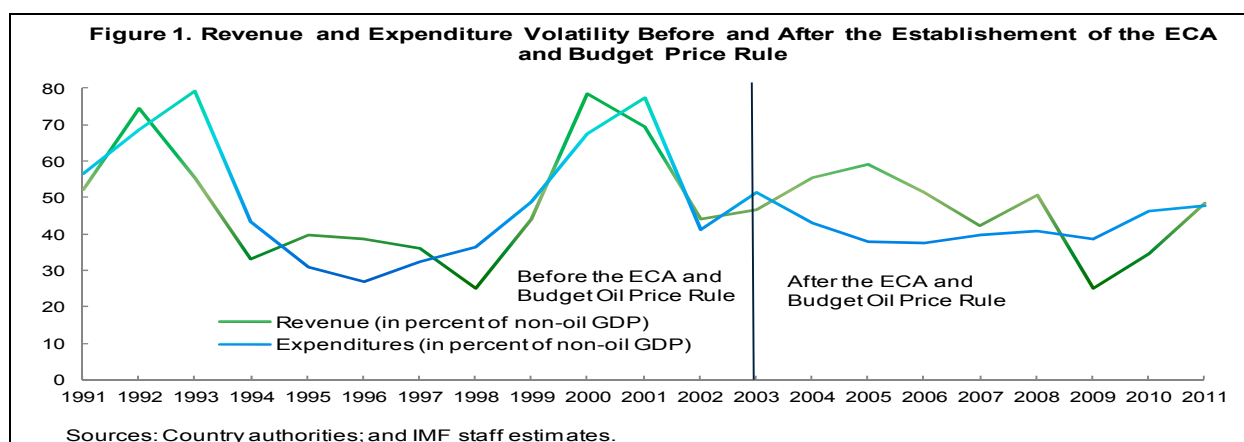
**Macroeconomic management in Nigeria is complicated by the country's dependence on volatile and uncertain oil revenues.** Oil revenues, which account for about 75 percent of total revenues, are shared by three tiers of government (federal, state, and local) and many extrabudgetary funds. About half of oil revenues go to the federal government and the rest to state and local governments. The federal government has little power of oversight over subnational government budgets. The central bank (CBN) targets single-digit inflation while keeping the naira-US\$ exchange rate within a narrow band and supporting financial sector stability. To attain its objectives the CBN uses a policy interest rate corridor, open market operations, monetary targeting, foreign exchange sales, and regulatory requirements. However, high economic volatility, partly caused by oil price volatility, has meant that at times it has struggled to attain its multiple objectives.

**The Nigerian authorities have made many attempts to improve management of oil and gas revenues.** In 2004 they introduced an oil price-based budget rule and established an oil stabilization fund, the Excess Crude Account (ECA). Although not well-grounded in law, the informal oil-price rule and the ECA had early successes. Oil revenues in excess of budgeted benchmark revenues—determined ex ante by the assumed oil price in the budget and projected oil and gas production—went into the ECA. Between 2004 and 2008, the economy was stabilized, and the procyclicality of aligning public spending with oil price fluctuations was substantially reduced (Figure 1). As oil prices rose, the budgeted oil price helped contain public spending, especially for the majority of subnational governments that do not have access to financing. Significant oil savings were also generated, which helped fund debt buyback operations in 2005–06 and build up the ECA to about US\$20 billion by the end of 2008.

**The countercyclical fiscal policy complemented the CBN anti-inflationary stance, dramatically suppressing inflation, which dropped from 17.9 percent in 2005 to 8.2 percent in 2006 and 5.4 percent in 2007.** Despite large oil-related liquidity inflows, the CBN stayed vigilantly anti-inflationary, mopping up liquidity through open market operations, but it also showed flexibility in its management of the exchange rate, allowing some appreciation in the naira-US\$ exchange rate, and accumulated substantial international reserves.

**Since 2008, due to large external shocks, the CBN has found it much harder to stabilize prices, the exchange rate, and the financial system.** In 2008 the Nigerian stock market plunged by 70 percent, partly because of the flight to quality when the global crisis began and partly because world oil prices collapsed, falling by 75 percent peak-to-bottom. These events deflated the credit bubble that had been generated during the oil windfall years. In the banking crisis that followed, 10 out of 24 banks—accounting for about 40 percent of banking system assets—were found to be either insolvent or undercapitalized. In response, the CBN relaxed monetary policy and used its reserves to offset the depreciation pressures on the naira. However, it could not fully resist those pressures; after a US\$10 billion drain on reserves in the last four months of 2008, in December 2008 and January 2009 the CBN allowed the naira to depreciate by 20 percent.

**Solid safety buffers, built from pre-crisis oil savings, allowed Nigeria to implement a countercyclical fiscal policy that cushioned the economy against the impact of the banking crisis and the oil price shock.** In 2009 government oil revenues declined by 15 percentage points of GDP, but consolidated public expenditures increased by about 2 percentage points—financed partly through drawdowns from the ECA. The consolidated government balance swung from a surplus of 6 percent of GDP in 2008 to a deficit of 9 percent in 2009, though real GDP growth was largely unchanged.



**However, since 2010 the oil-price rule and the ECA have lost traction.** Spending pressures resurged because of rebounding oil prices, political uncertainty associated with the illness and death of the president, and the subsequent election cycle. This resulted in a procyclical expansionary fiscal policy despite strong economic growth. The fiscal expansion was financed by discretionary withdrawals from the ECA that by year-end 2011 had nearly depleted it.

**Caught up in this procyclical fiscal expansion, the CBN faced difficult trade-offs.** Although double-digit inflation and continued reserve drainage justified tightening monetary policy, the CBN kept interest rates low (with highly negative real interest rates) in order to support the still-fragile banking system, and intervened in the foreign exchange market to support the currency. Expansionary policy contributed to a steady decline in international reserves (to below 5 months of imports by year-end 2010) despite high oil prices (Figure 2). However, in 2011, as the banking crisis was clearly being resolved, the CBN gradually tightened monetary policy, increasing policy rates and hardening regulatory requirements, and later allowed a small, much-needed, depreciation of the naira. By end-2011 these measures helped reduce inflation and stabilize reserves.

**Recognizing the ineffectiveness of the ECA, the authorities established an SWF with a much firmer legal foundation.** The SWF, which is not yet operational, has three separate components: a stabilization fund; an infrastructure fund to finance domestic infrastructure; and an intergenerational savings fund. The stabilization fund is expected to be better protected against ad hoc withdrawals with stricter rules than the ECA had. However, because the benchmark budget oil price is to be negotiated between the executive and the legislative branches, it is crucial that there be a rules-based approach to setting the budget revenue benchmark and spending oil revenues, and that there be closer coordination on fiscal policy between federal and subnational governments.

<sup>1</sup> Prepared by Mumtaz Hussain and Gonzalo Salinas (both AFR).

**Table 2. Policy Responses to a Natural Resource Windfall: A Schematic Representation**

		Fiscal Policy: Changes in the Non-resource Primary Balance (NRPB)		
		Full Spending $\frac{\Delta NRPB}{GDP} \cong \frac{\Delta windfall}{GDP}$	Limited Spending $\frac{\Delta NRPB}{GDP} \cong 0 \ll \frac{\Delta windfall}{GDP}$	
Monetary and Exchange Rate Policy			Savings in the Central Bank	Savings in the Sovereign Wealth Fund
Managed Float	Accumulation of limited reserves $\frac{\Delta R}{GDP} \cong 0 \ll \frac{\Delta windfall}{GDP}$	I	IVa	IVb
	Accumulation of large reserves $\frac{\Delta R}{GDP} \cong \frac{\Delta windfall}{GDP}$	IIa <ul style="list-style-type: none"> <li>The real appreciation rate is reduced</li> <li>Real interest rates increase</li> <li>The private sector is crowded out</li> <li>Inflationary pressures rise (real appreciation acts as an escape valve).</li> </ul>	III	<ul style="list-style-type: none"> <li>Similar to III</li> </ul>
Fixed Exchange Rate	Passive policy (no sterilization)	V	VII	
	Active policy (sterilization)	VI	<ul style="list-style-type: none"> <li>Similar to III</li> </ul>	

60. **The composition of government spending can greatly reduce the impact of commodity-induced fiscal expansion on aggregate demand and on the real exchange rate.** If a higher share of the fiscal expansion is directed toward imports, there is less pressure on domestic production. There is also less pressure for the real exchange rate to appreciate because there is less need to redirect private spending toward imports. While these features make it desirable to spend more on imports, it must be acknowledged that the import intensity of government spending is limited by the composition of spending—public investment is typically more import-intensive than current spending.

61. **When more of the windfall is saved, the choice of assets—domestic or external—may also have macroeconomic implications.** The government may choose to save abroad, by directly accumulating foreign assets in its sovereign wealth fund (SWF). Alternatively, it may choose to save domestically in the form of higher deposits or lower debt in the domestic banking system, higher deposits into the central bank, or curtailed central bank financing. In the first case, there is a perfect mapping between government savings and the country's external savings, since both are increasing simultaneously. In the latter cases, the government would end up selling most of the foreign exchange proceeds to the central bank in exchange for domestic deposits, either directly or through the banking system. The central bank would then decide whether or not to accumulate reserves. Here the decision to increase external savings would depend on the central bank reserve policy. The potential macroeconomic effects of the disconnect between public and external savings are explored next.

## Responses to a Resource Windfall: Monetary and Exchange Rate Policy

62. **While fiscal policy provides the initial impetus, the macroeconomic effects of a windfall depend on monetary and exchange rate responses.** When there is a managed float, the macroeconomic effect is influenced by the decision to accumulate reserves, whether reserves are sterilized, and the general stance of monetary policy. Where there is a hard peg, accumulation of reserves is endogenous to the macroeconomic adjustment to the windfall. However, if capital mobility is limited, the central bank may be able to sterilize some of the accumulated reserves.

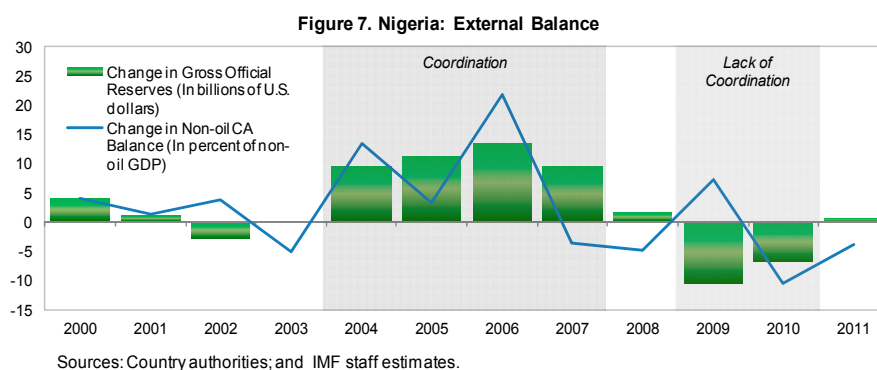
63. **In countries with a managed floating exchange rate, the decision to accumulate reserves can have macroeconomic implications.** Other things being equal, the policy response ranges from zero reserve accumulation (Table 3, row 1) to accumulating all the foreign exchange from the windfall (row 2). Depending on the fiscal response, there are a number of policy combinations including the following:

- **Spending the windfall, no reserve accumulation (Scenario I).** In this case nominal and real exchange rates appreciate, as is implied by the equilibrium real appreciation discussed earlier. The appreciation will affect the export sector in the short run, although access to cheaper imported capital goods may offset some of the implications for medium-term growth. Appreciation helps reduce domestic aggregate demand pressures because it encourages the private sector to switch to imports. Although the inflation rate for domestic goods may still rise, the nominal appreciation reduces the price of imports so that headline inflation may stay relatively flat or even decrease. Containing inflation eases the task of the central bank. However, if domestic goods inflation rises significantly, the central bank may have to tighten policy.
- **Spending the windfall, large accumulation of reserves (scenarios II.a and II.b).** Out of concern about real appreciation, the central bank may decide to accumulate reserves. If the accumulation is sterilized (Scenario II.a) the central bank is selling its own paper, or treasuries, in the domestic financial system. Assuming that domestic and foreign assets are not perfect substitutes, intervention in the foreign exchange markets may stem appreciation of the currency by increasing the premium required for domestic assets. However, in creating pressures on nominal and real interest rates to increase it can crowd out the private sector. Inflation may still increase: nominal appreciation is now smaller and the expenditure-switching role of the currency is reduced. Without sterilization, the injection of liquidity associated with the accumulation of reserves will exacerbate aggregate demand pressures, causing a substantial increase in inflation and a nominal depreciation. In both cases, the macro pressures stem from attempts to use the windfall twice: once as spending and once as reserves. Since this is not feasible, the private sector is crowded out, via increases in either real interest rates or the inflation tax.<sup>36</sup>

<sup>36</sup> An analysis of the management of large aid inflows in some SSA countries found this policy mix to be a common response (see Berg et al., 2007). The policy mix during large windfalls merits further research.



- Not spending the windfall, reserve or SWF accumulation (scenarios III and IV.b).**<sup>37</sup> In Scenario III, the government saves most of the windfall in the form of deposits at the central bank and the central bank accumulates reserves (as happened in Nigeria during the commodity boom of 2005–07). In this case the equilibrium real exchange rate will mostly stay flat, although it may still appreciate if appetite for domestic assets increases as a result of the windfall. This policy mix limits aggregate demand pressures and helps anchor inflation. The accumulation of reserves is automatically sterilized by the reduction in central bank net credit to the government, which is associated with a more prudent fiscal policy. In other words, the fiscal stance makes the task of monetary policy easier. A similar macro outcome occurs in Scenario IV.a except that external savings now take the form of the SWF buildup (Figure 7).



- Not spending the windfall, no reserve or SWF accumulation (Scenario IV.a).** If the government surrenders the foreign exchange to the central bank in exchange for a central bank deposit, and the central bank does not accumulate reserves, initially the supply of reserve money drops because the central bank's net domestic assets shrink by the amount of the government deposit. Keeping reserve money at the new lower level is equivalent to a reduction in monetary financing of the government and inflation will fall. Depending on whether it was expected, the contraction in the money supply may affect aggregate demand. If the central bank prevents reserve money from shrinking, real interest rates fall and the private sector is crowded in.

64. **In countries with fixed exchange rates, reserve accumulation is endogenous, although monetary authorities may be able to influence the macroeconomic outcome of the windfall by controlling liquidity.** We define monetary policy with a fixed exchange rate and limited capital mobility as either passive (reserve accumulation is not sterilized) or active (it is sterilized). If there is a fiscal expansion, a passive policy (Scenario IV) will result in an equilibrium real appreciation, which can only be achieved through higher inflation, and an expansion in aggregate demand is to some extent inevitable. An active policy, which would constitute Scenario V, will instead resemble Scenario II.a; issuance of central bank paper will push up real interest rates and crowd out the private sector and reserve accumulation will be larger. Finally, aggregate demand pressures will be contained if fiscal policy is restrained (Scenario V), regardless of whether policy is active or passive.

### LIC-Specific and Other Windfall Transmission Mechanisms

<sup>37</sup> The SWF here refers to a foreign asset fund accumulation that could potentially be used for stabilization, savings, or investment purposes.

65. **LIC-specific features may affect how a fiscal expansion financed by a natural resources windfall (NRW) influences aggregate demand and inflation.** In principle, two notable features of LICs—their lack of labor market flexibility and structural features that may result in large fiscal multipliers—are likely to amplify the effects of an NRW-financed fiscal expansion:

- The more labor markets are segmented by sector and region within a country, the less elastic the short-run supply of labor is likely to be. In this case, large increases in demand will raise production costs considerably and increase inflation.<sup>38</sup> More generally, the government is likely to run into barriers as it tries to ramp up spending, which will also increase costs and generate inflation.
- The large numbers of consumers who live closer to subsistence levels in LICs could result in more prominent fiscal multipliers, which would amplify the effect of NRW-financed government spending, interact with supply constraints, and have more impact on aggregate demand and inflation.<sup>39</sup>

More work is needed to assess the empirical relevance of these factors.

66. **A windfall may also result in a boom in the domestic financial system.** As a windfall improves a country's external outlook, appetite for domestic assets may increase, and the country may experience capital inflows. These inflows could feed into the domestic financial system, increasing the availability of domestic credit. Credit growth may stem from an accommodating monetary policy but may also arise if monetary policy is relatively neutral. In these cases, the windfall may be associated with very large expansions in credit, broad money, and the money multiplier. While some expansion in credit is beneficial, contributing to financial deepening, there is a risk that excessive credit growth could expose the domestic financial system to a reversal in foreign investor appetite for domestic assets and to a bust in credit quality, as Nigeria's experience suggests. If that happens, monetary authorities may decide to tighten policy but must consider the associated policy tradeoffs. Moreover, besides prudent macro-management, strengthened supervision and regulation are key to avoid the buildup of financial fragilities during a NRW.<sup>40</sup>

<sup>38</sup> An alternative view is that the labor supply curve in LICs is essentially flat because so many people are unemployed or subemployed. Nonetheless, this view is more likely to hold in the medium term.

<sup>39</sup> Consumers living close to subsistence levels in LICs could amplify the effects of fiscal expansion because they would spend all the additional income generated by the NRW-financed fiscal expansion, thus stimulating increases in aggregate demand. However, the evidence so far on fiscal multipliers in LICs does not support this view; see Dagher, Gottschalk, and Portillo (2012), Kraay (2010), and Shen and Yang (2012).

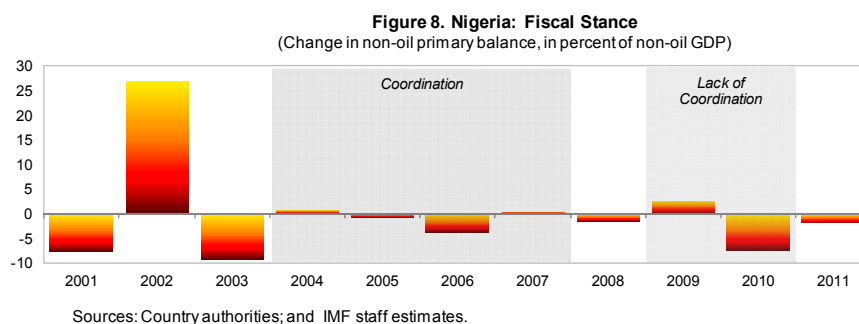
<sup>40</sup> Despite an adequate monetary policy stance, malpractice in bank supervision and regulation contributed to the buildup of financial fragilities that resulted in the 2008-2009 Nigerian banking crisis. By 2009, 10 out of 24 banks—accounting for around 40 percent of banking system assets—were either insolvent or undercapitalized.

## Navigating Through Policy Objectives

67. **When considering policy responses to the windfall, the authorities must be aware of what different responses imply.** Macro stability can be facilitated by coordination of fiscal and monetary policy and, more generally, by prudent fiscal management (see Table 2).<sup>41</sup> If fiscal policy is expansionary, then—in the case of managed floats—allowing the real exchange rate to appreciate can help facilitate macro stability, although monetary policy may need to be tightened.<sup>42</sup> Central bank efforts to limit the appreciation by accumulating reserves may be justified if there are concerns about Dutch disease or if the exchange rate overshoots. However, attempts to avoid an equilibrium appreciation may be counterproductive and have side effects: additional inflationary pressures if foreign exchange interventions are not sterilized, or increases in real interest rates (and crowding out of the private sector) if they are. In countries with fixed exchange rates, the appreciation means a rise in inflation, so aggregate demand pressures are to some extent inevitable with the macroeconomic adjustment. Independently of the exchange rate regime, concerns with real appreciation and inflationary pressures call for a more gradual fiscal response to reduce pressures on the real exchange rate and facilitate coordination of fiscal and monetary policy.

68. **The state of the economy and public finances at the beginning of the windfall may call for a particular policy response.** Countries starting with high inflation and fiscal dominance may use the windfall to reduce central bank financing of fiscal deficits. Countries with weak or depleted policy buffers may prefer to build up reserves. However, efforts to build reserves or other forms of external savings, e.g., SWFs, are best supported by a prudent fiscal policy. Finally, countries facing incipient credit booms or busts may wish to respond in ways that minimize amplification of the credit cycle.

69. **Policy makers must look beyond the windfall window when choosing the policy response.** Besides facilitating macroeconomic management, saving some of the windfall helps prepare for the post-windfall period when external sources of revenue may dry up and government spending may have to be slashed. A cautious fiscal response would reduce procyclicality in spending



<sup>41</sup> To prudently keep shocks to the fiscal impulse manageable, fiscal management should be guided by short- and medium-term fiscal policy frameworks that take into account the volatility of resource revenues. See the main paper, Section III for a discussion of price-based, structural, and non-resource balance rules.

<sup>42</sup> Frankel (2011) advocates the use of product price targeting (PPT) instead of consumer price targeting as a monetary anchor for commodity exporters. PPT has the property that when the commodity price of the exporting good increases, monetary policy is tightened, which leads to a nominal appreciation of the currency.

and help to stabilize the business cycle, as the Nigerian experience shows (Figure 8).

70. **The pursuit of multiple, possibly inconsistent, objectives makes policy coordination difficult and can result in a response that is erratic and unsuccessful.** One problematic mix is the combination of loose monetary conditions, an appreciated nominal exchange rate, and maintenance of increased fiscal spending (in the absence of fiscal buffers). Taken together, these conditions could result in surges in inflation and rapid depletion of reserves. Later efforts to undo the effects of past policies could result in abrupt exchange rate adjustments, large swings in real interest rates, and confusion in the private sector about the course of policy. Before making decisions policy makers must thoroughly assess all aspects of policy and the compatibility of their objectives.

71. **It is vital to consider the composition and speed of spending in amalgamating NRW-financed development plans with short-term economic stability.** Although some spending might be desirable short-term to contain aggregate demand pressures, in many resource-rich economies the people's needs might call for NRW-financed development. Because public spending on human and physical capital can translate into accumulation of domestic instead of foreign assets, such an accumulation is treated here as spending because its short-term effects may be similar. As noted, the high import content of infrastructure spending can help mitigate some of the short-term effects on the domestic economy. The pace of spending is equally important because it can limit the inflationary impact, real exchange rate appreciation, and crowding out of the private sector.

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## E. External Sector Assessments in Resource-Rich Developing Countries<sup>43</sup>

72. **Investment and pervasive frictions in developing countries can shape current account (CA) dynamics.** Araujo, Li, Poplawski-Ribeiro, and Zanna (2012) use a neoclassical model of a small open economy with public and private investment and frictions that capture pervasive features in developing economies—absorptive capacity constraints, inefficiencies in investment, and borrowing constraints that can be relaxed when natural resources are discovered—to study CA dynamics when there are natural resource windfalls. Relative to models that only consider consumption and satisfy the permanent income hypothesis (PIH), their paper shows the extent to which these features matter quantitatively (generating lower CA surpluses) and qualitatively (inducing CA deficits).

73. **The framework incorporates private and public investment decision plans, taking into account the frictions.** The framework has two sectors, non-resource and resource, and assumes that a representative agent derives utility from the consumption good. While investment in the resource sector is exogenously given, public and private non-resource investments are endogenously determined. Inefficiencies in private and public investment arise because one dollar in investment may translate into less than one dollar of productive capital. Absorptive capacity constraints are incorporated as investment adjustment costs because skilled administrators are in scarce supply in developing countries and therefore ambitious public and private investment programs are often plagued by poor planning, weak oversight, and a myriad of coordination problems, all of which contribute to cost overruns.

74. **Developing economies are characterized by an inability to fully access international capital markets because of borrowing constraints.** The framework assumes that the economy faces a country debt-sensitive interest-rate premium. For very small values of debt sensitivity, the capital account is for all practical purposes open, i.e., the borrowing constraint is not binding, illustrating perfect international capital markets. For very high values of debt sensitivity, on the other hand, the capital account is almost closed, i.e., the borrowing constraint is binding, capturing imperfect international capital markets. The specification of the borrowing constraint also considers situations in which the constraint is relaxed for resource-abundant countries when new resources are discovered, capturing insights from Mansoorian (1991) and Manzano and Rigobon (2007).

### Figures 1-4. Alternative Scenario Results

Scenario I—practically no borrowing constraints, so international capital is highly mobile; and no adjustment costs.

Scenario II—borrowing constraints may be binding, so there is little international capital mobility, but resource wealth does not affect the risk premium; and there are no adjustment costs.

<sup>43</sup> Prepared by Juliana Araujo (SPR) and Grace Bin Li and Felipe Zanna (RES). Bernardin Akitoby (AFR) and the IMF's CEMAC country teams advised on the application to CEMAC.

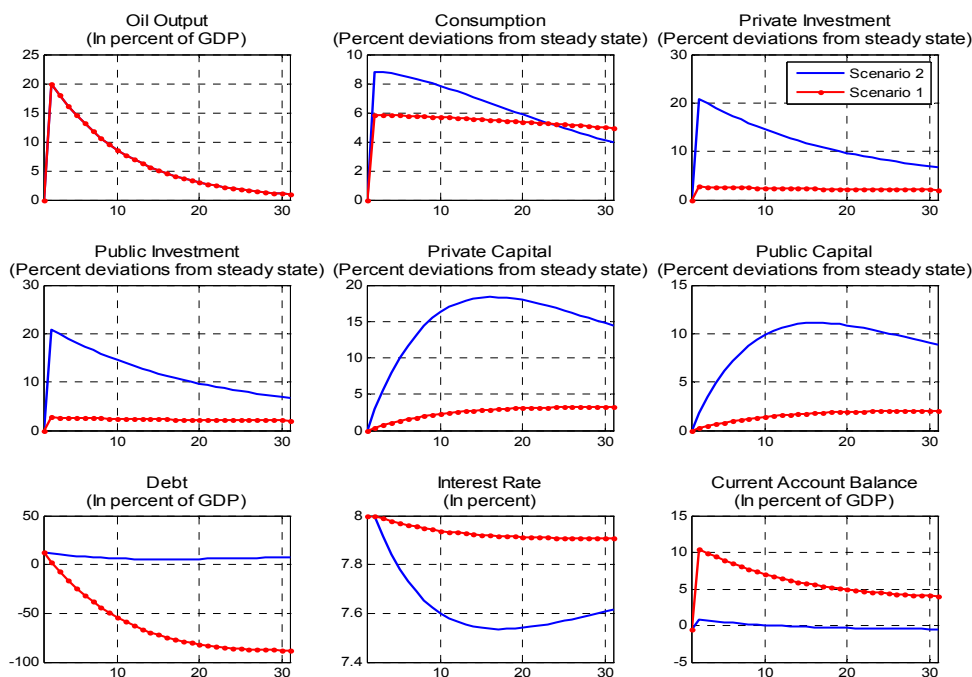
Scenario III—differs from Scenario II by adding absorptive capacity constraints.

Scenario IV—differs from Scenario II because resource wealth can affect the risk premium, relaxing borrowing constraints.<sup>44</sup>

Scenario V—there is an adverse resource shock that may or may not be expected.

75. **When there are no borrowing constraints, the PIH still holds, promising significant CA surpluses from natural resource windfalls.** In Scenario I—international capital is highly mobile—a resource shock has negligible effects on non-resource output, and it is optimal to save the windfall by accumulating holdings of external bonds to smooth consumption over time (Figure 9). The behavior of this economy mimics the endowment economy model analyzed in Bems and Carvalho (2009), as output and capital remain constant and consumption is smoothed over time. This scenario is a useful benchmark for PIH behavior, in which a windfall generates large CA surpluses and external savings for future consumption.

**Figure 9. Scenario I: High International Capital Mobility, No Resource Wealth in Risk Premium, No Adjustment Costs; Scenario II: Low International Capital Mobility, No Resource Wealth in Risk Premium, No Adjustment Costs**



Source: IMF staff estimates.

<sup>44</sup> The resource windfall of 20 percent of GDP is assumed to follow an autoregressive process with a coefficient of 0.8.

**76. Saving most of the resource wealth abroad might no longer be appropriate if there are borrowing constraints, which suggest lower CA surpluses relative to those advocated by PIH.**

Scenario II assumes that borrowing constraints may be binding and therefore there is little international capital mobility—the capital account is somewhat closed. When borrowing constraints are prominent, profitable investment opportunities are foregone because the premium on borrowing is too high, or credit is unavailable. In this case the resource windfall helps drive down the country risk premium because resource revenue is used to repay debt. A lower risk premium drives down interest rates, raising private and public investment and non-resource production, also financed by the windfall. The lower interest rates also promote frontloading of consumption relative to an economy with no capital market imperfections. As a result, natural resource wealth is partly converted into productive capital and partly consumed, with very little saved abroad. Consequently the CA surplus is smaller than in Scenario I, which replicates the PIH.

**77. During resource booms, absorptive capacity constraints can induce a larger CA surplus than when there are no constraints.**

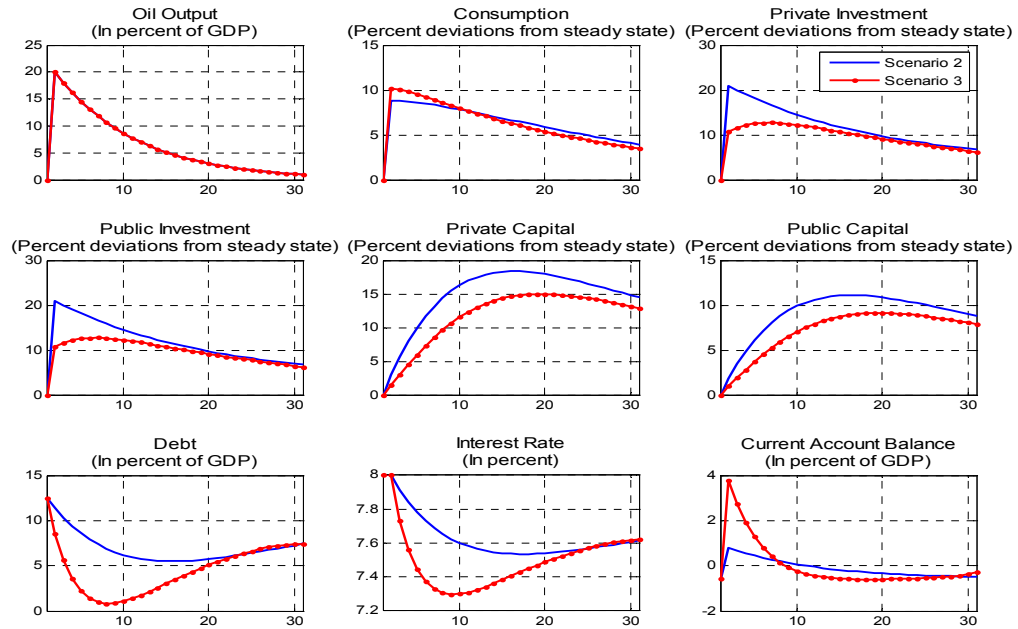
Absorptive capacity constraints are related to technical capacity; waste and leakage of resources in the investment process—which impact project selection, management, and implementation—can have long-lasting negative effects on growth.<sup>45</sup> Therefore, even if resource-abundant developing economies get enough revenues to invest, these frictions can interfere with the process of translating investment into growth-inducing capital accumulation. Comparing Scenarios II and III shows that when costs are higher for accumulating capital over the medium run, it is optimal to consume slightly more in the short to medium term, but invest considerably less relative to an economy with no absorptive capacity constraints (Figure 10). As a result, the CA balance tends to be more in surplus in the short to medium term when there are such constraints than when there are none. However, it would never be as high as the CA balance implied by Scenario I. Similar CA results are obtained when investment is highly inefficient.

**78. By helping relax borrowing constraints in developing countries, natural resource wealth can induce CA deficits.** If a country's risk premium depends not only on external debt but also on natural resource assets underground, new discoveries or an increase in resource prices relaxes the borrowing constraints and therefore lowers the premium (Figure 11). As shown by Scenario IV, when resources lower the risk premium, countries may decide to boost current private and public investment by acquiring foreign debt and taking advantage of lower borrowing rates, relative to Scenario II, where natural resources do not help relax borrowing constraints. As consumption behavior remains almost unchanged, more investment associated with higher borrowing translates into a CA deficit in the short to medium term. This starkly differs from the results in Scenarios I–III, where a windfall always leads to accumulation of financial assets (foreign bonds) or divestment of financial liabilities (foreign debt) and therefore to CA surpluses.

<sup>45</sup> See Esfahani and Ramirez (2003), among others.

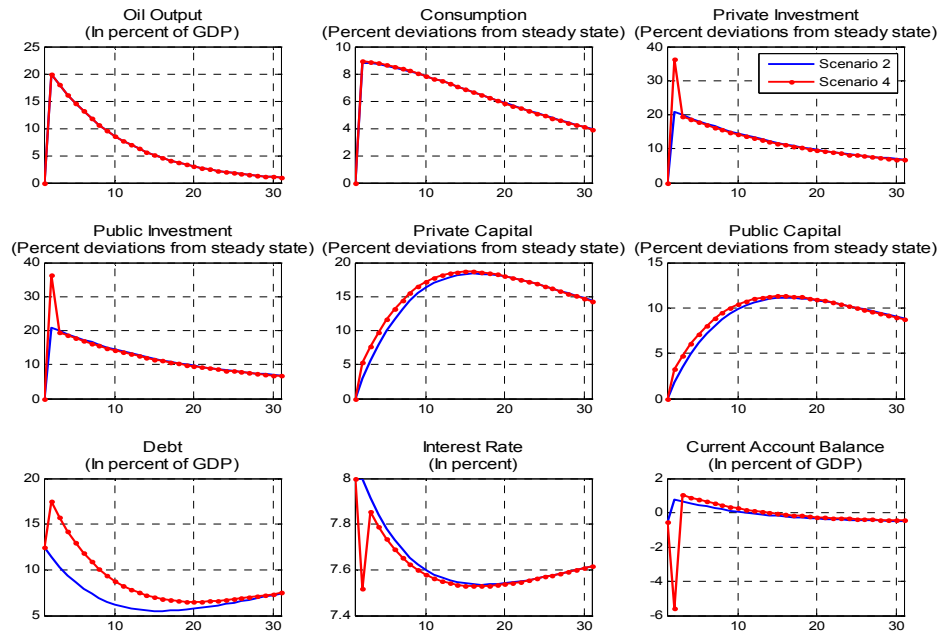


**Figure 10. Scenario II: Low International Capital Mobility, No Resource Wealth in Risk Premium, No Adjustment Costs; Scenario III: Low International Capital Mobility, No Resource Wealth in Risk Premium, with Adjustment Costs**



Source: IMF staff estimates.

**Figure 11. Scenario II: Low International Capital Mobility, No Resource Wealth in Risk Premium Function, No Adjustment Costs; Scenario IV: Low International Capital Mobility, Risk Premium Sensitive to Resource Wealth, No Adjustment Costs**



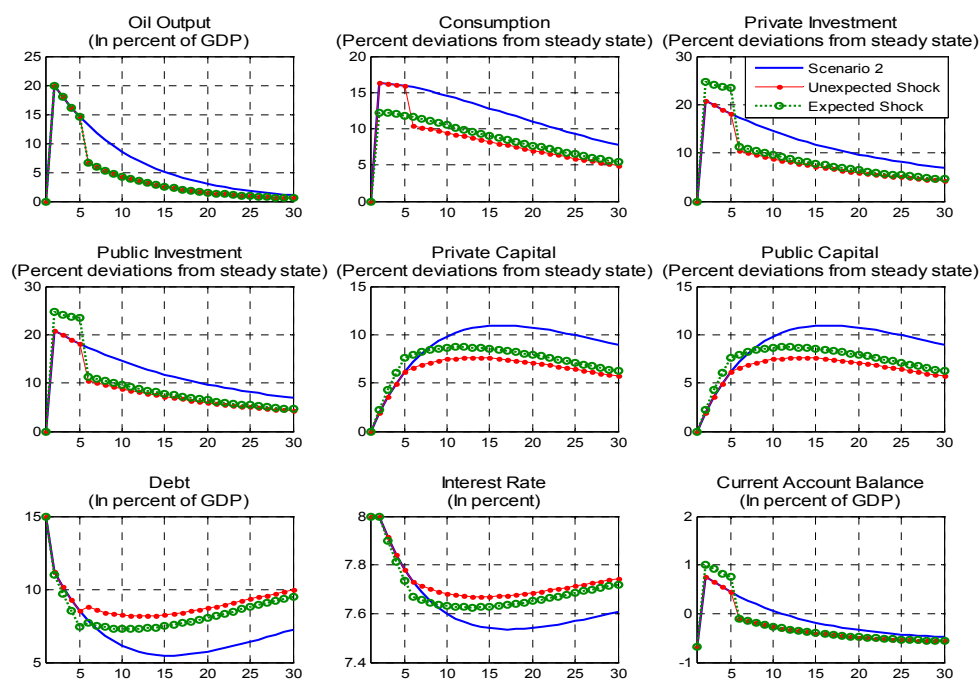
Source: IMF staff estimates.



79. **Adverse resource shocks may call for buffer-stock savings, and therefore CA surpluses.**

Figure 12 simulates a sudden drop in resource output at year 5, reflecting, for instance, a decline in resource prices. The figure compares the macroeconomic adjustment of three cases: (i) the drop is fully expected; (ii) the drop is unexpected; and (iii) no drop occurs as in Scenario II (with little capital mobility, no absorptive capacity constraints, and no resource impact on risk premium). To grasp the buffer-stock savings effect, the analysis focuses on the macroeconomic adjustment in the first five years before resource output collapses. Up to year 5, consumption, private investment, public investment, and the CA behave exactly the same in the unexpected shock case and Scenario II, since the resource drop takes agents by surprise. If the collapse is expected, on the other hand, consumption is smoothed over time and, prior to the shock, does not increase as much as in the case of unexpected shocks (or even the base case). This reflects the buffer-stock savings effect, where agents save for bad times. These additional savings translate into both lowering external debt and increasing private and public investment. The overall impact, though, is an increase in the short- to medium-term current account surplus relative to both the unexpected shock case and Scenario II.

**Figure 12. Adverse Shocks**



Source: IMF staff estimates.

80. **The framework is applied to the member countries of the Economic and Monetary Community of Central Africa (CEMAC), which face the challenge of managing exhaustible natural resources and simultaneously addressing development needs.** Oil is dominant in the CEMAC countries: on average, it accounts for about 40 percent of regional GDP, 70 percent of total

exports, and 75 percent of revenue. However, after having peaked in 2010, oil production is projected to decline fairly rapidly over the next decades. Exhaustion of this central source of revenues is a matter of concern, given that the governments in these countries still have little access to credit markets<sup>46</sup>, and have daunting development needs. For instance, the region is plagued with dire infrastructure gaps, which risk widening because the decline in oil revenues might soon translate into less public investment.<sup>47</sup>

**81. Before and after the global crisis, oil prices and production booms improved CA balances and pushed up public investment in the CEMAC region.** Since 2003, increases in oil prices and production caused a boom in government revenues, which boosted government spending, particularly capital spending (Figure 13). Nevertheless, despite considerable additional public investment, GDP growth, in particular non-oil GDP, fell below the 2000–04 average, in part due to constraints such as inadequate infrastructure services, inefficiencies in investment, a poor business environment, and low-quality health and education services.<sup>48</sup> Yet, from 2003 to 2008, the CEMAC CA registered improvements; as a consequence, NFA and foreign reserves increased steadily.<sup>49</sup> The deterioration of the CA in 2009 was associated with the global financial crisis, but soon after, a new oil price boom induced an improvement in the CA as well as in government revenues and public investment.

**82. CEMAC external sustainability assessments, as part of CGER, estimate a larger current account surplus than the underlying CA has.** The assessments are based on two methodologies suggested by Bems and Carvalho (2009) that are modified versions of the CGER macroeconomic balance (MB) and external stability (ES) approaches. The MB approach estimates a norm as a function of fundamentals (including the oil fiscal balance and a dummy for oil-exporting countries); the ES approach determines the external sector balance consistent with a long-term trend in NFA in a model-based approach.<sup>50</sup> For the CEMAC as a whole, the CA norm using the MB approach is a surplus of 2.1 percent of GDP in 2011, while the ES approach estimates the norm to be a 3.5 percent surplus. On the other hand, in 2011 the underlying CA for CEMAC was almost in balance.

<sup>46</sup> In CEMAC, although national treasuries are allowed to issue treasury bills and bonds through weekly and monthly auctions, government securities markets have yet to take off.

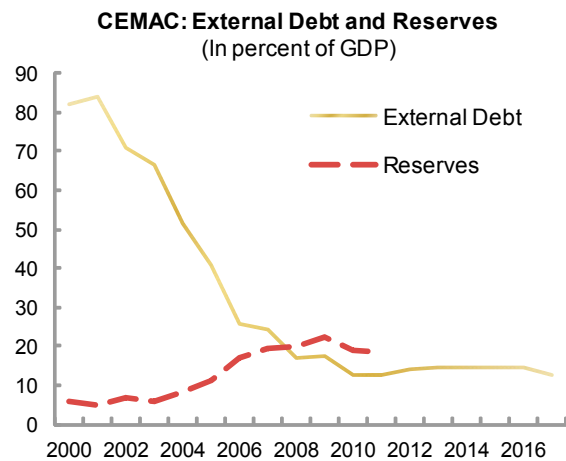
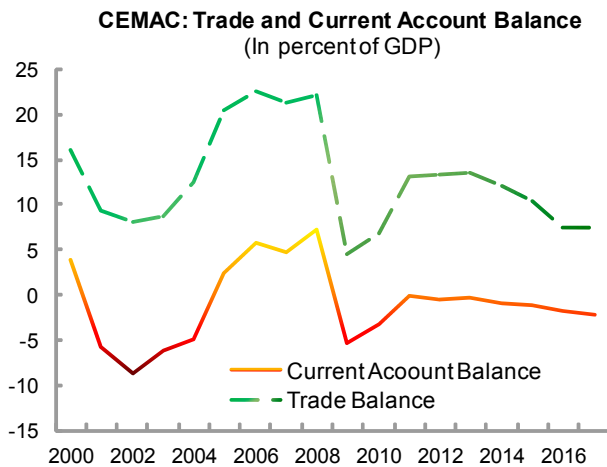
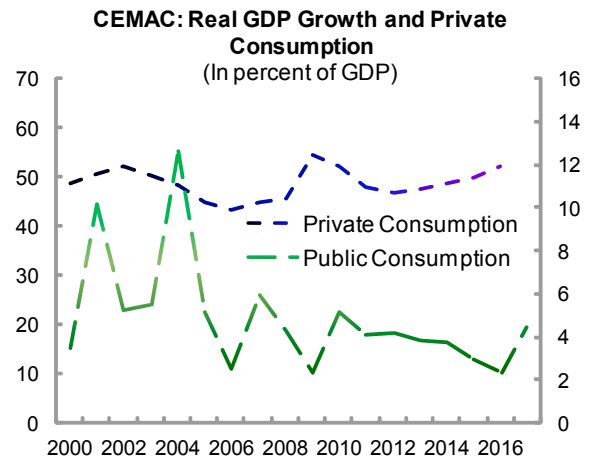
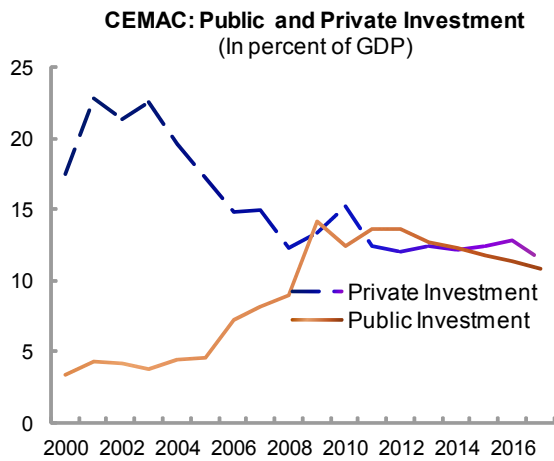
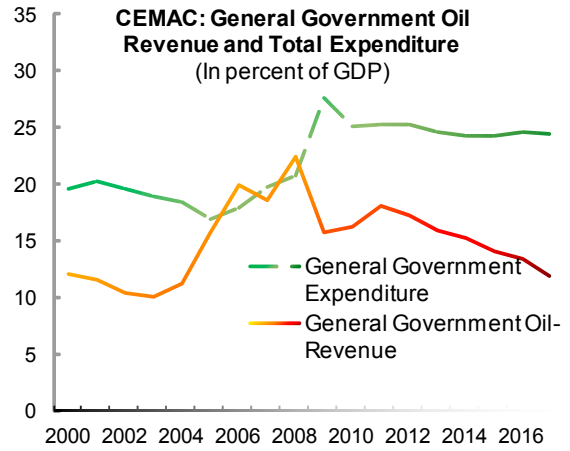
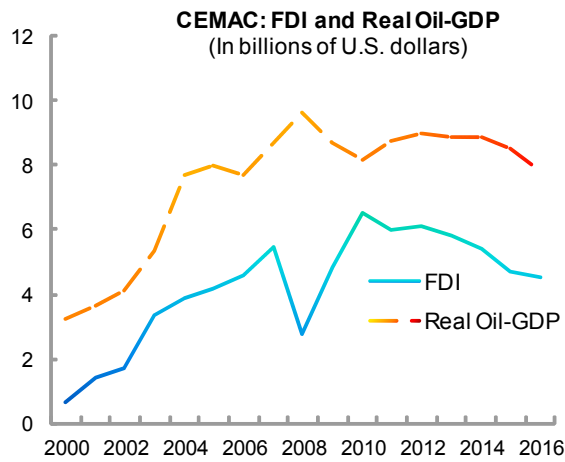
<sup>47</sup> Indicators in transport, electricity, and communication sectors are close to the average for SSA LICs but lower than for SSA resource-abundant countries. See Ranganathan, Foster, and Briceño-Garmendia (2012).

<sup>48</sup> According to the World Bank's 2011 Doing Business Indicators, CEMAC's average ranking, 172 (out of 183 countries), is lower than the SSA average of 137. See also Ranganathan, Foster, and Briceño-Garmendia (2012).

<sup>49</sup> External positions have been further strengthened by HIPC and MDRI debt relief in Cameroon, the Central African Republic, and the Republic of Congo.

<sup>50</sup> When calculating the ES, it is assumed that an exogenous rule for domestic absorption keeps annuity payments constant in real terms.

**Figure 13. CEMAC: Selected Macroeconomic Indicators, 2000–2017**



Sources: World Economic Outlook; and IMF staff estimates.

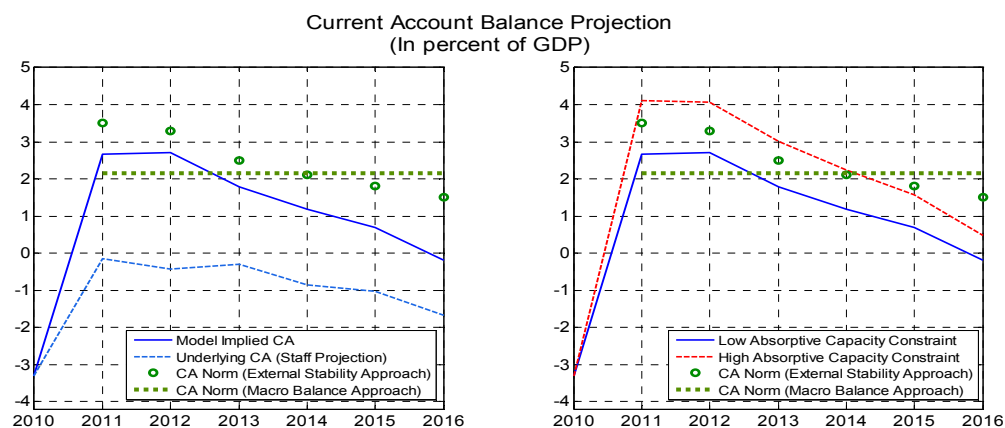
83. **Araujo and others (2012) present a new framework to calculate CA benchmarks that explicitly takes into account optimal consumption and investment decisions and pervasive frictions in developing economies.** The benchmarks are based on simulations of a simple neoclassical model with private and public investment and frictions, including absorptive capacity constraints, inefficiencies in public investment, and borrowing constraints. Consistent with the development literature, the economies are assumed to start off steady state, with a starting point that matches real data on key macroeconomic variables (CA, consumption, investment, and external debt to GDP ratios). Then resource shocks are applied to derive the future dynamics of the CA and other macroeconomic variables.

84. **Applying this framework to CEMAC makes explicit the role of investment dynamics as well as frictions, such as absorptive capacity constraints, in deriving CA benchmarks.** The framework is calibrated to match CEMAC region data for 2010 as the starting point and simulated using oil production projections for 2011–2016.<sup>51</sup> The simulated CA is shown in the left-hand side of Figure 14 (blue line). This provides a benchmark (norm) of about 2.6 percent of GDP in 2011, which is within the norms derived using the MB and ES approaches of Bems and Carvalho (2009). In the medium term, however, the benchmark points to a deficit of –0.2 percent of GDP. Moreover, for the projection period the framework delivers a CA benchmark that is below the ES estimates, since the return on both private and public capital is calibrated to be higher than the interest rate paid on foreign assets, making it optimal to invest domestically instead of saving abroad. Investment inefficiencies and other frictions can also influence the return on private and public investment and the estimated CA benchmark. Given the lack of information in developing economies, the simulations assume that absorptive capacity constraints reflect investment cost overruns of 5 percent. Overruns of about 20 percent—illustrating higher absorptive capacity constraints—would be associated with higher CA benchmarks (see Figure 14, right-hand side). This underscores the need to quantify frictions in developing economies and to apply judgment in estimating CA benchmarks.

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<sup>51</sup> It should then be clear that the dynamics of the macroeconomic variables, including the CA, are driven by both the projected oil path and the inherent dynamics associated with starting the economy off as steady state.

**Figure 14. Model Implied Current Account, Macro Balance CA Norm, and Bems and Carvalho (2009) ES CA Norm for CEMAC Countries (2011–2016)**



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## II. OTHER TOOLS AND FRAMEWORKS

### A. Absorptive Capacity<sup>52</sup>

85. **Absorptive capacity constraints are those economic, policy, and institutional constraints that result in a declining rate of return as the pace of investment rises.** The concept has long been recognized (e.g., Horvat, 1958; Rosenstein-Rodan, 1961; Adler, 1965; Chenery and Strout, 1966; and Berg, 1983). Many studies on aid effectiveness also document diminishing growth returns, which supports the existence of such constraints in aid-recipient countries (e.g., Hansen and Tarp, 2000, 2001; Dalgaard and Hansen, 2001; and Feeny and McGrillivary, 2010). Like aid allocation, using natural resource revenues to scale up public investment requires careful considerations of absorptive capacity. Investing more than can be absorbed may substantially raise both the direct investment cost and the general economic cost.

Absorptive capacity constraints arise through a number of mechanisms.

86. **At a basic level, the marginal product of capital naturally tends to decline as the amount of capital installed increases, assuming that the most productive investment opportunities are made first.** For capital-scarce economies, a declining marginal product of capital is less a concern during the scaling up stage, because of the breadth and depth of the need for capital and the possibility that one investment will make a second more productive, but it does underscore the need to first execute the most productive projects to maximize investment return and counteract constraint costs generally.

87. **One mechanism often highlighted for LICs is low investment efficiency, which can be defined as the ratio of public investment spending to the value of the resulting installed public capital.** To understand the role of efficiency, it may be useful to imagine that all public investment options at a given point are ranked from highest to lowest on rate of return. In a fully efficient investment process, an additional dollar is spent on the best available project. It is possible, though, that because of incompetence, corruption, or imperfect information a government may choose less preferred projects. Lower efficiency is a measure of the degree of deviation from the fully efficient process. A complementary way to think about efficiency is that a fraction of spending is simply wasted, e.g., misclassified as investment when it in fact covers only transfers to civil servants.<sup>53</sup> Investment efficiency is presumably related to institutional quality. One aspect of institutional quality is underdeveloped legal and administrative systems. The other is the strength or weakness of public-sector management. An important criterion of productive investment is the ability of government officials to select and complete projects that have high rates of return. Given a scarcity of skilled personnel, major public investment can be a heavy administrative burden, further

<sup>52</sup> Prepared by Andrew Berg and Susan Yang (RES).

<sup>53</sup> In the model in Chapter I.C, efficiency is captured by the parameters in the equation for public capital accumulation.

lowering the quality of performance at all stages from planning and contracting through supervision and evaluation.<sup>54</sup> During a scaling up, if more poor projects are selected and more implementation mistakes are made, average investment returns would fall, indirectly driving up investment costs.<sup>55</sup>

**88. In addition to low investment efficiency, LICs also face severe supply bottlenecks when investment is scaled up beyond the production limit of an economy.** Bottleneck issues can be extensive. In the construction stage, insufficient supply of skilled labor and production capacity push up the costs of production inputs, generating less effective investment for a given expenditure. When sectoral mobility is limited, shortages can be aggravated. In the service delivery stage, a low stock of human capital would prevent facilities from operating at full capacity. For example, when a large number of schools and hospitals are built, there may not be enough teachers, doctors, and nurses to staff them.<sup>56</sup>

**89. The effect of supply bottlenecks can in fact spill over to the entire economy.** Production of public capital often requires local inputs. Unless the demand for production factors—intermediate goods, capital, and labor—can be met entirely through imports, scaling up investment is likely to drive up prices of local factors and hence the entire costs of producing non-resource goods. Aside from inflationary pressure, the real exchange rate is likely to appreciate—this is part of the mechanism that drives the factor reallocation to build up public capital. However, a necessary corollary is that the tradable sector may shrink. If scaling up yields more productive public capital—including for the tradable sector—the appreciation effect can be temporary or even eventually reversed. In the meantime, though, the smaller tradable sector may imply lower productivity growth, if productivity externalities like learning-by-doing are important in that sector—the so-called Dutch disease.<sup>57</sup>

**90. To assess the costs of absorptive capacity constraints, it is necessary to account for various mechanisms discussed above.** To evaluate the output effect of installed capital, the literature has estimated average output elasticity with respect to infrastructure to be about 0.1.<sup>58</sup> Because countries vary in the quality of their institutions and the composition of the projects they scale up, a country-specific elasticity may be adopted. For example, an economy with good institutions and a sound policy environment is likely to have higher elasticity. Also, a scaling up plan

<sup>54</sup> See Belli et al. (2011) for a description of common problems underlying public investment operations in developing countries.

<sup>55</sup> The outcome that poor projects are selected may be driven by the institutional or administrative capacity constraints noted here or by political constraints resulting from non-inclusive political institutions (see Acemoglu and Robinson, 2012).

<sup>56</sup> In Chapter I.C, see equation (18) for a specific formulation of this bottleneck-related absorptive capacity constraint.

<sup>57</sup> In Chapter I.C, the strength of this effect is mainly governed by the parameters  $\rho$  in equation (4) that determines the flexibility with which factors can be reallocated across sectors, as well as the import intensity of public capital investment. The potential negative effects of real exchange rate appreciation on productivity growth are captured by parameters  $\rho_{zT}$  and  $\rho_{zT}$  in equation (8).

<sup>58</sup> Based on data for 88 countries (both developed and developing), Calderon et al. (2011) estimated that long-run output elasticity with respect to infrastructure ranges between 0.07 and 0.1.

that simultaneously invests in human capital (such as education and health) can also have higher elasticity or even improve total factor productivity (Bourguignon and Sundberg, 2006).

91. **Rough estimates of the efficiency of public investment have been made.** Pritchett (2000) very broadly estimates that the fraction of public investment spending that is productive averages about 0.49 for sub-Saharan African countries. Hurlin and Arestoff (2010) arrive at efficiency estimates of 0.38 for Mexico and 0.40 for Colombia. However, the very different methods used by these authors make many strong assumptions that are hard to test. A complementary approach is to associate country-specific estimates with indicators that signal the quality of governance and institutions—e.g., the Worldwide Governance Indicators (Kaufmann et al., 2011); the public investment management index, PIMI (Dabla-Norris et al., 2011); and the index of capacity constraints on absorbing foreign aid (Feeny and de Silva, 2012).<sup>59</sup> A caution, however, is that these indicators are *ordinal* measures; they are presumably correlated with but are not direct estimates of the fraction of investment that is not well spent. To make use of these indicators for individual countries, a mapping between an index and investment efficiency must be assumed.

92. **As for the costs of supply bottlenecks, Foster and Briceño-Garmendia (2010) report that building infrastructure in Africa often runs into cost escalations for bottleneck reasons (such as domestic inflation or tight construction industry conditions) and institutional reasons (such as inadequate competition for tenders).** For road projects, they estimate that cost escalations averaged 35 percent but in other cases, it can be as high as 50 to 100 percent. Since cost escalations vary by the amount of total investment within a period, to obtain a more accurate measure countries may look into past budgetary data for similar projects to assess the additional costs incurred for a given level of actual investment.

93. **Finally, the macroeconomic costs depend on scaling up composition in terms of nontraded and traded goods.** When management and production inputs can be imported, supply bottlenecks (hence the economic cost related to real appreciation and Dutch disease) can be alleviated. This solution to bottleneck issues, however, is only partial. As the amount of public capital is built up and the economy grows, absorptive capacity must ultimately be expanded by an economy's ability to supply qualified labor and goods within a more diversified economic structure.

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<sup>59</sup> Another country-specific indicator that could proxy absorptive capacity constraints is data on the extent of capital budget execution, which is a component of the PIMI.



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## B. Wealth Accounting<sup>60</sup>

94. **Development is a process of building wealth, which is broadly defined to include manufactured, natural, human, and social capital.** For resource-rich countries it is a process of managing their natural resources to further their goals for their people.

95. **To support this process of building wealth, detailed statistics can help support resource management strategies.** While the System of National Accounts (SNA) provides detailed statistics on management for many economic sectors, it does not cover natural resource sectors. This realization led to the global process that has created the System of Environmental and Economic Accounts (SEEA). By compiling natural capital accounts, countries make explicit the contribution to the economy of natural resources, not only minerals and energy, forest timber, agricultural land, fisheries, and water but also ecosystem services, such as air and water filtration, flood protection, carbon storage, pollination for crops, and habitat for fisheries and wildlife.

96. **In February 2012 the UN Statistical Commission (consisting of heads of all national statistical offices and international organizations like Eurostat, the IMF, the OECD, the UN, and the World Bank) approved the SEEA as an international statistical standard like the SNA.** This was a fundamental leap forward; now, natural capital can be accounted for at scale. The SEEA standards cover both material natural resources like minerals and timber and environmental protection expenditures, taxes, and subsidies.

97. **The SEEA does not replace or change the most common measure, GDP—it simply fits alongside the current SNA as a set of satellite accounts.** Countries then devise accounts that target their own policy concerns. When natural capital is mainstreamed into economic accounts, it can inform analysis and development decisions. That is what makes SEEA an effective tool for ministries of finance and planning.

98. **Take a country like Botswana that is rich in natural resources: minerals, energy, protected areas, crop and pastureland, and non timber forest products that make the country's natural capital worth a third of its total wealth.** As part of a regional program initiated in 1995, environmental accounts based on the SEEA were constructed for Namibia, Botswana, and South Africa, each reflecting the national priorities. For instance, in addition to mineral and water accounts, Botswana also constructed accounts for livestock, wildlife, and energy.

99. **Environmental accounts provide measures of natural capital that can be used to monitor total wealth over time and to determine whether investment in other assets is compensation for depletion of resources.** They also detail statistics to assess whether natural capital is being used to build national wealth: maximizing income from natural capital, recovering resource rents, and reinvesting the rents.

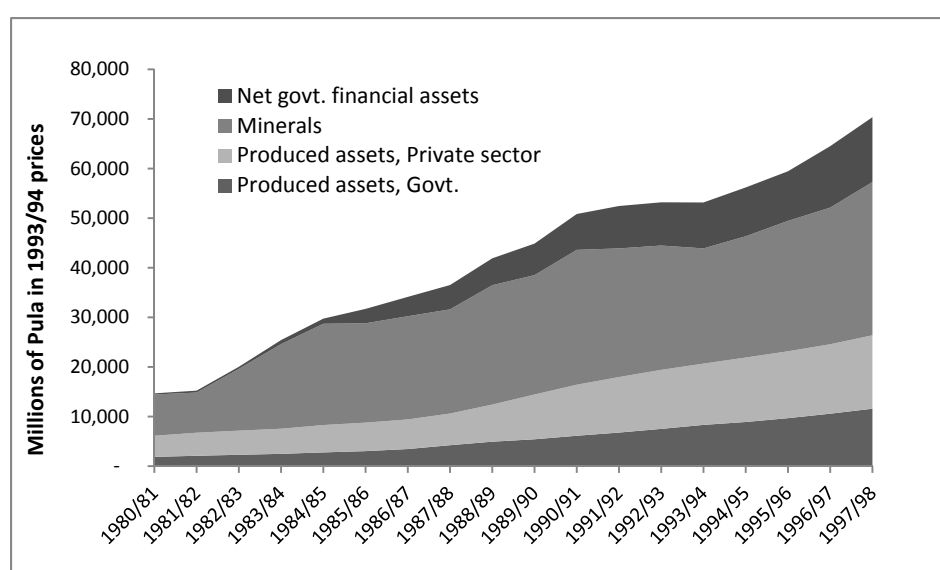
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<sup>60</sup> Prepared by Hannah Behrendt (World Bank).

100. **SEEA physical asset accounts provide indicators of ecological sustainability and detailed information for resource management.** The volume of mineral reserves, for example, indicates how long a country can rely on its minerals; it is needed to plan extraction paths. While the physical accounts for individual assets can be used to monitor ecological sustainability, a more comprehensive assessment of sustainability requires calculation of the economic value of a resource. From this, trends in per capita national wealth can be derived. These can be analyzed to assess characteristics important to economic development, such as the diversity of wealth, ownership distribution, and volatility due to price fluctuations—an important concern for economies dependent on primary commodities.

**Figure 15. Botswana: Total National Wealth of Botswana, 1980–1997**

(In millions of pula, constant 1993/94 prices)



Source: Lange, Hassan, and Alfieri (2003).

101. **Botswana has been successful in using its natural capital to build national wealth.** From 1980 onward, over the period of two decades, total wealth increased by about 500 percent, with per capita wealth increasing by about 250 percent (Figure 15). Since 1994, fiscal policy in Botswana has been guided by a Sustainable Budget Index principle, which seeks to ensure that “non-investment” spending is financed only with non-resource revenue—with resource revenues used either to finance investment or saved for the future.

102. **Today, with diamond mining having driven Botswana’s economic growth and development for more than 30 years, careful management and reinvestment of resource rents into building human and manufactured capital has helped the country become the fourth richest in Africa.** However, at current production rates, diamond reserves will run out in a few decades. Keen to stimulate growth, diversify its economy, and eradicate poverty, Botswana has identified options for development that give priority to economic diversification with a focus on nature-based tourism and expanded mining and agriculture.

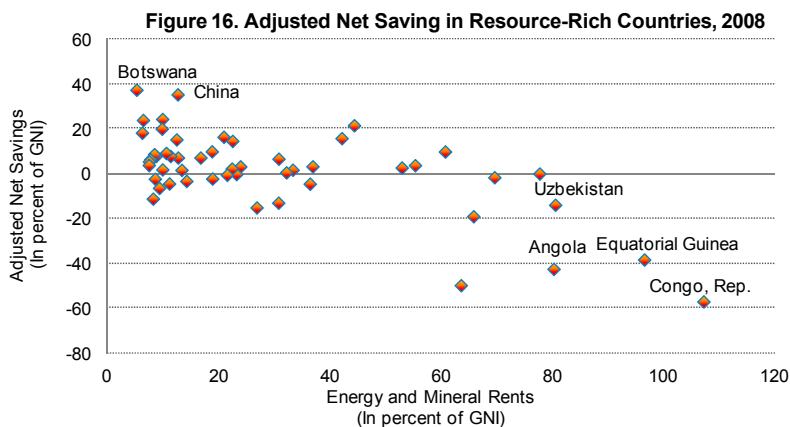
103. **The new program for natural capital accounting in Botswana, supported through the World Bank-facilitated WAVES partnership, will focus not only on minerals and energy, water, ecosystems, and landscapes but also on development and refinement of macroeconomic indicators of sustainable development.** In resource-rich countries in particular, such

macroeconomic indicators as adjusted net savings (ANS)<sup>61</sup> can be a useful complement to GDP, making it possible to view economic growth from a different angle. For countries where resource rents are at least 5 percent of GNI, transforming nonrenewable natural capital into other forms of wealth is a major challenge.

Figure 16 shows the

performance of resource-rich

countries measured by the importance of resource rents in GNI. ANS is positive in countries like Botswana and China, where mineral depletion is offset by investment in other types of capital, so that the countries are adding to wealth and ensuring future well-being. Countries with negative ANS, which are depleting their natural capital without replacing it, are becoming poorer over time by running down their capital stocks and reducing future social welfare.



Sources: World Development Indicators, World Bank; and IMF staff estimates.

104. **Natural capital accounts provide not only information for compiling indicators like ANS but also detailed sector-level information for policy making.** Developing countries like Mexico, Colombia, the Philippines, and South Africa are compiling accounts ranging from energy and water to how minerals and timber contribute to national economic growth. Uptake in Europe has been heavily influenced by EU regulations mandating certain accounts.

105. **Implementation is not easy, however; many countries are now reaching out to the international community for assistance in better understanding natural capital accounting.** Where once there was little experience to draw upon, a global community of practice is gradually building and is designing SEEA training programs similar to those for the SNA.

<sup>61</sup> Adjusted net savings (ANS) is defined as gross national savings adjusted for annual changes in the volume of all forms of capital. It measures the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources, and damage caused by pollution.

## The WAVES Partnership—Implementing Natural Capital Accounting

106. **To support countries as they move to natural capital accounting, the World Bank has initiated a new partnership, WAVES—Wealth Accounting and the Valuation of Ecosystem Services;** among the partners are several UN agencies, national governments, nongovernmental organizations, and academic and other institutions. WAVES will support a range of activities to achieve three objectives:

- Establish environmental accounts and incorporate these into national policy analysis and development planning.
- Draft internationally agreed guidelines for ecosystem accounting.
- Expand the use of environmental accounting through a global partnership.

107. **Itself a global partnership, WAVES includes developing countries Botswana, Colombia, Costa Rica, Madagascar, and the Philippines, which are all working to establish natural capital accounts; and developed countries like Australia, Canada, Denmark, France, Japan, Norway, Spain, and the United Kingdom, which are already exploring natural capital accounting and have learned valuable lessons.** UN agencies—UNEP, UNDP, and the UN Statistical Commission—are helping countries with environmental accounting and reviewing scientific evidence and methods. The WAVES partnership is currently supported by founding partners to the Multidonor Trust Fund—Japan, the United Kingdom, Norway, and France.

108. **The Rio+20 summit recently channeled great momentum: 62 countries came out in support of natural capital accounting, more than half of them developing countries.** Rio+20 offers a unique opportunity to implement natural capital accounting at scale.

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### C. Non-Resource and Resource Revenue in Sub-Saharan Africa<sup>62</sup>

109. **Non-resource revenue is lower in sub-Saharan African (SSA) resource exporters that are fiscally dependent,<sup>63</sup> which may reflect both policy preferences and weak institutions.** Krugman (1987) argued, for instance, that low non-resource revenue ratios reflect optimal taxation policy: the government finds it best to promote the development of the non-resource sector by not taxing it (for example, Nigeria has no income tax). This argument, however, implicitly assumes that development needs—hence spending needs—can be fully covered by resource-related revenue. While this may be plausible for some resource-abundant countries, it is certainly not true of most. Moreover, it could also be argued that low non-resource revenue reflects reduced (costly) enforcement, more evasion, or both, which contradicts both good fiscal practices and standard policy advice. In the short term, this may induce excess volatility of total revenue given a large exposure to commodity price shocks. In the long term, as natural resources are depleted, the costs of raising domestic taxation could be significant (Bornhorst, Gupta, and Thornton, 2009). A political economy argument against lower taxation of the non-resource sector relates to accountability. Collier (2006), for example, has argued that a lower domestic tax effort reduces citizen incentives to hold the government accountable, which promotes inefficient and wasteful spending. A low fiscal burden on the non tradable sector can exacerbate Dutch disease effects by attracting resources into the sector.

110. **A panel regression of the determinants of 2000–11 non-resource revenue for SSA countries illuminates some of these issues.** Controlling for a number of factors, resource exporters have significantly lower non-resource revenue than other SSA countries. In fact, for every 1 percentage point increase in resource revenue as a proportion of GDP, non-resource revenue is lower by about 0.12 percent of GDP. Moreover, after controlling for country-specific factors, the incidence of corruption is associated with a lower ratio of non-resource revenue to GDP, which supports the view that fragile institutions undermine collection of non-resource taxes.

111. **The combination of poor collection of VAT revenue and medium-term sustainability concerns suggests that fiscally dependent RRDCs need to closely monitor the ratio of non-resource revenue to non-resource GDP.** One rationale for their low non-resource tax intake is that it may stimulate the non-resource export sector. While non-resource exports have grown over the past decade, there are two difficulties with the rationale. First, while country data are not available on trade taxes or investment tax allowances, VAT data indicate that though the de jure tax rate is generally higher among resource exporters than the sample average, collection of VAT revenue is far less efficient (IMF 2011); where VAT data are concerned, the low tax ratio is thus more a function of collection efficiency than explicit tax policy. Second, fiscally dependent resource exporters are

<sup>62</sup> Prepared by Alun Thomas, Juan Treviño, Shawn Ladd, and Geoffrey Oestreich (all AFR), Research assistance was provided by Cleary Haines and Luiz Oliveira (AFR).

<sup>63</sup> Fiscally dependent countries are defined as those resource-exporting countries in SSA where resource-related revenue amounted to at least 20 percent of total revenue excluding grants for the 2005–10 period. See IMF (2012).

spending more than estimated long-run resource revenues (see IMF (2012)). More efficient collection of non-resource revenue would address both these concerns.

### Box 3. Domestic Revenue Effort in Resource Exporters

We explore the possible effect of resource abundance on non-resource fiscal revenue in resource-rich SSA countries following Bornhorst, Gupta, and Thornton (2009), which focused on oil exporters; we expand the analysis to all types of natural resources. A first look at the data for these countries yields a negative and significant correlation between resource and non-resource fiscal revenue.

To control for other factors, we estimate a panel regression of the form

$$\left(\frac{NRR}{Y}\right)_{it} = \alpha_i + \beta \left(\frac{RR}{Y}\right)_{it} + controls_{it} + u_{it}$$

where  $\left(\frac{NRR}{Y}\right)_{it}$  and  $\left(\frac{RR}{Y}\right)_{it}$  denote the

ratios of non-resource and resource revenue to GDP, respectively, for country  $i$  at time  $t$ .

As controls we use external financing, measured by the grants-to-GDP ratio;

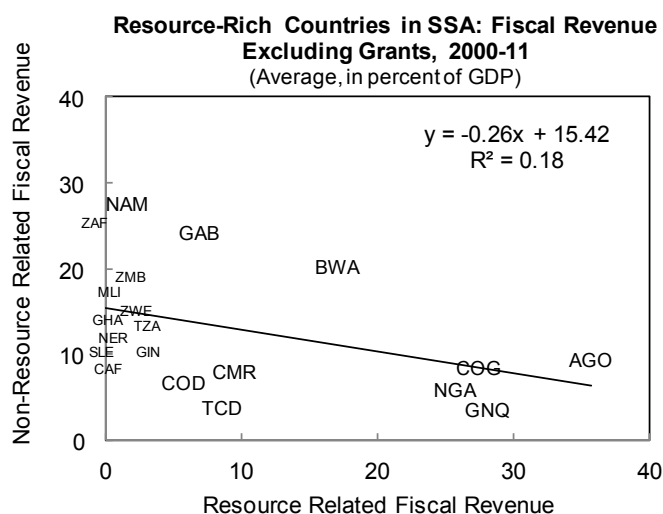
income (measured by the log of real per

capita GDP); openness to international trade (exports plus imports to GDP); the share of agriculture to GDP; the share of urban to total population; and a corruption index (ICRG). In our regression we include all SSA countries from 2000 to 2011 and allow for country-specific (fixed) effects (a detailed description of the data used in this exercise can be found in IMF (2012)).

Resource abundance crowds out other sources of revenue after controlling for different factors. As shown in the Table 1 (columns 1 and 2), the coefficient associated with resource revenue is negative and significant. In particular, the fixed-effects contemporaneous estimation (column 1) implies that every additional point of GDP of resource revenue is associated with lower non-resource revenue amounting to 0.12 percentage points of GDP. The coefficient increases to  $-0.07$  if we include the lag of the dependent variable on the right-hand side (column 2), which itself is positive and significant, consistent with the finding elsewhere that revenue ratios are persistent over time. This implies that in two years, the cumulative impact would be  $-0.11$ . Interestingly, when including the lags of both the resource and non-resource revenue to GDP ratios as regressors (column 4), only the latter is positive and significant. This suggests that the effect of additional resource revenue on collection of non-resource revenue is relatively short-lived.

The signs of other coefficients are generally consistent with previous studies. A larger inflow of foreign financing (grants) in proportion to GDP has a negative effect on non-resource-related revenue mobilization (this result is robust to the specification). The coefficient of  $-0.02$  implies that an additional 10 percent of GDP in resource revenue reduces grant funding by 0.2 percent.

Interestingly, the development of the economy as a whole (proxied by real per capita GDP) is positively and significantly associated with higher revenue (though it becomes insignificant when lags of the revenue ratios are included, column 4). Trade openness and the share of urban population each have a positive and significant effect on non-resource revenue, whereas the share of agriculture is significant only for the baseline regression (column 1). Overall, this suggests that less developed countries tend to exhibit lower revenue mobilization. By construction, the measure for corruption (ICRG) increases as corruption diminishes, hence the positive sign, and is robust to all specifications (we used an indicator of rule of law as an alternative for the ICRG, which rendered insignificant in specifications 2 and 4).



Source: IMF staff estimates.



**Table 1. Regression Results**<sup>1,2</sup>

Dependent Variable: Non-Resource Revenue to GDP				
	(1)	(2)	(3)	(4)
Constant	-0.149*** (0.022)	-0.075*** (0.017)	-0.173*** (0.025)	-0.028 (0.019)
Resource Revenue to GDP	-0.119*** (0.033)	-0.070*** (0.006)		
Resource Revenue to GDP (lag)			-0.078** (0.034)	0.038 (0.028)
Non-Resource Revenue to GDP (lag)		0.535*** (0.040)		0.581*** (0.050)
Grants	-0.019** (0.010)	-0.024** (0.009)	-0.021** (0.011)	-0.024** (0.009)
Real Per Capita GDP	0.020*** (0.004)	0.011*** (0.004)	0.017*** (0.005)	0.001 (0.006)
Trade Openness	0.048** (0.020)	0.094*** (0.035)	0.138*** (0.026)	0.083** (0.037)
Share of Agriculture	-0.078** (0.034)	-0.039 (0.030)	-0.049 (0.031)	-0.024 (0.031)
Share of Urban Population	0.006*** (0.000)	0.003*** (0.001)	0.007*** (0.001)	0.003*** (0.001)
Corruption	0.018*** (0.003)	0.012*** (0.003)	0.017*** (0.003)	0.013*** (0.003)
Weighted				
R-squared	0.96	0.98	0.97	0.98
Adjusted R-squared	0.96	0.98	0.96	0.97
Sum Squared Resid	0.17	0.09	0.14	0.09
Unweighted				
R-squared	0.94	0.97	0.95	0.97
Sum Squared Resid	0.19	0.09	0.15	0.09

Source: IMF staff estimates.

<sup>1</sup>S.E. in parentheses<sup>2</sup> \*\*\*, \*\*, and \* indicate 99, 95, and 90 percent levels of confidence respectively.

112. **For other resource exporters, more effort is needed to generate more resource revenue.** Although fiscally dependent countries have clawed back between 30 percent (Chad and Gabon) and 60 percent (Cameroon and Nigeria) of resource exports to the government, other exporters have only clawed back between 4 percent (Zambia) and 18 percent (Mali). Efforts are underway in a number of countries to establish new resource taxation regimes (the DRC, Ghana, Namibia, and Zambia).<sup>64</sup> Tools developed by the IMF's Fiscal Affairs Department (FAD) could help to assess resource taxation regimes and formulate more precise and consistent macroeconomic assessments of the impacts of various projects (see Box 4).

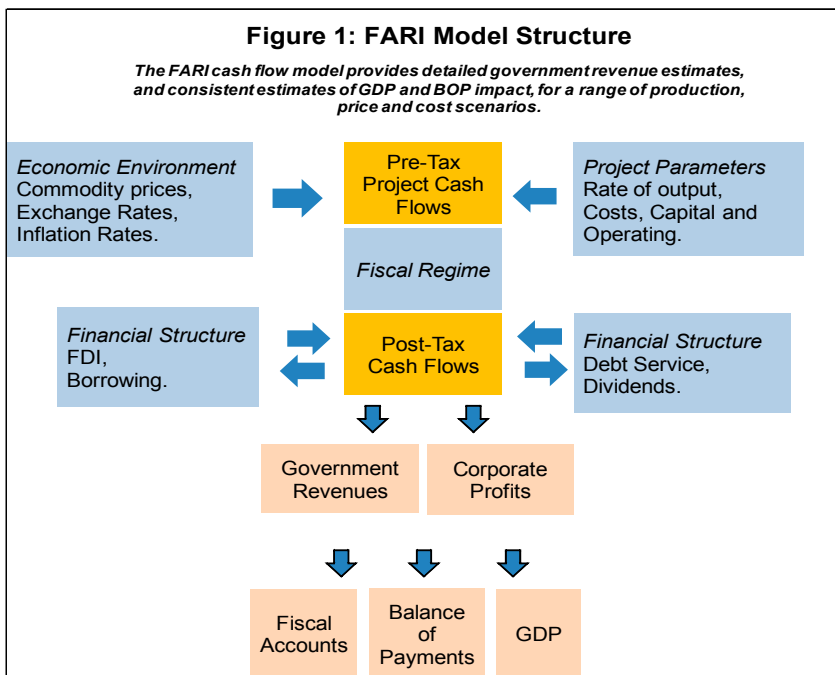
<sup>64</sup> See, for instance, "Wish You Were Mine," *The Economist*, February 11, 2012.



**Box 4. The FARI\* Model for Forecasting and Managing Natural Resource Revenue**

The Fiscal Analysis of Resource Industries (FARI) model is a spreadsheet-based cash flow model built by the IMF’s Fiscal Affairs Department (FAD) that can be used in forecasting and managing natural resource revenues. It can be applied to most nonrenewable resource projects, from iron ore and gold to oil and gas ventures. The model, which can be used to help determine the fiscal and economic impact of large-scale resource projects, is well-suited for use in SSA, where such projects often dominate fiscal developments.

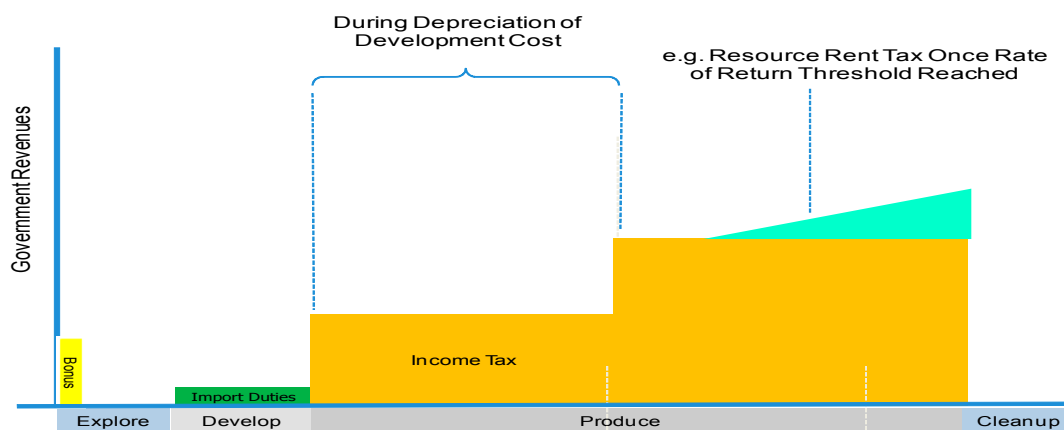
Starting with a standard template, a model is prepared using the specific production, cost, and fiscal regime parameters for each natural resource project. Revenue and investor outcomes can then be evaluated for a range of alternative tax or financial arrangements and exogenous assumptions. The process is facilitated by the IMF’s collection of natural resource laws and agreements from around the world, covering a wide variety of commodities. Originally developed to analyze fiscal regime design and to facilitate comparisons between regimes, the FARI model has since been extended to determine the full economic impact of a project, including its effect on the fiscal, external, and real sectors (Figure 1).



The FARI model offers a number of significant benefits.

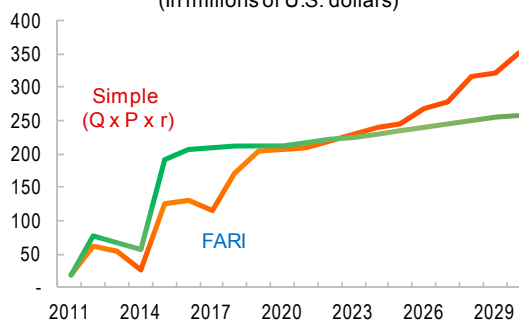
- *A more precise and consistent macroeconomic assessment of project impact.* These projects are typically large relative to the size of the host economy, which is why it is essential to develop a more accurate picture of their impact on the country. Implementing the model helps to forecast a project’s cash flows and its effect on the fiscal, external, and real sectors.

**Figure 2. Life Cycle of Mining Revenues**



- More sophisticated and accurate revenue projections.* Natural resource fiscal regimes usually comprise multiple taxation mechanisms (e.g. import duties, royalties, corporate income taxes, resource rent taxes), the specifications of which can change depending on the triggers built into the development contract (Figure 2). A FARI model provides the structure needed to capture these large, often macrocritical, nonlinear changes in revenue, which would be missed by simpler “rate x base” estimations (Figure 3).

**Figure 3. FARI vs. Simple Government Revenue Estimates For An Iron Ore Mine**  
(In millions of U.S. dollars)



Source: IMF staff estimates.

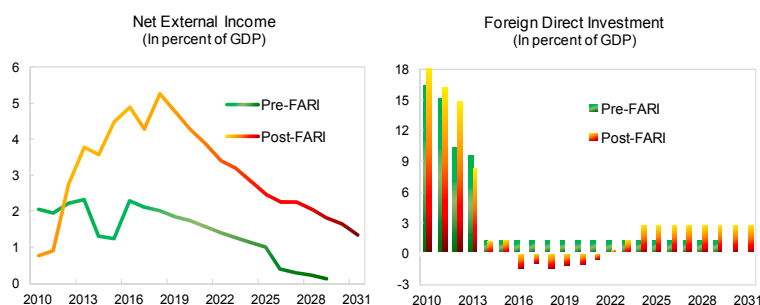
- Anticipation of policy and administrative challenges, particularly for public financial management.* Even when a project is still in the planning stage, having an estimate of its revenue potential can usefully inform policy. For example, the rationale for early adoption of stabilization and wealth funds would be more apparent if there is an expectation of rapidly rising revenue from a large project over the medium-term. The model can also expose cases where initial revenue expectations are overly optimistic.
- Improving policy dialogue and transparency.* The model is constructed with Microsoft Excel, which is widely used. This facilitates sharing the model template with officials, transparently articulating all assumptions and calculations, and enabling economic policy analysts to incorporate the project into their macroeconomic models and forecasts consistently. Finally, the FARI model is particularly well adapted to perform sensitivity analysis exercises and facilitates comparisons between different projects and fiscal regimes.

Transparency about the fiscal regime and production, cost, and financing assumptions is critical if the FARI approach is to be useful. While the parameters of a fiscal regime are usually readily available in the legal agreements governing a project, obtaining production and cost data can be more problematic and usually requires the consent and cooperation of the project’s operators and investors.

*Country Experience*

The FARI model template can be applied to any project in any country where the necessary data are available. IMF African Department staff has recently adopted FARI cash flow models for projects in Liberia (iron ore), Chad (oil), and Niger (oil and uranium). In the last few years, Fiscal Affairs Department (FAD) staff has also built FARI models for a number of other SSA countries with mineral and hydrocarbon resources,

**Figure 4. Niger: Projections Before and After Adoption of FARI Model**



Source: IMF staff estimates.

including the DRC, Mauritania, Mozambique, Namibia, Sierra Leone, and Tanzania. Such projects are subject to a wide range of economic, financial, technical, and political risks, any of which can cause corporate and fiscal results to differ from forecasts. The continuing usefulness of the model therefore depends on the commitment of officials to collecting and sharing the necessary data to calibrate the results ex post. The case of Niger (Figure 4) clearly illustrates the advantages of using the FARI model to estimate external income and FDI, where FARI-based projections are higher by 1–3 percent of GDP than those from a baseline “naïve” model.

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### III. APPLICATIONS

#### A. Republic of Congo—Anchoring Fiscal Policy when Needs Are Large<sup>65</sup>

##### Background

113. **The Republic of Congo is a resource-rich country in Central Africa.** Peace was restored in the early 2000s after nearly a decade of civil war and conflict; after many failed economic programs, the authorities completed their first IMF-supported program in July 2011. Economic reforms, debt relief following the HIPC completion point (January 2010) and high oil revenues have helped to stabilize the economy and lay the groundwork for economic development.

114. **Although it has sizable oil wealth and the per capita income of a LMIC, in many respects Congo faces the same challenges as do LICs.** Inclusive growth is hindered by a large infrastructure gap and a difficult business climate. Social infrastructure is underdeveloped, and more than half the population lives in poverty. Policies are designed to close the infrastructure gap and diversify the economy, but fiscal institutions are fragile and the efficiency of public spending is low.<sup>66</sup> For oil wealth to be transformed into growth-enhancing infrastructure will require improvements in project appraisal and selection, implementation, and monitoring to ensure that public resources are not wasted.

115. **Nevertheless, Congo is in the enviable position of having sufficient resources to finance development—if they are used effectively.** This raises the question of how to anchor fiscal policy. Traditional methods for doing so are ill-suited to resource-rich countries that have development needs. Models based on the permanent income hypothesis (PIH models) are particularly inappropriate: because they aim to smooth consumption, they cannot capture the growth-enhancing benefits of near-term scaling up of investment. External stability and debt sustainability analyses also have limitations in anchoring fiscal policy when net debt is negative and assets are projected to climb.<sup>67</sup>

116. **Congo's conduct of fiscal policy and its budgetary planning are further complicated by heavy reliance on highly volatile oil revenues.** Volatility weakens prospects for an extended period of sustained economic growth, which is a precondition for inclusive growth. Although the currently extensive oil deposits could serve as a fiscal buffer, there are no institutions regulating the management, short-term or medium-term, of oil resources.

<sup>65</sup> Prepared by Carol Baker, Javier Arze del Granado, and Darlena Tartari (all AFR); with contributions from Santiago Acosta (FAD) on application of the FSF.

<sup>66</sup> Congo has a CPIA of 2.9 and ranks 70<sup>th</sup> out of 71 countries surveyed on the Public Investment Management Index (PIMI) (Dabla-Norris et al., 2011).

<sup>67</sup> As 2011 closed, Congo had negative net debt of 31 percent of GDP. Over the medium term, new large revenue streams are expected from oil field contracts being negotiated and from new mining megaprojects projected to start production by 2017 (one iron mining project alone could generate as much as 30 percent of current oil revenues).

117. **Under such conditions, one option would be to anchor fiscal policy by using a simple oil revenue rule to pin down expenditures and basing capital spending on an assessment of what might be an adequate capital spending envelope over the scaling up period.** A simple oil-price fiscal rule can be used to buttress economic stability by smoothing government spending and preventing abrupt swings in absorption while institutionalizing the use of fiscal buffers. The path of investment spending can be derived from a required investment envelope, taking into account absorptive and implementation capacity. The spending path can then be calibrated to promote fiscal sustainability based on total net wealth (defined as the sum of the present value of future oil revenue plus net financial assets).

118. **Applying a fiscal rule in Congo would be consistent with its obligations as a member of CEMAC.** Fiscal rules are not applied in the Congo although some institutional arrangements have been put in place through the regional central bank, BEAC (Box 5). An oil price rule would be consistent with CEMAC fiscal convergence criteria, and the rule itself could be designed and calibrated to be fully consistent with all convergence criteria.

### **A Framework for the Stabilization Objective**

119. This section first presents the volatility-reducing benefits of a price-based rule for oil revenues, followed by calculation of the implied stabilization buffer required to mitigate spending volatility.

#### ***Oil Price-Based Rule***

120. **In the simplest case, an oil price-based rule can be used to smooth budgetary expenditures.**<sup>68</sup> In that case expenditure levels are set on the basis of prospective revenues projected using a smoothed formula-based oil price and an adjusted fiscal target.<sup>69</sup> When actual (realized) revenues are higher than projected, the surplus is accumulated in a stabilization buffer. Conversely, when actual oil revenue is lower than the formula projected, the deficit is financed by drawing down resources previously accumulated in the stabilization buffer.

121. **The larger the desired smoothing and the less responsive expenditure becomes to price shocks, the larger the stabilization buffer needed.** Cross-country simulations suggest that using an 8-year moving average of oil prices (5 historical years and 3 years projected forward) would strike an appropriate balance between reducing volatility relative to actual prices and forcing some adjustment in response to market shocks.

<sup>68</sup> Given the dominance of oil in GDP and national revenues, adding a structural revenue rule for non-oil revenues in Congo does not have much impact on estimated annual flows to the stabilization fund—the difference is less than 0.4 percent. Hence, for the sake of simplicity, the use of an oil price rule is recommended.

<sup>69</sup> If expenditures are set equal to oil price-based budgeted revenue, the structural balance would be zero. If the structural balance target is a positive number (i.e., expenditures are set below the oil price-based budgeted revenue) an additional surplus could be saved and held outside the stabilization fund.

### Box 5. CEMAC Surveillance Framework

*This box presents the convergence criteria for the CEMAC region and the framework in place to manage oil revenue volatility.*

#### Convergence Criteria

**CEMAC's multilateral surveillance framework is based on four mandatory convergence criteria aimed at preventing excessive fiscal deficits.** CEMAC members adopted this framework in 1994; in 2008 the CEMAC Commission also used a non-mandatory set of supplementary surveillance criteria to evaluate progress toward convergence. The surveillance criteria are:

- Nonnegative basic fiscal balance measured as a percent of total GDP.
- Average annual inflation of 3 percent or less. In 2008 a supplemental criterion for core inflation (excluding food) of no more than 3 percent was added.
- Stock of domestic and external debt of no more than 70 percent of total GDP.
- Non accumulation of domestic and external payment arrears.

**Sanctions for noncompliance are weak.** Countries formally sanctioned for policies inconsistent with the union's objectives are required to adopt adjustment programs, but there are no sanctions for noncompliance with convergence criteria. Surveillance is carried out by the a Surveillance Council, chaired by the CEMAC Commissioner and composed of representatives from the national units in charge of multilateral surveillance, BEAC, and the Central African Economic Union. The council meets semiannually and prepares an annual report on progress on convergence that is discussed by the Council of Ministers.

**Large oil revenues have undermined the ability of the regional surveillance framework to foster fiscal coordination in support of the peg.** The convergence criteria on fiscal balances and debt are nonbinding in oil-producing countries, while the 70 percent of GDP ceiling on public debt is not only nonbinding (the CEMAC average is 15 percent) but inconsistent with the nonnegative threshold on the basic fiscal balance. Consideration could be given to tailoring the criteria to country-specific conditions, taking into account the management and use of oil revenues, to ensure that each criterion is consistent with policy objectives, and to render them functional and enforceable.

#### Managing Oil Revenue Volatility

**In 2001 BEAC put in place a regional legal framework to manage oil revenue volatility and to save for future generations.** Countries can establish two BEAC accounts: a stabilization account and a Fund for Future Generations (FFG). In a given year, to smooth oil revenues using the stabilization account countries can deposit or withdraw 50 percent of the excess or shortfall of oil revenue, provided that the balance remains positive. Excess occurs when the oil price exceeds its five-year historical average, shortfall when it is lower than that average. Countries can also deposit up to 10 percent of oil revenues in the FFG. In 2005 the Congolese authorities established a stabilization account but not an FFG.

**Across the region these accounts have had limited use due to their low remuneration.** Deposit rates are linked to the European Central Bank Interbank rates (Eurolibor) net of an operational fee charged by BEAC. The current interest rate and maturity structure is:

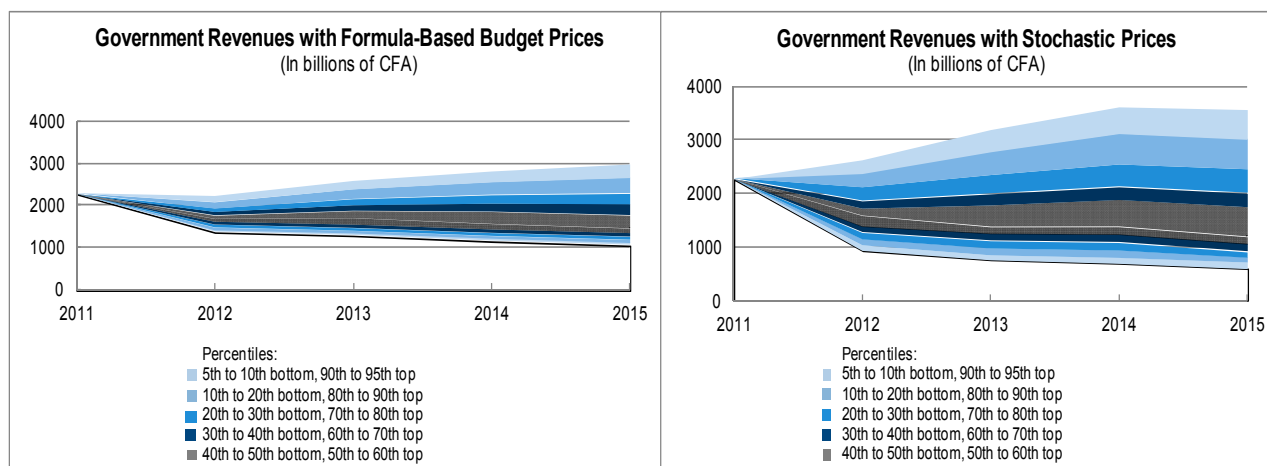
- Revenue stabilization accounts: Minimum maturity of six months; interest rate of 1.10 percent; subject to a 30 percent penalty for early withdrawal.
- Fund for Future Generations: Minimum maturity of five years; remuneration rate of 1.50 percent; subject to a retroactive penalty for early withdrawal.

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Sources: IMF staff and CEMAC authorities.

122. **Application of a moving-average oil price to data for the Congo would significantly reduce the volatility of budgeted oil revenues.** The within-year standard deviation of budgeted revenues resulting from the stochastic simulation of oil prices under the smoothing rule decreases in the fourth year of implementation by more than 35 percent relative to observed volatility without the smoothing rule (Figure 17).

**Figure 17. Republic of Congo—Distribution of Future Government Oil Revenues With and Without a Stabilization Buffer, 2011–15**



Source: IMF staff estimates based on WEO oil prices applied to oil revenue forecast models.

### Determining the Size of the Stabilization Buffer

123. **VaR modeling is used to estimate the optimal size of a local currency–denominated stabilization buffer by simulating the potential volatility of oil prices.** This type of modeling is often considered more rigorous than simple benchmarking that does not take into account volatility determinants of the value to be insured by the policy: namely, the contribution of oil revenue to the budget.<sup>70</sup>

124. **The initial stabilization buffer should be large enough to ensure that, given an oil price-based budget rule, with a high degree of confidence it would take more than three years to fully deplete the buffer.** This aims to avoid the high cost of adjustment that would result if the buffer were fully depleted. The minimum required size of the buffer is estimated based on the oil production profile and the fiscal regime as well as stochastic simulation of future oil prices.

125. **Assuming the 8-year moving average price rule recommended, the estimated minimum size of a stabilization buffer for Congo is about CFAF 1,005 billion (about 48 percent of non-oil GDP).** As of 2011 Congo’s net government deposits in BEAC and known offshore holdings (114 percent of non-oil GDP) are more than sufficient to set up the buffer.

126. **Given Congo’s natural resource wealth, anchoring expenditure on a stabilization objective alone would lead to very high spending and no savings for future generations.** In the

<sup>70</sup> Examples of benchmarking are: targets based on averages observed in other countries (cross country comparisons) and coverage based on the historical (backward-looking) statistical volatility of price shocks (e.g., a buffer sufficiently large to cover a hypothetical decline of half a percent in the annual standard deviation of crude oil prices for a period of three years).

next sections, we present a method for determining a sound level of spending that ensures fiscal sustainability despite scaling up and capacity constraints, as well as a framework for financial savings.

### Fiscal Sustainability

127. **This section presents a framework for anchoring expenditure that moves beyond the PIH model but is consistent with fiscal sustainability.** It allows for scaling up investment to close the infrastructure gap while remaining mindful of absorptive and implementation capacity constraints. Net government wealth is stabilized over the long term.

#### *Front-loaded Investment—Beyond the PIH*

128. **Frameworks based on the PIH have provided a benchmark for fiscal and external sustainability in some resource-rich countries.** However, several limitations make the PIH ill-suited for some LICs and LMICs like Congo that have endemic poverty, a large infrastructure gap, and negative net debt. The slow build-up of capital stock suggested by a standard PIH that keeps consumption/spending constant is unlikely to be an optimal development strategy, given the current dilapidation of infrastructure, particularly in energy and transport, and headcount poverty of 50 percent. Moreover, given Congo's high levels of capital spending in 2011, even a gradual path of consolidation toward a PIH consistent level (e.g., over 2012–17) would imply a massive fiscal withdrawal (about 15 percentage points of non-oil GDP a year), which over the medium term would push the economy into recession and lower per capita GDP by more than half (Table 3).

**Table 3. Republic of Congo: Selected Economic Indicators Under Baseline and Standard PIH Scenarios**

	Baseline (front-loaded investment)		Standard-PIH	
	2017	2032	2017	2032
Per Capita GDP (in U.S. dollars)	3,868	4,872	2,992	2,571
Real GDP (annual percent change) <sup>1</sup>	5.1	3.9	-1.7	2.3
Public Capital Spending (in percent non-oil GDP)	23.8	9.1	6.8	17.3
Cumulative Capital Spending (in billions of U.S. dollars)	18.8	40.9	4.6	26.5
Non-Resource Primary Balance (NRPB)	-28.7	-3.5	-14.9	-14.9
Net Financial Assets (in billions of U.S. dollars)	18.2	100.8	30.2	135.2

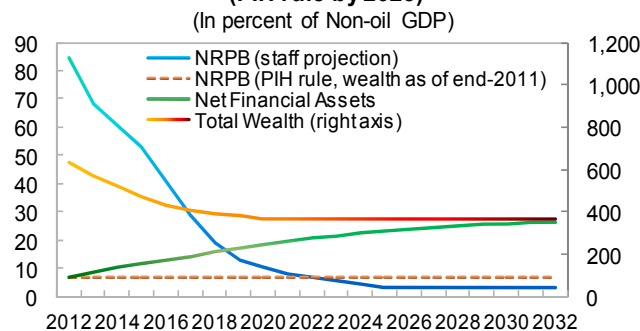
Source: IMF Staff estimates.

<sup>1</sup>Data for 2017 report the average of 2013-17, and 2032 report the average of 2018-32.



129. **In contrast, scaling up investment would boost short-run growth, raise the productivity of the private sector, and in the short run improve welfare by drawing down net government wealth.**<sup>71</sup> In the baseline scenario, investment is front-loaded, decreasing only slightly from 2012 to 2015 (from 25.7 percent of GDP to 18.8 percent), and declining gradually thereafter to 4.7 percent of GDP by 2025. With infrastructure needs met in 2025, the underlying non-resource primary deficit (NRPD) would reach a level (about 3½ percent of non-oil GDP) that is consistent with maintaining total net wealth at about 400 percent of non-oil GDP.<sup>72</sup> A fiscal sustainability analysis based on this framework detailed in Chapter I.B suggests that this scenario is sustainable (Figure 18).<sup>73</sup>

**Figure 18. Republic of Congo: NRPB and Wealth (PIH rule by 2025)**



Sources: Country authorities; and IMF staff estimates.

130. **As the exercise demonstrates, scaling up investment can be consistent with fiscal sustainability.** This is in part the result of the potential growth-enhancing impact of government spending, in particular public investment and the associated increase in non-oil revenue. Projecting intertemporal paths for current and capital spending, oil revenue, the return on accrued financial assets, and non-oil revenue allow for a holistic and dynamic assessment of fiscal sustainability. In contrast, implementing a standard-PIH framework in Congo would likely cause economic and social conditions to deteriorate given the important role of public investment in economic activity and diversification. However, while the macroeconomic scenario outlined is consistent with fiscal sustainability, it is not unique—indeed, many paths for scaling up may be consistent with fiscal sustainability. The next section presents a heuristic benchmarking method for anchoring the size and path of public investment.

<sup>71</sup> The fiscal multiplier for capital spending is assumed to be 0.15. This is an adjusted result from a panel data system-GMM regression of the real GDP growth rate against public capital spending as a percent of GDP and other control variables. The initial coefficient for capital spending was 0.35, but it was adjusted downward using an estimated efficiency factor of 0.4 (computed based on PIMI and other governance indicators).

<sup>72</sup> The large non-oil primary deficit (NOPD) for 2012 includes significant public spending for reconstruction after the explosion of a munitions depot in Brazzaville on March 4, 2012, which caused loss of life and massive destruction.

<sup>73</sup> The FSF analysis entails first deciding on a path for scaling up investment. During this period, net wealth declines. Once the desired capital stock is attained, the NRPB is fixed at a constant level that leaves total net wealth unchanged (see Chapter I.B for a formal definition of the net wealth-stabilizing level of the NRPB).

### ***Size and Path of Public Investment***

131. **In the above application of the fiscal sustainability framework, the target long-term stock of desired wealth is based on an assessment of how much is required for public investment and its annual path.** Cumulative investment (minus depreciation) over the scaling up period should be consistent with the amount estimated to be needed to bring the capital stock to an adequate level.<sup>74</sup> The baseline (heuristically) assumes a level of capital spending that would allow Congo to achieve the mean level of total (public plus private) capital stock of middle-income countries by 2015 (i.e., 220 percent of GDP),<sup>75</sup> followed by a 10-year consolidation to bring total investment to the average observed in middle-income countries (about 25 percent of GDP).<sup>76</sup> The assumed capital spending for 2012–15 is only slightly lower than envisaged in the authorities' poverty reduction strategy, the National Development Plan 2012–16.

132. **However, to avoid wasting resources, it is critical to firm up PFM and institutions.** It is questionable whether the high level of capital spending contained in the National Development Plan is consistent with the degree of PFM and institutional capacity required to efficiently implement it. Given known PFM weaknesses—which range from project selection and through implementation and monitoring—the scaling up of investment should likely be reduced in magnitude until there is clear evidence that capacity is sufficient to support more spending. Future work should formalize the relationship between scaling up and implementation capacity to ensure that growth dividends are maximized.

### **A Framework for Savings**

133. **If Congo's abundant natural resource wealth is spent efficiently, it is sufficient to finance basic investment needs.** The stabilization framework (see above) sets a target for the precautionary fiscal stabilization buffer (Table 4), while the fiscal sustainability framework points to stabilization of net wealth at about 400 percent of non-oil GDP. Savings in any given year are equal to the difference between budgeted revenue and expenditures. If expenditures are larger than revenues the stock of savings would be drawn down by this amount (assuming there is a stock of savings), while the stock of savings would increase if the opposite is true.

<sup>74</sup> Briceño-Garmendia and others (2011) estimated infrastructure spending needs for Congo for 2005–15 to be US\$946 million a year. However, this number should be seen as a lower bound—unit costs have dramatically increased and development needs have evolved.

<sup>75</sup> We use un-adjusted capital stock data computed by Gupta and others (2011) to compute the regional average. As in that paper, capital stock is defined as the cumulative sum of annual public and private real investment spending coupled with an assumption of 4 percent annual depreciation.

<sup>76</sup> The investment path could also be determined as the amount of capital spending that maximizes annual returns on investment while gradually adjusting to that level (if it is lower than what is currently observed) in order to prevent a sharp fiscal contraction.

**Table 4. Republic of Congo: Stabilization Buffer and Savings Illustrated**

	2011	2012	2013	2014	2015
	(In percent of Non-oil GDP)				
Oil Production (in million barrels per day)	109.0	105.3	104.7	103.4	96.9
IMF WEO Oil Price (U.S. dollar per barrel)	104.0	114.7	110.0	102.8	97.2
Total Revenue					
(1) Actual	136.2	128.8	119.4	106.7	94.3
(2) Budget	...	105.4	105.9	99.9	95.1
Oil Revenue					
(3) Actual <sup>1</sup>	108.9	103.9	93.9	81.2	68.8
(4) Budget (price-rule based)	...	80.2	80.3	74.5	69.6
Non-Oil Revenue					
(5) Actual	27.2	25.0	25.5	25.5	25.5
(6) Structural Revenue	26.9	25.1	25.5	25.4	25.5
Use of Budgetary Revenue					
(7) Expenditure	85.0	117.5	96.1	87.0	79.4
(8) Saving Fund Flow	0.0	-12.1	9.7	12.9	15.7
Saving Fund					
(9) Stock	66.4	54.2	64.0	76.9	92.6
Stabilization Fund					
(10) Annual Flow (=1-2)	0.0	23.5	13.5	6.8	-0.8
(11) Stock	48.0	64.1	68.9	66.8	59.1
Structural Balance (=2-7)	...	-12.1	9.7	12.9	15.7
Overall Balance (=1-7) or (8+10)	52.7	11.3	23.3	19.7	14.9
Non-Oil Primary Balance					
Non-Oil GDP (in billions of CFA)	2,096	2,472	2,867	3,288	3,671

<sup>1</sup> Actual oil revenue denotes a projection based on the actual projected oil price.

134. **Savings could be accumulated in the BEAC in a FFG, a vehicle the central bank established in 2006.** A domestic currency–denominated long-run investment of this type would be fully consistent with the CEMAC 100 percent repatriation requirement. The shift of government CFA-denominated savings (the counterpart of international reserves) within BEAC from liquid current accounts to longer-term savings would affect international reserves; however, in the region reserves are currently ample. Member countries might also consider, in coordination with the BEAC, the merits of alternative investment vehicles.

135. **Regardless of the modality used for saving, to minimize political influences there must be a solid institutional structure for managing financial wealth stemming from natural resources.** Such a structure would also enhance transparency and governance of natural resource

revenue flows and accrued assets while promoting public awareness of the government’s financial position.

### Key Policies and Lessons

136. **As an anchor for fiscal policy Congo should consider both introducing a fiscal rule to smooth budgeted revenue and basing capital expenditure on an assessment of an adequate capital spending envelope for the scaling up period.** The medium-term spending path should then be calibrated annually to ensure fiscal sustainability and expenditure in line with absorptive and implementation capacity. The pace of scaling up should be consistent with improvements in PFM. The following conclusions can be drawn from this exercise:

- Given Congo’s high oil dependence, a simple budgetary oil-price rule is preferable; this would not only reduce volatility on par with more complex structural balance rules but would be easy to implement.
- Current government deposits are sufficient to establish a stabilization fund and a saving fund. Savings could be accumulated in the BEAC in the FFG or in an alternative investment vehicle agreed by member countries in coordination with the BEAC.
- The cumulative value of investment over the scaling up period should be capped at a level consistent with the amount estimated to bring the capital stock to a relevant benchmark, such as the regional average or the average level of capital for upper-middle-income countries.
- Finally, revenue and spending paths should be calibrated to ensure fiscal sustainability from the perspective of total net wealth (financial and physical assets).

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### Appendix I. Value-at-Risk Modeling and Forecasting of Oil Prices

This approach to estimating the appropriate stabilization fund size uses stochastic simulations of oil revenues and stabilization funds based on an oil production profile, oil prices, and the fiscal regime.

Oil prices are modeled using an AR(1) process in logarithms. The current year's oil price is estimated using the previous year's price and a random variable ( $\varepsilon$ ):

$$\log(P_t) = \alpha + \beta \log(P_{t-1}) + \varepsilon_t,$$

where  $\alpha = 0.058$ ,  $\beta = 0.90$ , and  $\varepsilon \sim N(0,0.29)$ . These parameters were estimated using data from the BP Statistical Review 2011 covering 1969–2010 controlling for a possible regime change in the oil market in 1974.

The oil price is simulated 5,000 times. For each simulation, oil revenues are computed based on a production profile and fiscal regime in Congo, and outcomes of the fiscal rule are simulated as described in Appendix II.

### Appendix II. Expenditures and the Stabilization Buffer

Formula-based revenue in time  $t$  ( $R_t^b$ ) is defined as the sum of formula-based oil revenues ( $OR_t^b$ ), which are estimated using the oil fiscal regime and the budgetary oil price, and structural non-oil revenues ( $NOR_t$ ) –or as suggested previously for simplicity, just actual non-oil revenues. Actual revenues in year  $t$  ( $R_t^a$ ), on the contrary, are defined as the sum of actual oil and non-oil revenues in that period.

$$R_t^b = OR_t^b + NOR_t \quad (1)$$

$$R_t^a = OR_t^a + NOR_t \quad (2)$$

If a saving component is part of the fiscal rule, the formula-based revenue is divided between expenditures and the amount of targeted savings ( $S_t$ ), where expenditures are defined by the fiscal sustainability exercise.

$$R_t^b = E_t + S_t \quad (3)$$

This entails having a formula-based structural surplus. ( $R_t^b - E_t > 0$ ).

Transfers to or withdrawals from the stabilization fund in time  $t$  ( $T_t$ ) are computed as follows:

$$T_t = R_t^a - R_t^b$$

or using (3):

$$T_t = R_t^a - E_t - S_t$$

Solving for savings in time  $t$ , savings are defined as:

$$S_t = R_t^a - E_t - T_t$$

The minimum initial stabilization fund size  $T_0$  is the minimum initial amount that, given the price rule and simulated oil prices and the resulting stabilization transfers, would not result in the stabilization fund stock being fully depleted over a three year horizon (that is,  $TT = \sum_{i=0}^2 T_{t+i} \geq 0$ ) with an 85 percent level of confidence.

The stock of savings ( $SS_t$ ) at time  $t$  can be computed as:

$$SS_t = (1 + i)SS_{t-1} + S_t,$$

where  $i$  denotes the nominal annual interest rate.

## B. Investing Oil Revenue in Capital-Scarce Economies: An Application to Angola<sup>77</sup>

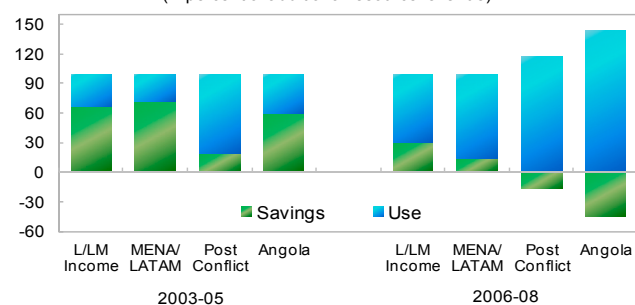
137. Angola currently has no comprehensive fiscal framework to shield the economy from volatility in oil prices, and oil production; and the uncertainty stemming from the institutional setting. Without such a framework, hard-won macroeconomic stability gains and realization of ambitious development plans could be undermined. The fact that economic activity in such sectors as construction and commerce is closely linked to budget execution tends to magnify the negative effects on the real economy of sudden stops and starts in the public investment program. This chapter sets out building blocks for a fiscal framework that would allow Angola to build sufficient buffers to withstand oil revenue shocks without disrupting investment.

### Background

138. Angola emerged from more than four decades of war to become Africa's second largest oil exporter and third largest economy. The civil war that ended in 2002 decimated infrastructure, weakened institutions, and brought the economy to a standstill. In the decade since, real growth has averaged more than 10 percent a year and Angola made progress on a variety of fronts—yet it still ranks only at 148 out of 187 countries on the Human Development Index (United Nations Development Programme, 2011) and scores a 3 out of 6 on the Country Policy and Institutional Assessment's fiscal policy index (World Bank, 2011). Three-quarters of GDP is concentrated in Luanda, the oil sector is an enclave, and the public sector dominates the economy. Angola clearly has substantial development challenges.

139. The global financial crisis of 2008 that precipitated a drop in world oil prices led Angola to reassess how it was managing resource revenues. During the oil price boom of 2003–08 Angola began to rebuild its infrastructure, both oil and non-oil sectors grew substantially, and per capita GDP reached middle-income levels. However, by 2008 expansionary fiscal and monetary policies and an overvalued exchange rate had left the country vulnerable. In the early years of the boom, Angola saved about 60 percent of the oil revenue that exceeded the budget estimate, but as oil prices stayed up, leading to the belief that they were permanent, spending increased sharply (Figure 19). From 2006 to 2008 Angola spent 140 percent of the additional oil revenue, more than most other low- and middle-income oil producers.

Figure 19. Use and Savings of Additional Resource Revenue, 2003–08  
(In percent of additional resource revenue)



Sources: World Economic Outlook; and IMF staff estimates.

<sup>77</sup> Prepared by Christine Jane Richmond (FAD), Irene Yackovlev (AFR), and Susan Yang (RES).

140. By 2009, Angola faced growing macroeconomic instability against a backdrop of significant downside risks. International reserves had fallen by one-third in the first half of the year. The authorities' program, backed by the IMF, sought to stabilize the economy in the short run through a combination of fiscal consolidation, an orderly exchange rate adjustment backed by tighter monetary policy, and measures to safeguard the financial sector.

141. Angola currently produces about 650 million barrels of oil a year, mainly offshore, and the volume is expected to increase over the medium term. Oil revenues have comprised more than 75 percent of total revenue since 2002. They accrue to the government through two separate tax regimes: the tax and royalty regime that applies to Cabinda and onshore production, and production-sharing agreements (PSAs) that apply to newer contracts and are seen as more favorable to the government since Angola retains ownership of the oil and control of oil activities. Sonangol, the national oil company established in 1976, is the sole concessionaire for Angola's oil exploration and extraction and contributes about two-thirds of government oil revenues; the rest comes from taxes paid by private companies.

142. While oil wealth has made Angola a middle-income country,<sup>78</sup> its physical and human capital needs more closely resemble a low-income country. This dichotomy underscores the importance of finding a framework for building fiscal buffers that would allow it to avoid stops and starts in investment due to oil revenue shocks.

143. Because Angola has a long oil revenue horizon, the main challenge for its policymakers is managing oil revenue volatility. Prices, production, and institutions can all subject Angola to oil revenue shocks (Box 6). In a sample of 16 mainly low- and lower- middle-income oil producers plus Gabon and Equatorial Guinea, oil revenues in 2002–12 averaged 19.4 percent of GDP, with a standard deviation of 5.2 percent of GDP. Compared to this average, the Angolan economy is more oil-dependent and experiences more revenue volatility; since 2002, its oil revenues have averaged 33.3 percent of GDP, with a standard deviation of 6.2 percent of GDP.

144. In capital-scarce economies, the volatility of resource revenue can be particularly damaging if investment spending is dictated by the amount of flows in each period. Stop-and-go investment paths substantially lower the return on investment projects. Moreover, volatile government spending can translate into a destabilized economy. In Angola, as in LICs, the problem is exacerbated by binding absorptive capacity constraints. During a boom, the costs of such constraints can be large enough to significantly lower the rate of return on investment.<sup>79</sup>

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<sup>78</sup> In 2011, Angola's income per capita was over US\$5,000.

<sup>79</sup> For the impact of absorptive capacity constraints on returns to investment, see Chapter II.A.



### Box 6. Sources of Oil Revenue Volatility in Angola

Although Angola is now well on the road to recovery, there is consensus among policymakers and stakeholders that significant challenges remain. Arguably, the most pressing of these is to put in place a fiscal framework to protect public investment spending before another global crisis hits. Three sources of oil revenue uncertainty pose risks to Angola's fiscal performance:

- *Prices.* As with all oil exporters, prices for Angola's oil production are volatile. To hedge against this risk, the authorities have used conservative oil price assumptions (typically two-thirds of the realized world price) in formulating their budget.
- *Quantities.* Oil production is inherently uncertain. Technical problems can arise at any time, and uncertainty increases as wells age. For nine of the last ten years the budget forecast for oil production has been overly optimistic, which exacerbates the risk.
- *Revenue transfers.* The recurrent problem of unpredictable transfers of oil revenue from Sonangol (the state oil company) to the treasury has been an additional source of uncertainty, a function of Angola's institutions. The risk is that what is transferred is only what is left after Sonangol's financial operations. The authorities recognize that of these three sources of uncertainty the relationship between Sonangol and the central government is the only one fully under their control.

145. This analysis adapts for Angola the analytical framework constructed in Berg, and others (forthcoming), which studies the scaling up of public investment in RRDCs.<sup>80</sup> The framework is a small, open, DSGE model with three production sectors: non traded goods, traded goods, and oil. It accounts for features that are important in simulating public investment effects, such as investment inefficiency and low absorptive capacity. To capture the potential for Dutch disease from spending oil revenues, the model features learning-by-doing externalities in the non-oil traded-goods sector. Also, to capture uncertain forecasts of oil revenues, the model assumes a stochastic process for oil prices and production quantities. Oil tax rates in the model mimic the price-dependent schedule implemented in Angola.<sup>81</sup>

### Two Approaches to Investing Oil Revenue

146. Since policymakers intend to invest oil revenues, fiscal specification in the model looks at two approaches to scaling up public investment. The exercise simulates the macroeconomic effects of continuing with the "spend-as-you-go" approach to fiscal policy (similar to what Angola has practiced until now) or of adopting a "gradual scaling up" approach. Based on the sustainable investing approach, which combines investing with external savings (Berg et al., forthcoming), the

<sup>80</sup> Chapter I.C details model specifications.

<sup>81</sup> The oil tax rate is 0.56 of the sales price if the crude oil per barrel is less than US\$75, 0.58 if it is between US\$75 and US\$100, 0.6 if it is between US\$100 and US\$125, and 0.65 if it is above US\$125.

gradual scaling up approach increases investment spending gradually and sustains it at a higher percentage of GDP. Meanwhile, a stabilization fund is built up to support the investment path specified.

147. To focus on spending decisions, income tax rates are assumed to be constant at the level in 2011. Also, to focus on oil revenue–financed (non debt) spending, government debt is kept at the initial level. Other assumptions for each approach are detailed below.

- *The spend-as-you-go approach:* This approach assumes that each year all the oil revenue is spent on goods and services, capital investment, or transfers to households. It is also assumed that 40 percent of resource revenue additional to the initial level goes to government consumption and 60 percent to public investment. The feedback effect of more government spending generates higher non-oil revenue, so that transfers to households are also higher.
- *The gradual scaling up approach:* This approach assumes that during the first few years the focus is on building up fiscal buffers, so that public investment is scaled up gradually. Rather than being procyclical like the spend-as-you-go approach, the gradual scaling up approach delinks spending decisions from oil revenue flows. Public investment is gradually scaled up from 8.7 percent of GDP in 2011 to 13 percent in 2020, and government consumption as a share of GDP is kept at 18 percent, down from 19.5 percent in 2011. For this path of public investment and government consumption, surplus revenues are saved in a stabilization fund modeled after those in Chile and Colombia. When there is a revenue shortfall, the fund is drawn down to maintain investment commensurate with the set investment path. Should negative oil shocks be unexpectedly large, it is assumed that investment spending in that period is reduced to the point where the value of the stabilization fund is kept at almost zero.<sup>82</sup>

148. Fiscal sustainability in the model is maintained in the sense that adjustments are imposed to satisfy the flow and the intertemporal budget constraint. With the spend-as-you-go approach, government consumption, investment, and transfers all adjust automatically to changes in oil revenue. With the gradual-scaling up approach, all adjustment falls on public investment if there is not enough in the stabilization fund. The large and frequent adjustments, however, raise concerns about fiscal sustainability in reality because drastic changes in policy may not be feasible due to political economy constraints. Thus, when a simulation results in frequent or large reductions from a predetermined investment path, it signals a possible need for a less ambitious scaling up plan. The magnitude of the scaling up and the government consumption paths assumed in this exercise are guided by considerations of both fiscal and capital sustainability.

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<sup>82</sup> Theoretically, other fiscal variables can also adjust when the balance in a stabilization fund is insufficient. However, given the difficulty of cutting current spending and raising taxes, in practice investment spending is likely to absorb most of the cuts, as was seen recently in Angola.

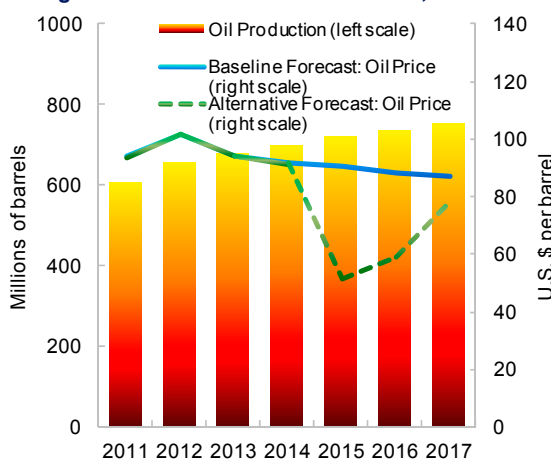
## Simulation Results for Two Price Scenarios

149. The simulation traces the macroeconomic dynamics of the two approaches to investing Angola’s oil revenues. To highlight the dependence of macroeconomic outcomes on the oil revenue forecast, the results are presented for two oil price forecast scenarios (Figure 20). The baseline scenario assumes a less volatile path and the alternative scenario assumes a period of large negative price shocks. Oil revenues continue to increase gradually under the baseline scenario, but drop sharply during the years that the shock hits (Figure 21). Figure 22 contrasts the macroeconomic effects of the two investing approaches under the baseline scenario (left column) and alternative scenario (right column).<sup>83</sup>

### Baseline Scenario

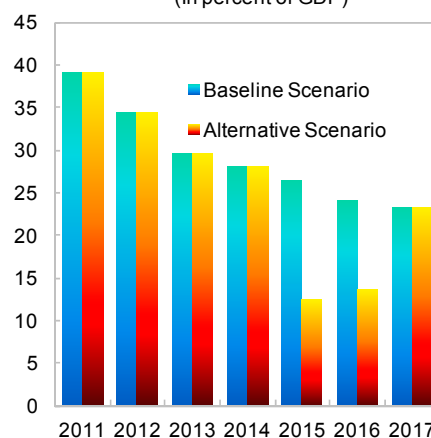
150. The baseline scenario is based on the *World Economic Outlook* (WEO) forecast updated in June 2012, which has an average oil price of US\$101.80 for 2012 followed by a gradual decline through 2017. Starting in 2018, the scenario draws a price shock each period from an estimated distribution based on oil price data.<sup>84</sup> Oil revenue increases over time because of relatively steady production, combined with a slightly declining projection of oil prices.

**Figure 20. Oil Production and Prices, 2011–17**



Source: IMF staff estimates (based on WEO Spring 2012).

**Figure 21. Oil Revenue, 2011–17**  
(In percent of GDP)



Source: IMF staff estimates.

<sup>83</sup> Since the model does not capture growth from improvement in total factor productivity or population growth, “percent deviations” in Figure 4 are deviations from a balanced-growth path in the absence of oil revenue increase relative to the 2011 level.

<sup>84</sup> The oil price in the model follows a unit root process without a drift (as estimated by Hamilton, 2009). The oil price shocks are assumed to have a normal distribution with mean zero. The standard deviation (0.1) is calibrated to the estimate based on real annual oil prices (simple average of three spot prices: Dated Brent, West Texas Intermediate, and the Dubai Fateh) from 1980 to 2011. The forecast of the two scenarios presented is only one possible path of realization in shocks. Later the stochastic simulation exercise uses a large number of draws to account for the uncertainty in the oil revenue forecast.

151. Figure 22 shows that spend-as-you-go fiscal policy is procyclical. Public investment and government consumption move in tandem with oil revenue, and the stabilization fund remains at about the initial 2 percent of GDP. Government consumption plus public investment as a share of GDP fluctuates between about 30 percent and 37 percent. Gradual scaling up fiscal policy is less volatile.

152. In general, spending oil revenue has a direct effect through higher demand pressure on domestic production. Since part of additional government spending raises demand in non traded goods, it also raises the real wage rate in the non traded sector and hence the general wage rate for the economy. Higher wages increase income, leading to higher private consumption and investment. The strength of this demand-side effect depends on the composition of government purchases in terms of traded and non traded goods. In Angola, where most demand is met by imports, the demand-side effect is rather feeble.

153. In addition to the demand-side effect, there is also a supply-side effect because of a higher stock of productive public capital. Since public capital is an input into private production, more public capital makes private inputs more productive, which in turn crowds in private investment and hence produces more non-oil GDP.

154. From 2012 to 2017, non-oil GDP is higher with the spend-as-you-go approach, but after 2017 the gradual-scaling up approach performs better. The relatively high oil revenue in early years leads to more government spending than in the gradual-scaling up approach and hence a stronger demand-side effect. More public investment, despite the higher costs of the absorptive capacity constraint, still produces more public capital. The calibration assumes that the net annual rate of return on public capital (defined as the marginal product of public capital net depreciation) is 8.8 percent.<sup>85</sup> Thus, with higher public and private capital (due to more private investment), the spend-as-you-go approach generates a boom along with more oil revenue. Later, the fluctuating path of public investment with the spend-as-you-go path lowers the return on investment because the depreciation rate is higher. On the other hand, steadily increased public investment as modeled by the gradual-scaling up approach builds up more productive capital over time, and starting in 2017 the economy enjoys higher non-oil GDP and private consumption than with the spend-as-you-go approach.

155. To quantify the costs of absorptive capacity constraints and investment inefficiency, Figure 22 also reports the “waste” per dollar of investment expenditure. The calibration assumes that even without binding absorptive capacity constraints, on average a dollar of investment expenditure

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<sup>85</sup> This assumption is relatively moderate: The World Bank (2010) reports that the median rate of return on World Bank projects in about 2001 in sub-Saharan Africa is about 22 percent. However, there is also evidence that the output effect for World Bank lending projects is quite small (Kraay, 2012).

only leads to 0.4 dollar of effective investment, so 60 percent is wasted.<sup>86</sup> With additional scaling up, waste can be higher because of absorptive capacity constraints.

156. As for Dutch disease, the real exchange rate appreciates (much more with the spend-as-you-go approach) under the baseline scenario, which leads to an initial decline in traded goods production. However, as productive public capital gradually increases, productivity in the traded goods sector also rises through learning-by-doing, and Dutch disease turns to “Dutch vigor” as in Berg et al., 2010 for analyzes aid-scaling.

### **Alternative Scenario**

157. The path of oil prices in the baseline scenario is relatively non volatile, which may be unrealistic. In the alternative scenario, we subject oil prices to large negative shocks for 2015–17. Oil prices fall by 44 percent from US\$91.6 in 2014 to US\$51.7 in 2015, and then recover to US\$78.0 in 2017. Oil prices from 2018 to 2020 are assumed to then be subject to the same realized shock values as in the baseline.

158. With a more volatile path for oil prices, the benefits delivered by gradual scaling up become more discernible. The right column of Figure 22 shows that the unexpected drop in oil revenues in 2015. A forces public investment to be reduced from 10.2 percent of GDP in 2014 to 5.0 percent in 2015. As a result starting in 2015 non-oil GDP and private consumption even falls below the constant-trend-growth path. The abrupt decline results in too little investment spending to properly maintain existing capital. Consequently, the depreciation rate for existing capital rises, lowering investment return. By 2017, public capital is almost 10 percent below the balanced-growth path.

159. In contrast to the dramatic fall in public investment with spend-as-you-go, gradual scaling up manages to sustain public investment despite big negative shocks. Since public investment only scales up gradually from 2012 on and government consumption is held at 18 percent of GDP, by 2014 the stabilization fund reaches about 10.4 percent of GDP. When the shock hits in 2015, the stabilization fund is drawn down to support uninterrupted scaling up. In the medium term, taking the gradual-scaling up approach, the economy substantially outperforms what would happen with spend-as-you-go in terms of public capital, private investment, private consumption, and non-oil GDP. In 2020, public capital is 9.4 percent and non-oil GDP is 1.5 percent above the balanced-growth path, compared to 9.7 and 1.1 percent with spend-as-you-go.

160. The stable gradual-scaling up fiscal regime effectively shelters the economy from oil revenues volatility. Moreover, through a sustainable investing strategy, the growth benefits from high public capital stock are also sustained in the longer run.

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<sup>86</sup> The assumption of an investment efficiency parameter of 0.4 is in line with Pritchett’s estimate (2000) for sub-Saharan countries.

## Coping with Oil Revenue Volatility

161. The simulation results in Figure 22 show that between the two investing approaches, gradual-scaling up can better manage with oil revenue volatility and on average deliver better growth outcomes, especially in the medium and long term. When following a sustainable investing strategy, however, there is still a policy question: how to determine the scaling up magnitude (and hence the amount of savings in stabilization fund) when future oil revenues are uncertain. More aggressive scaling up leads to faster accumulation of public capital and higher economic growth. However, as more oil revenues are devoted to investment, less can be saved in a stabilization fund, leaving the economy vulnerable to future shocks.

162. To demonstrate how the fiscal framework can be used to advise allocation decisions between investment and savings in a stabilization fund, stochastic simulations that account for the historical volatility in oil prices are conducted. Figure 23 plots the one- and two-standard deviation (68 percent and 95 percent) confidence intervals of key variables for two investment paths using the gradual-scaling up approach. Instead of assuming that oil prices follow a certain path, for each period starting from 2012 a price shock is drawn from the historical distribution. The confidence bands are plotted based on 100 series of draws of oil price shocks. The solid black lines are mean responses, and the blue (gray) shades are the one (two) standard deviation intervals. The left column—the conservative path— assumes that public investment and government consumption follow the path assumed earlier, with public investment rising slowly from 9.2 percent of GDP in 2012 to 13 percent in 2020. The right column assumes a more aggressive path: public investment quickly rises to from 9.2 percent of GDP in 2012 to 20 percent in 2016. Figure 23 supports a few observations:

- The wide confidence intervals for oil prices (from about US\$50 to US\$150) underscore the volatility of oil prices and hence oil revenue flows. The uncertain revenue forecast implies a wide range of possible economic outcomes. This suggests that *any* macroeconomic forecast based on a specific path of oil revenues will be very uncertain. The exercise assumes no production shocks. The degree of volatility would likely be higher if oil production shocks are also incorporated.
- The two seemingly conflicting policy objectives of economic growth and stability can be dealt with if a proper balance between investing and external savings can be reached. With the conservative scaling up plan (left column), by 2022 mean public capital is 21.1 percent above the balanced-growth path. The mean size of the stabilization fund is 54.3 percent of GDP, with a 95 percent lower bound of 0.05 percent and a 68 percent lower bound of 12.3 percent. This suggests that for the vast majority of realized oil price shocks, the stabilization fund is sufficient to support the planned scaling up path. As a result, less economic stability is sacrificed due to oil revenue volatility. For example, the range of non-oil GDP performance is relatively narrow throughout the projection horizon; the 68 percent interval is 3.0 percent and a 4.2 percent deviation from the balanced-growth path in 2022.
- On the other hand, with the more aggressive scaling up plan (right column), starting in 2015 about 30 percent of the time the stabilization fund cannot fully support the intended scaling up path. While public capital can be higher (the upper bound of the 68 percent interval is

29.3 percent above the balanced-growth path in 2022, compared to 25.6 percent with conservative scaling up), on average non-oil GDP performs similarly on both scaling up paths. Yet macroeconomic uncertainty rises significantly, as shown by wider intervals for public investment, public capital, and non-oil GDP. For example, the 68 percent interval of non-oil GDP is now 2.0–5.3 percent, a much wider spread than with conservative scaling up.

163. That a more aggressive scaling up plan does not lead to better average economic outcomes may seem puzzling. When oil revenues are higher, it is true that a more aggressive path leads to higher and faster economic growth, mainly by expanding the stock of public capital. When negative shocks hit, however, the adverse impact of an insufficient buffer does more than suppress investment spending. As in the spend-as-you-go approach analyzed earlier, the fluctuating investment path of more aggressive scaling up can lower the return on earlier investment and hence undermines the growth effect of investing oil revenue.

164. The exercise on the stochastic simulations performed here suggested that the conservative investing path analyzed runs a much smaller risk of jeopardizing economic stability while achieving sustainable growth. The comparison of two scaling up paths highlights the risks of scaling up too fast. Similar analysis can be conducted on moving from the conservative path to an overly conservative scaling up path. It can be expected that when scaling up is slow and minimal, economic growth is also likely to be slow. Yet the stabilization fund could end up with an unnecessarily large buffer that earns a relatively low return at a high opportunity cost in economic growth.

### **Key Messages**

165. If there were an oil price shock, Angola’s macroeconomic performance would be markedly better if it had a stabilization fund that would allow it to build a fiscal buffer and gradually scale up investment, such as the nascent Oil for Infrastructure Fund. With the spend-as-you-go approach, the country would be vulnerable if oil revenue were to decline as much as it did during the 2008–09 crises. Such a shock in the next three to five years would quickly deplete Angola’s current buffers, which are low, and capital spending would be significantly disrupted for years after.

166. Three key messages emerge from this exercise:

- Without fiscal buffers, Angola is vulnerable to oil revenue volatility. A repeat of the 2008–09 shock would significantly disrupt investment spending for years. Scaling up investment more slowly would allow the stabilization fund to become fully effective. Saving stabilization fund resources to be used during bad times would make space for moderate scaling up over the medium term as capacity builds while maintaining the buffers needed to prevent disruptions to investment from a shock.
- A stabilization fund appears to be advantageous to macroeconomic performance. In the baseline scenario, the stabilization fund would moderate upward pressure on the REER that might otherwise undermine competitiveness. If there were a shock, a stabilization fund would



support a more stable REER. A stabilization fund would also protect private consumption during a shock.

- Finally, there is an urgent need to move to a medium-term planning horizon for fiscal policy. The build-up of buffers needs to begin now if Angola is to withstand a shock in three to five years.

## Conclusions

167. The recent economic turmoil in Angola offers RRDCs a valuable lesson about managing volatile resource revenues. Taking the spend-as-you-go approach forward could destabilize the economy and lead to the types of boom-bust cycles that many resource-dependent economies have suffered. This chapter constructs a fiscal framework for managing Angola's oil revenues and proposes gradual scaling up to address the two most important policy objectives, economic growth and stability.

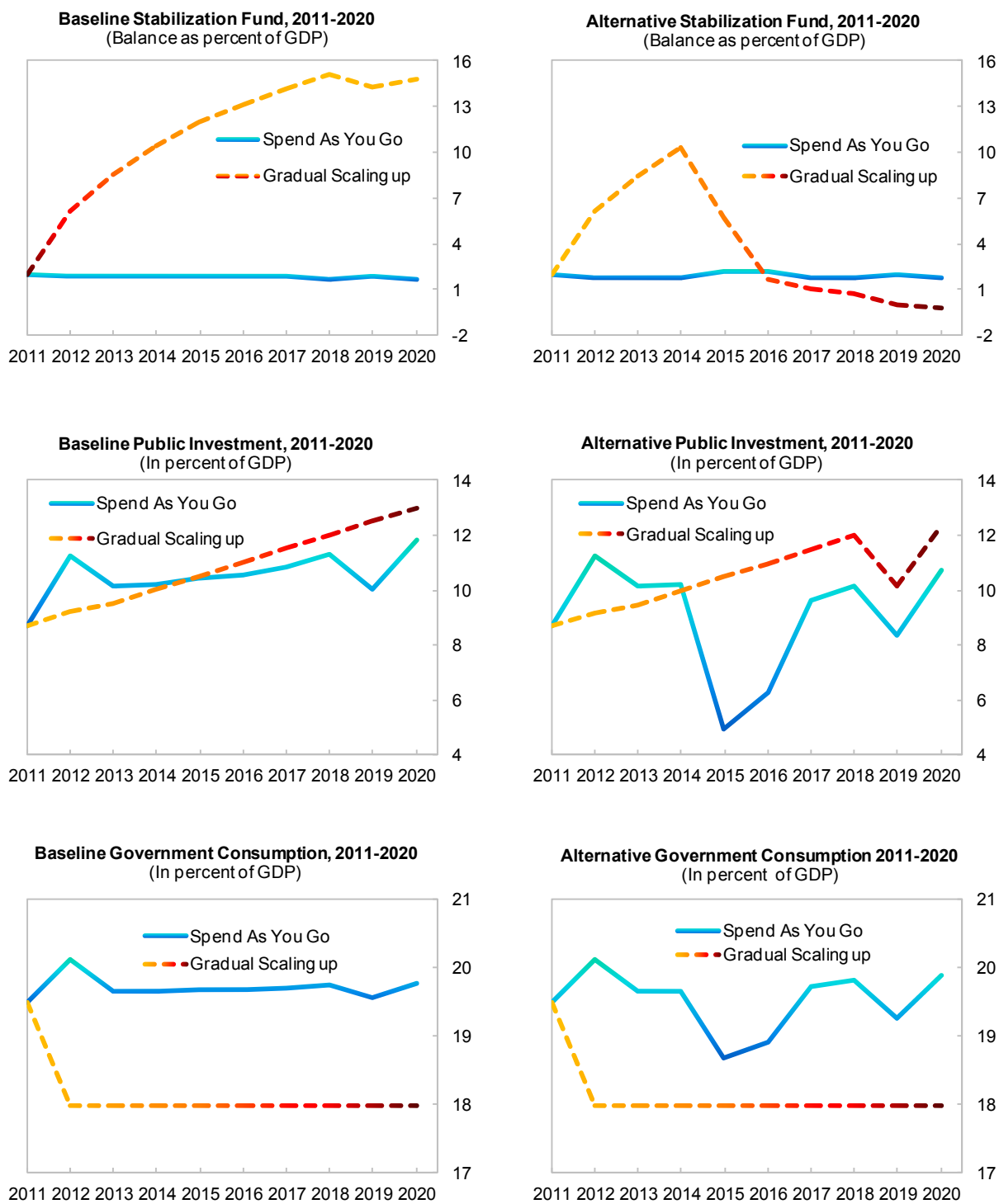
168. Gradual scaling up strikes a balance between promoting growth through investment and ensuring economic stability through a stabilization buffer. By scaling up public investment slowly at first, this approach could allow Angola to shore up its stabilization fund and also mitigate any Dutch disease impact on traded goods production. As the public capital stock gradually increases, public investment as a share of GDP can continue at a higher level than in the beginning to ensure that the growth benefits from more public capital can be sustained.

169. The fiscal framework used in this analysis can also be used to inform decisions about allocations to investment and to external savings. Stochastic simulations that account for the historical process of oil prices and other important sources of volatility can deliver a probabilistic assessment of stability risks and a range of macroeconomic outcomes for a particular investment scaling up path. While over-investing leaves the economy vulnerable to volatility risks, under-investing can cause economic development to stagnate.

170. Lastly, the scaling up path analyzed here for Angola is only one example of a sustainable investing approach. For a country where absorptive capacity constraints are less a concern (perhaps because of international collaboration in development projects) and resource flows are sufficiently high, public investment might be front-loaded in a sustainable investing framework so long as investment is sufficient after the frontloading stage to maintain public capital. For a country with a long revenue horizon like Angola, securing funding for maintaining higher capital stock is less an issue. However, for countries with short revenue horizons, decisions about scaling up magnitudes should take into account securing resource for maintaining public capital after resource reserves are exhausted.

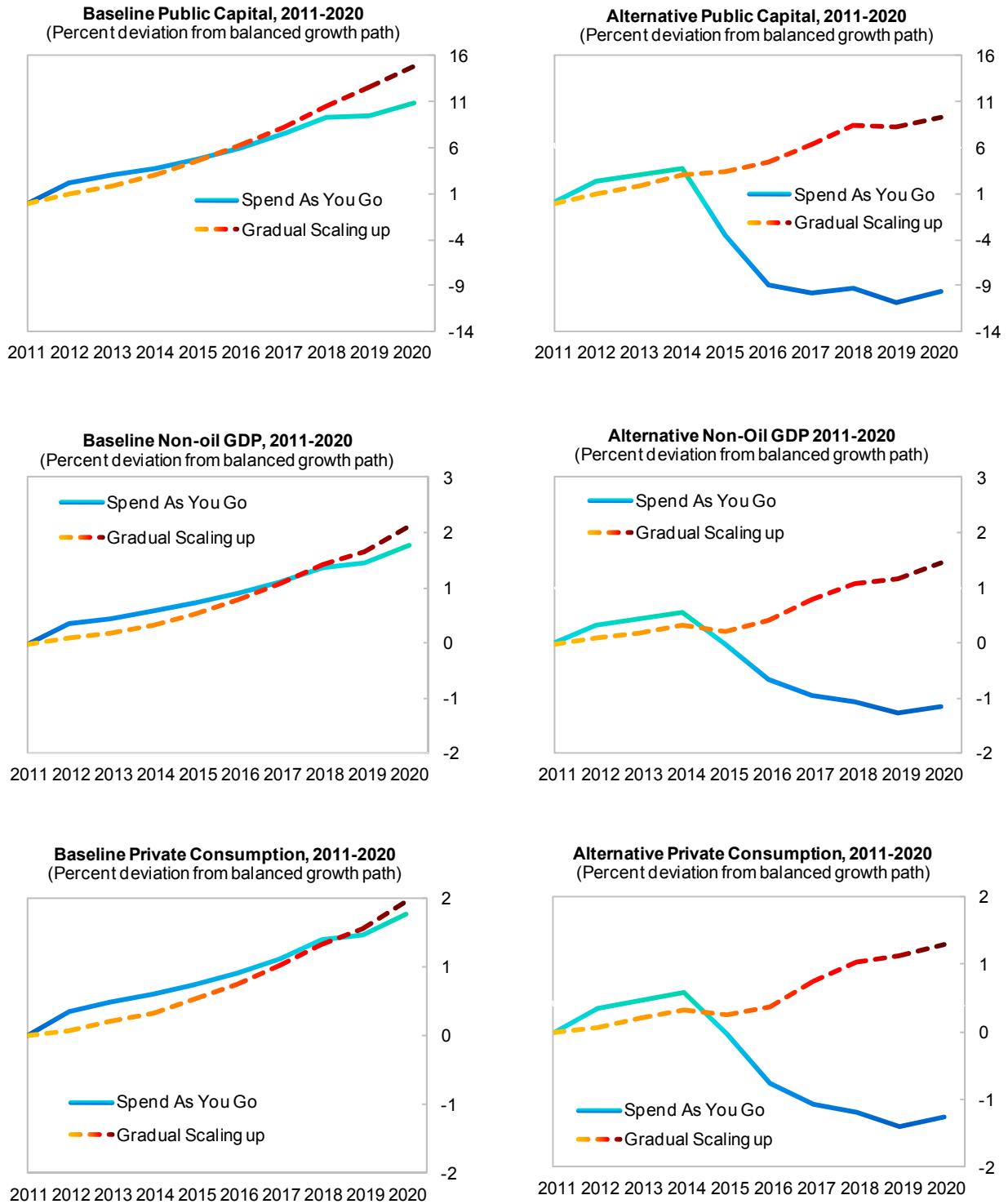


**Figure 22. Angola: Effects of Fiscal Approaches under Baseline and Alternative Oil Price Scenarios, 2011–2020**



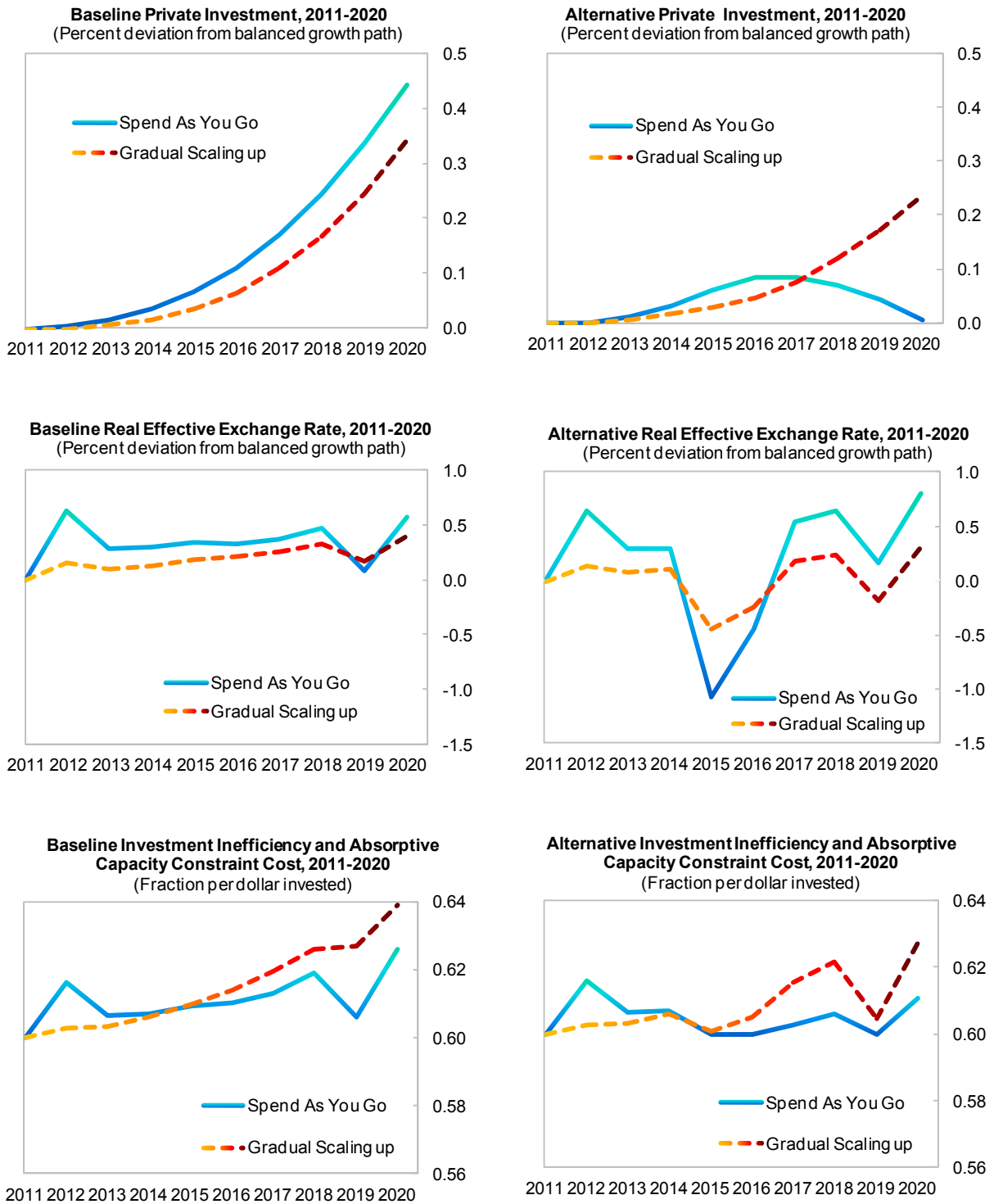
Source: IMF staff estimates.

**Figure 22. Angola: Effects of Fiscal Approaches under Baseline and Alternative Oil Price Scenarios, 2011–2020 (continued)**



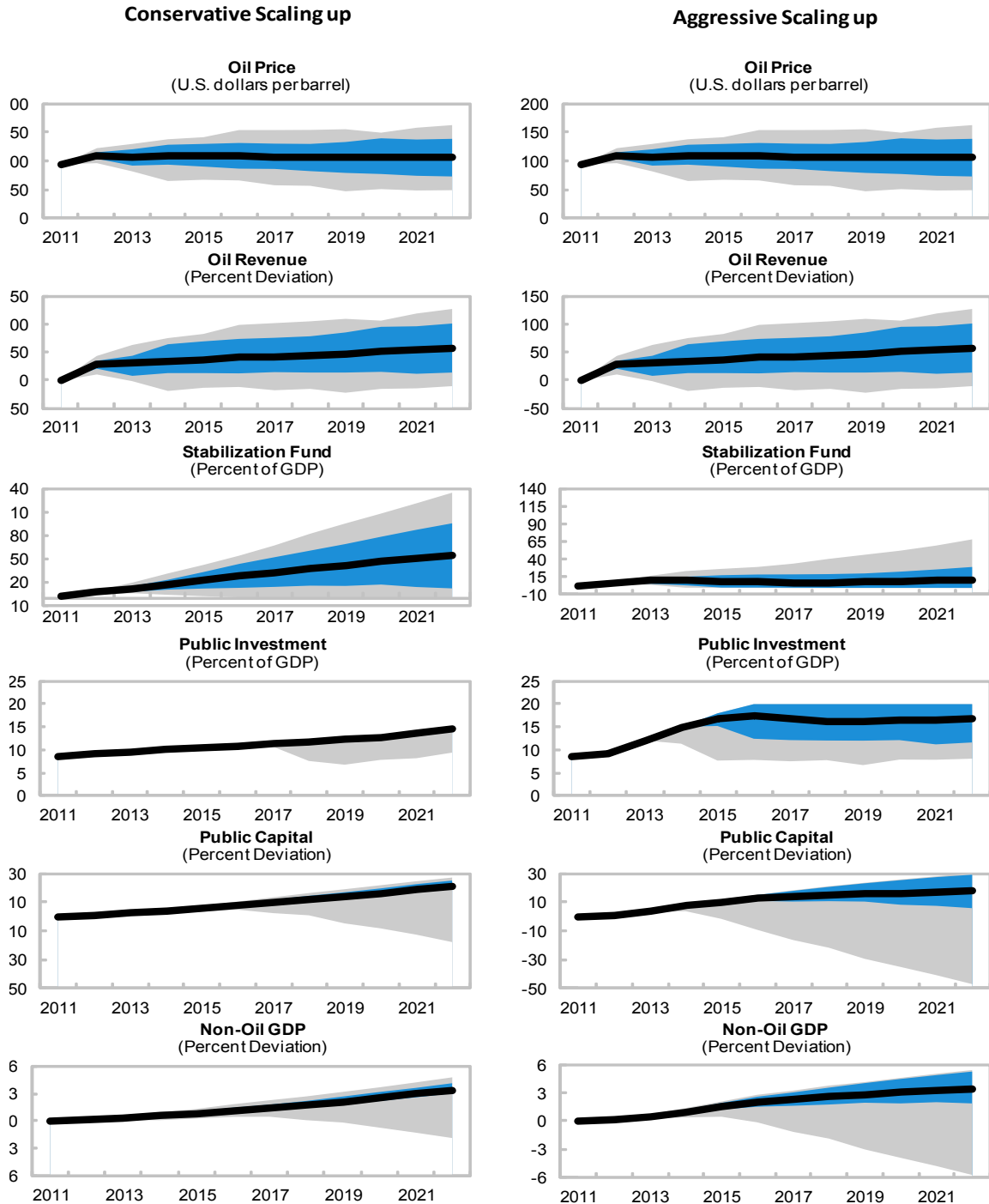
Source: IMF staff estimates.

**Figure 22. Angola: Effects of Fiscal Approaches under Baseline and Alternative Oil Price Scenarios, 2011–2020 (concluded)**



Source: IMF staff estimates.

**Figure 23. Effects of Investing Oil Revenue under Uncertain Oil Prices: Conservative vs. Aggressive Scaling-Up, 2011–2022<sup>1</sup>**



Source: IMF staff estimates.

<sup>1</sup> Solid lines are mean responses. Blue shades are one-standard deviation (68 percent) intervals. Gray shades are two-standard deviation (95 percent) intervals.

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## C. A Sustainable Investment Approach to Scaling Up: The Case of the Democratic Republic of Congo<sup>87</sup>

171. **In natural resource–dependent developing countries like the Democratic Republic of the Congo (DRC), public savings, investment, and consumption decisions are especially complex.** There is an inherent tension between the country’s enormous physical and human capital investment needs and its lack of fiscal buffers and limited access to financing. That tension is magnified by the volatility of commodity-related revenues. The DRC’s decisions depend not only on macroeconomic stability considerations but also on the need to jump-start economic development. Despite its abundance of natural resource wealth, the DRC is one of the least developed countries in the world—it ranks last on the UN Human Development Index—because of governance issues and a long period of civil war and internal conflict that adversely affected the stability and management of the economy.

172. **The DRC’s first democratic elections in 2006 brought about a measure of political and internal stability, which was also reflected in better macroeconomic management and performance.** In recent years, real GDP growth has averaged 6–7 percent a year and the medium-term outlook is benign, although risks remain high. A driving force behind the recovery has been investment in the natural resources sector, with a significant increase in FDI from private mining companies over the last five years and a large minerals-for-infrastructure joint venture with China in 2009. Loans from the joint venture will finance US\$3 billion worth of public investment over the medium term, to be repaid from the government’s participation in a copper and cobalt mining project that will not reach full production capacity for 15–20 years. Recent investment in the mining sector and the consequent rise in production pushed up mineral export volumes by an estimated 149 percent between 2007 and 2012. This has improved the DRC’s external position and, if progress on reforms is accelerated, could bring about a rapid and sizable increase in fiscal revenue over the medium to long term.

173. **Copper and cobalt are the two most important minerals currently being exploited (80 percent of total DRC goods exports by value in 2011), though the DRC also possesses deposits of gold, industrial diamonds, tin, zinc, manganese, and coltan that are only now beginning to be more fully explored and developed.** For a number of years oil has also been produced in the western part of the country in mature fields similar to and bordering those of Angola and the Republic of Congo, and new hydrocarbon reserves are being explored in the Albertine basin in the east. Mining and oil together are estimated to account for more than 30 percent of GDP and over 95 percent of goods exports by value, yet they bring in revenue worth only about 5 percent of GDP (25 percent of total domestic revenue), half of which comes from oil production in the mature fields.

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<sup>87</sup> Prepared by Nathaniel Arnold (FAD), Felix Fischer (AFR), and Friska Parulian (SPR), with contributions from Susan Yang (RES).

174. **Besides fundamental problems with governance and corruption in the DRC, there are several other reasons for the resource sector's fairly small contribution to revenues relative to its share of GDP.** For instance, many mines are still at a loss-making stage of development for corporate income tax purposes due to generous rules on accelerated depreciation of investments and losses carried forward. Additionally, tax administration is fragmented and the tax agencies lack the capacity to deal with complex modern mining operations, with both of these problems exacerbated by tax policy weaknesses exacerbate these problems. There are also state-owned enterprises active in the mining and oil sectors that contribute little or nothing to the Treasury.

175. **While the resource sector is expected to continue growing over the medium term, power supply, infrastructure, and human capital constraints, as well as the possibility of unrest in some areas, are all expected to slow the pace at which it develops.**<sup>88</sup> Combined with the potential for rapid growth in the non-resource sector (from a low base), these constraints motivate the fairly conservative baseline projection that the natural resources sector will constitute a relatively stable share of GDP for much of the next two decades. After 2020, mining production is likely to plateau and the non-resource sector's growth will outstrip that of the resource sector, so that its share of GDP will gradually diminish over the long run.

176. **Though current projections of the resource sector's growth over the next two decades are conservative, the potential of the sector is certainly greater than such projections imply.** Its full potential could likely be realized if the DRC authorities were to take a more comprehensive approach to the management of natural resources, both in identifying and ameliorating supply-side constraints (e.g., targeting some public investment to improve power-generation capacity and railroads) and in improving sector fiscal regime and tax administration, and governance generally. Such an approach would not only support the development of the resource sector but also provide substantially more fiscal revenue. Additional resource revenues could be considered a boon; however, they would also generate new challenges in terms of effective, prudent, and sustainable use of the revenue windfall.

177. **The reforms and capacity improvements needed to speed up development of the resource sector and increase its contribution to revenue are being supported by a substantial IMF TA program over the medium term, financed by the Managing Natural Resource Wealth Topical Trust Fund (MNRW TTF), and by other donors, such as the World Bank's project to bolster the capacity of the Ministry of Mines to better manage the sector.** The DRC authorities have only recently begun to consider the medium-term strategic and policy challenges that a significant increase in resource revenues would create, such as the optimal balance between

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<sup>88</sup> Some large mining companies have entered into deals to finance improvements in power-generating capacity and infrastructure, but significant supply-demand imbalances are expected to persist over the medium term. Moreover, the state-owned railroad company has not invested enough in additional capacity to reduce transportation costs and bottlenecks.

necessary investments and the need for a fiscal buffer.<sup>89</sup> Here we describe the simulation of two illustrative policy options that the DRC could explore for utilizing higher resource revenues.

### The Model and the Main Assumptions

178. **The model we use to simulate the two policy options for the DRC is implemented in an Excel template, constructed from a simplified version of the model developed by Berg and others (forthcoming).** The model is designed to simulate the impacts of different policy options for RRDCs that go beyond the standard PIH approach in considering the tradeoffs between investing more in public capital and boosting external savings. The model can also be used to simulate a “sustainable investment” approach that would sustain the growth benefits of investing resource revenues in public capital while also building a fiscal buffer to avoid exacerbating economic instability through a procyclical fiscal policy that depends on a volatile stream of resource revenues (i.e., cutting public investment sharply when commodity prices fall).<sup>90</sup>

179. **The Excel template incorporates features of the original general equilibrium model, including both the positive feedback effects of public capital on growth and the constraints absorptive capacity and investment efficiency frictions place on public investment.** Public capital impacts growth through two channels: (1) through a “crowding-in” effect, where higher public capital increases the marginal product of private capital, which encourages more private investment, which in turn generates more private capital<sup>91</sup>; and (2) by entering the production function for the non-resource sector, such that, other things being equal, a higher public capital stock produces more non-resource GDP.

180. **The positive effect of public capital on growth is moderated by absorptive capacity constraints and low investment efficiency.** When there are absorptive capacity constraints, as the pace of investment rises, there is less “effective investment”.<sup>92</sup> Low investment efficiency is modeled such that the fraction of effective public investment that accrues to the public capital stock is less

<sup>89</sup> Discussions during the 2012 Article IV consultations centered on the need to improve governance and management of the resource sector, accelerate structural reforms, and design an appropriate medium-term fiscal framework to deal with volatile resource revenues and enhance the effectiveness and efficiency of public investments.

<sup>90</sup> While conducting the analysis in the spreadsheet is simpler than using the full model, it misses important channels that are captured in a general equilibrium model, such as the Keynesian effects resulting from higher government spending and the Dutch disease effect (a real exchange rate appreciation that makes non-resource export industries uncompetitive) associated with spending resource revenues.

<sup>91</sup> In Berg, and others (forthcoming), the link between public capital and private investment arises endogenously from optimal investment behaviors of the private sector. In the template, this link is a reduced-form relationship that captures the qualitative result that higher public capital leads to more private investment in the non-resource sector, but not in the resource sector, where in all scenarios we take resource GDP as given.

<sup>92</sup> We assume that absorptive capacity constraints do not apply to foreign-financed projects since they are often implemented and managed by foreign development partners, involve competitive bidding and international firms, and fully translate gross investment into effective investment. However, the investment efficiency constraint does apply to the foreign-financed investments because they are not always well-coordinated with the government.



than one and reflects the poor quality of institutions, lack of administrative and technical capacity, and poor prioritization and coordination of projects that are common in many LICs.<sup>93</sup>

**181. On the fiscal side, in the baseline projection, we assume that the implicit tax rate on the resource sector remains similar to the current (inferior) level due to capacity and policy constraints.** “Windfall” resource revenues are calculated based on the effective share of mining sector sales that the government could capture with an improved fiscal regime and effective revenue administration.<sup>94</sup> The policy simulations focus on two options for the distribution of windfall revenues between building up a fiscal buffer through external savings and increasing public investment. We assume that both the implicit tax rates on non-resource GDP and the government’s consumption and transfers spending as a share of GDP are the same as the baseline in both scenarios. The baseline debt stock and interest payments are also taken as given in both scenarios.

### **Baseline Public Investment and Policy Options**

**182. In both policy options we study, the foreign and the domestically financed public investment in the baseline scenario continue to serve as the basis for public investment.** In the baseline, the foreign-financed part of public investment is three times larger than the domestic at the start of the simulation period and rises in the near term as a share of GDP, though not as quickly as domestically financed public investment. Over the medium and long term, foreign-financed public investment declines as a share of GDP, from more than 8.5 percent of GDP at its peak to less than 1.5 percent in 2030, as resource-for-infrastructure loans are exhausted and project grants from donors decline. For both options foreign-financed public investment is assumed to be the same as in the baseline.

**183. Domestically financed public investment in the baseline is projected to rise quickly as a share of GDP over the next five years before the pace moderates; over the following 15 years it increases more gradually.** In the baseline, increases forecast for domestically financed investment are not sufficient to offset the decline in foreign-financed investment, causing total public investment as a share of GDP after an initial rise to decline over the medium and long term. Note that a public investment path is considered sustainable if it generates a non decreasing public capital stock-to-GDP ratio for the entire projection period. By this definition the baseline public investment path is sustainable since the public capital stock-to-GDP ratio is increasing through 2030. However, after increasing by 25 percentage points of GDP in the first decade, in the second

<sup>93</sup> Using data for 1960–90 and assuming no TFP growth, Pritchett (2000) estimates an investment efficiency parameter of about 0.5 for sub-Saharan Africa. In a full general equilibrium model, calibrating this parameter involves targeting the rate of return to public investment and the public capital stock-to-GDP ratio in the steady state. In the exercise for Angola using the full general equilibrium model, to be conservative about the benefits of investing all of the oil revenues this parameter was set at 0.4. For DRC the parameter value chosen was 0.7, with the higher value justified by the fact that public investment that is both foreign financed and implemented constitutes a large part of total public investment for much of the simulation period. This is also the value used in Berg, and others (forthcoming).

<sup>94</sup> This is estimated using the Fiscal Analysis of Resource Industries (FARI) model developed by FAD as applied to a large mining project in DRC.

the public capital stock-to-GDP ratio increases by less than 5 percentage points, due to base effects and the decline in total public investment as a share of GDP.

184. Two policy options are explored to illustrate the potential macroeconomic impact of different approaches to saving and investing the resource revenue windfall and the related tradeoffs.<sup>95</sup>

- **Option I (“bird-in-hand”):** This is a conservative scenario in which windfall revenue is saved in an SWF and only the income earned on the savings is used to finance more public investment. This differs from a PIH rule in that, before the SWF has been built up, the authorities do not borrow the projected income based on the present value of the SWF to immediately begin investing more in public capital; rather, only the income realized from the SWF is used for public investment.
- **Option II (balanced investment/saving):** This more balanced scenario allows for a gradual increase in public investment and savings in the form of financial assets held in a SWF. Public investment is determined by two ad hoc rules: (i) only 50 percent of the windfall revenue is allocated to public investment as long as the SWF is less than 10 percent of total GDP; and (ii) once the SWF surpasses 10 percent, the share of the windfall revenues and the income from the SWF allocated to public investment increases by 5 percent a year up to a maximum of 90 percent of the windfall revenue and the SWF income.

### Simulation Results<sup>96</sup>

185. **Recall that in the baseline scenario, total public investment as a share of GDP is projected to decline over time as foreign-financed investment falls.** While domestically financed public investment rises over time as a share of GDP in the baseline scenario, due to limited domestic resources, it does not fully offset the decline in foreign-financed investment. In this regard, the conservative approach in Option I provides a similar result to that in the baseline in the first few years of the projection period, since all of the windfall revenue is saved. However, over the medium to long term, the Option I public investment-to-GDP ratio is higher than in the baseline because the income from the SWF becomes more substantial and is allocated to public investment.

186. **Under Option I the SWF expands significantly over time, reaching nearly 100 percent of GDP after two decades.** This is the result of a considerable improvement in the fiscal balance relative to the baseline because the windfall is saved while spending initially does not increase by much (Figure 24). Interestingly, the NRPB<sup>97</sup> is better in the baseline than in either of the policy

<sup>95</sup> When windfall resource revenues are used for public investment, the additional investment in each year is added to that year’s baseline level of domestically financed public investment.

<sup>96</sup> The results of the simulations over 2012–30 are presented in Table 5 and the Figures below.

<sup>97</sup> The non-resource primary balance is the same as the standard primary balance less resource revenue and the income from the SWF. It is defined as:  $NRPB = (\text{total revenue \& grants}) - (\text{resource revenue \& SWF income}) - (\text{total expenditure} - \text{interest expense})$ .

options because total spending is lower and resource-related revenues, both windfall and SWF income, represent a smaller share of total government revenues (Figure 25).

**187. Both the baseline and Option I generate a lower public capital stock-to-GDP ratio in the first decade.** In Option I the public capital stock only slowly begins to exceed that in the baseline in the second decade due to increased investment from the SWF income (Figure 26). Correspondingly, Option I generates slower real GDP growth, closer to that of the baseline, than Option II (Table 5, Figure 27). However, since public investment in Option I does not ramp up as quickly as in Option II, the public investment lost to absorptive capacity constraints is lower in Option I, though still higher than in the baseline over the medium term (Figures 29 and 29).

**188. Over both the medium and the long term, Option II, the more balanced saving and investment policy, produces better macroeconomic outcomes than Option I** in terms of faster real GDP growth, a larger capital stock, and higher real non-resource GDP (Table 5, Figures 26, 27, and 28). However, there is a sizable direct cost to the higher gross public investment, especially in the first few years. Even in 2015, as the cost starts to decline as a share of GDP, when public investment expenditure in Option II is 2 percentage points of GDP higher than in Option I, the effective public investment Option II generates is worth barely 1 percentage point of GDP more (Figures 29 and 30). Due to the absorptive capacity constraint, the full direct cost of allocating more of the windfall revenue to public investment over the entire projection period (the sum of the annual difference between gross and effective public investment as a percent of GDP) is twice as much for Option II as for Option I (14 percent vs. 7 percent). It should also be noted that with both policy options the public investment approach is sustainable (public capital stock non decreasing) over the forecast horizon.

**189. Besides the direct cost due to the absorptive capacity constraint of a more rapid increase in public investment, there is also an indirect cost in the risk posed by having a smaller SWF to serve as a buffer against shocks over the medium term.** By 2017, the fiscal buffer accumulated under Option I (over 19 percent of GDP) is almost twice as large as under Option II (Table 5). We do not explicitly analyze the optimal size of the fiscal buffer the country should maintain,<sup>98</sup> but in the short term there is clearly a tradeoff between increasing the rate of public investment and building up a fiscal buffer. Over the medium to long term, more rapid investment will generate a higher stock of public capital, which will have positive spillovers on private investment and thus generate higher real GDP per capita, but in the short term it also has high costs due to absorptive capacity constraints on public investment. If a commodity price shock occurs in the next few years (e.g., due to a global economic shock) and eliminates expected windfall resource revenues, with a smaller fiscal buffer the government would be able to maintain only a fraction of the public investment planned under Option II.

<sup>98</sup> In a similar exercise in Chapter III.A for the Republic of Congo, which is dependent on oil, they estimate that, given oil price dynamics, for a buffer that is unlikely to be fully depleted over three years, at a minimum the stabilization fund (or SWF) should be 48 percent of non-oil GDP.

**Table 5. Democratic Republic of Congo: Selected Economic Indicators Under Alternative Scenarios (2012, 2017, 2030)**

	Option I			Option II		
	(Save Resource Windfall)			(Balanced Investment/Savings)		
	2012	2017	2030	2012	2017	2030
	(Billions of CGF <sup>1</sup> , unless otherwise indicated)					
Real GDP	15,315	21,319	42,330	15,315	21,434	45,174
Resource GDP	4,779	6,655	9,867	4,779	6,655	9,867
Non-Resource GDP	10,536	14,663	32,463	10,536	14,779	35,306
Real GDP (annual percent change)	6.48	6.89	4.80	6.48	7.14	5.11
Real GDP Per Capita (relative to baseline)	100	100	104	100	101	111
	(Billions of CGF)					
Effective Capital Public Spending	1,939	2,681	5,104	1,943	3,158	6,266
Public Capital Stock	6,337	12,696	33,378	11,814	13,434	44,138
Private Capital Stock	9,286	15,558	46,817	9,286	15,672	56,428
Non Resource Primary Balance (NRPB)	-979	-1,301	-3,037	-1,013	-1,917	-3,855
Debt Stock	5,402	6,924	5,383	5,402	6,924	5,383
Financial Assets (Stabilization Fund)	68	4,093	40,606	34	2,137	13,519
	(Percent of GDP)					
Effective Public Capital Spending	12.7	12.6	12.1	12.7	14.7	13.6
Public Capital Stock	41.4	59.6	78.9	41.4	62.4	95.7
Private Capital Stock	60.6	73.0	110.6	60.6	72.8	122.3
Non-Resource Primary Balance (NRPB)	-6.4	-6.1	-7.2	-6.6	-8.9	-8.4
Debt Stock	35.3	32.5	12.7	35.3	32.2	11.7
Financial Assets	0.4	19.2	95.9	0.2	9.9	29.3
	(Billions of CGF, unless otherwise indicated)					
Total Net Wealth <sup>2</sup>	10,289	25,424	115,417	15,732	24,319	108,703
Cumulative Capital Spending	3,606	16,495	66,747	3,640	18,352	88,638

Source: Staff calculations

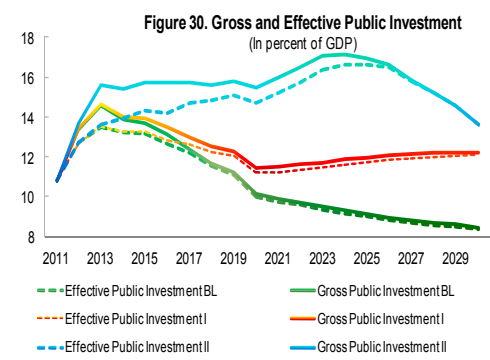
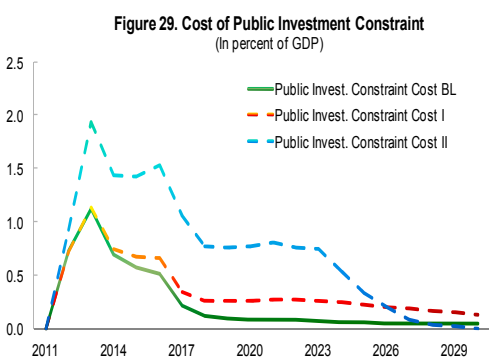
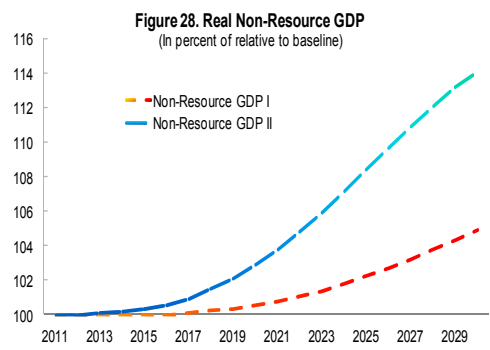
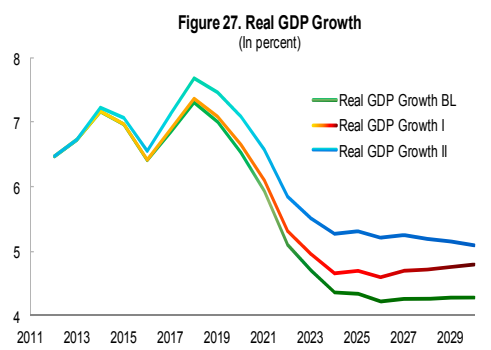
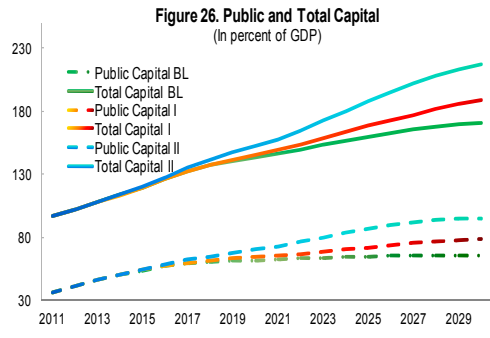
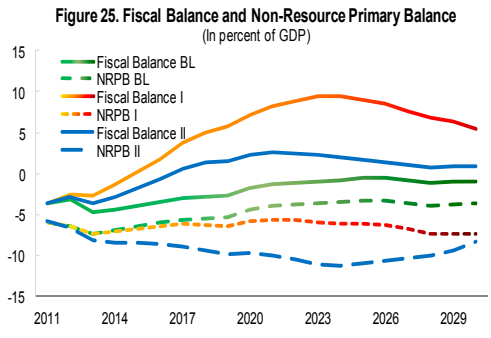
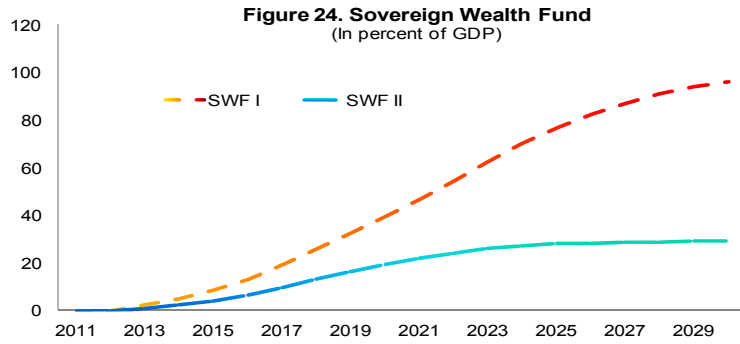
<sup>1</sup>All CGF values are in real terms with 2011 as the base year.

<sup>2</sup>Does not incorporate natural resource wealth. Defined as total capital stock + financial assets - debt stock.

## Policy Implications

190. **The results of the simulations for the two policy options illustrate some of the costs and benefits inherent in choosing different mixes for investing and saving windfall resource revenues.** This is a preliminary application to the DRC of this modeling approach, and the results depend on a number of assumptions, including the assumptions made for the baseline scenario and the adoption of parameter values not specifically calibrated to the DRC. Consequently, the results should be interpreted cautiously—but they do have policy implications:

- Given the DRC's development needs, allocating a portion of higher resource revenues to public investment would likely have a beneficial medium-term impact by attracting private investment to the more labor-intensive non-resource sector, raising the real GDP growth rate, and accelerating poverty reduction. If anything, given the dearth of infrastructure throughout the DRC, this model probably underestimates the positive spillovers from increases in *effective* public investment and the stock of public capital. However, the simulations may also underestimate losses due to absorptive capacity and investment efficiency constraints.
- Additional study of the costs and benefits, direct and indirect, of increasing public investment in the DRC is necessary to ensure informed policy decisions. Even so, it seems clear that to tilt the balance in favor of the benefits public investment can generate and to lower the costs of absorptive capacity and investment efficiency constraints, more must be done to reinforce public financial management, build the technical capacity of the civil service, and put in place institutional structures and procedures that ensure government transparency and accountability.
- In a financially constrained country like the DRC, it is necessary in the short term to build up fiscal buffers to minimize instability from investing volatile resource revenues by improving the fiscal position and accumulating savings in an SWF. Subsequently, determining how much of any additional resource revenues should be saved rather than invested in public capital would depend in part on how strong the positive public investment spillovers are compared with how much of any increase in public investment is likely to be lost to inefficiency and mismanagement.
- Finally, setting up a rule to save more of the additional resource revenue early in the exploitation of the country's natural resources should make it easier for the authorities to resist political pressures to increase government consumption spending when it is building up a fiscal buffer. As this exercise indicates, if the country is to maximize the benefits from exploiting its resource wealth, a sound analytical framework would support a disciplined assessment of the tradeoffs and potential returns inherent in the different policy choices to determine the allocation of resources to, and sequencing of, increases in savings and public investment.



Source: IMF staff estimates.

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