WP/11/207

IMF Working Paper

External Sustainability of Oil-Producing Sub-Saharan African Countries

Misa Takebe and Robert C. York

INTERNATIONAL MONETARY FUND

 WP/11/207

IMF Working Paper

African Department

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Prepared by Misa Takebe and Robert C. York

Authorized for distribution by Bernardin Akitoby

August 2011

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In the extensive empirical work carried out across the IMF on oil-producing sub-Saharan African (SSA) countries, the notion of "sustainability" is often directed toward fiscal policies, and, in particular, views on the "optimal" non-oil primary fiscal deficit. The bulk of this work does not, however, address external sustainability, which is a concern especially for those SSA oil producers operating under a fixed exchange rate regime. A couple of recent papers have extended the existing methodologies to assess external sustainability for some oil-producing countries but they do not focus on those in sub-Saharan Africa. In this paper, we bolster this empirical work by providing a range of estimates for the long-run external current external account balance for each of the SSA oil-producing countries, based on three widely used methodologies in the IMF. Our research strategy is to apply these models to the eight countries in the subregion—Angola, Cameroon, Chad, Côte d'Ivoire, Equatorial Guinea, Gabon, Nigeria, and the Republic of Congo—using similar simplifying assumptions so that we are using the same lens to view how they do and do not differ.

JEL Classification Numbers: E6, H5, H6, N5, O2

Keywords: external sustainability, oil-producing countries, sub-Sahara Africa

Author's E-Mail Address: mtakebe@imf.org; ryork@imf.org

Contents

I. INTRODUCTION[1]

In the extensive empirical work carried out across the IMF on oil-producing sub-Saharan African (SSA) countries, the notion of "sustainability" is often directed toward fiscal policies, and, in particular, views on the "optimal" non-oil primary fiscal deficit.[2] The bulk of this work does not, however, address external sustainability, which is a concern especially for those SSA oil producers operating under a fixed exchange rate regime. A couple of recent papers have extended the existing methodologies to assess external sustainability on some oil-producing countries but they do not focus on those in sub-Saharan Africa.

The lack of attention to external sustainability issues for oil-producing SSA countries is short-sighted for several reasons.

- The horizon for oil production in most of these countries is relatively short; consequently, they will need to manage their foreign assets in a way that anticipates oil depletion and an abrupt decline in oil exports.

- Despite their oil resources, these countries remain vulnerable to external shocks including volatile world oil prices and their generally weak non-oil sectors. Maintaining a foreign asset cushion could help mitigate these shocks and benchmarking the external balance would guide policy makers in determining the magnitude of policy adjustments needed to provide adequate cover.

- Fiscal sustainability is not a perfect substitute for external sustainability, unless the government fully owns and operates the oil business. In most SSA countries, governments are a relatively small player in the oil sector. This creates distortions that drive a wedge between it and the private sector. The savings and investment decisions of the private-sector participants can accentuate the difference between fiscal and external sustainability. Consequently, large external current account deficits can emerge when oil production is depleted, non-oil exports have not been developed to take their place, and private saving is low, even if public saving is high. In this case, the external balance can be unsustainable even if the fiscal position is sustainable. On the other hand, a potential divergence could also arise when governments develop domestic debt markets and start domestic borrowing. The interest rate and rollover

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[1] This paper was prepared for a research project on the Central African Economic and Monetary Community (CEMAC) region and will be included in a collection of papers on CEMAC's recent economic policies. We would like to thank without implication, Rudolph Bems, Alcino Conceicao, Irineu de Carvalho Filho, Alun Thomas, and Uwatt Bassey Uwatt for insightful comments and suggestions on our work. Any errors are, however, our own.

[2] In this paper, we include both oil and gas production in the term "oil producers", although we recognize the importance of accounting for both resources in the economic analysis and policy discussions.

> risks of private external debt can be higher than those of public domestic debt. Akitoby and others (2011) note, for example, a close mapping in SSA oil-producing countries between fiscal and external sustainability only under certain model specifications, including under-development of the private sector. Chalk and Hemming (2000) also showed there is not a one-to-one relationship between fiscal and external sustainability, but they are not entirely independent.

To help fill this void, this paper provides a range of estimates for the long-run external current account balance for each of the SSA oil-producing countries, based on three widely used methodologies in the IMF. Our research strategy is to apply these models to the eight countries in the sub region—Angola, Cameroon, Chad, Côte d'Ivoire, Equatorial Guinea, Gabon, Nigeria, and the Republic of Congo—using similar simplifying assumptions so we are using the same lens to view how they do and do not differ. In essence, this is the external counterpart to the work done by York and Zhan (2009) on fiscal sustainability and vulnerability in these eight countries. We assess the robustness of the models by varying the parameters and assumptions, and compare the overall results with high- and middle-income oil-producing countries to highlight the unique characteristics of those in the sub region.

The paper assumes no change in the exchange rate: it does not examine the optimum exchange rate level. Instead we assume the current exchange rate level is at the optimum. At first glance, this may seem to be a rather strong assumption because one reason for assessing external sustainability is to identify whether an exchange-rate adjustment is required to restore the equilibrium. In countries with flexible exchange rates, the exchange rate is the mechanism to do achieve this. This, however, is not the case in countries with fixed exchange rates. Because most of the oil-producing SSA countries have a fixed exchange rate, this is a reasonable assumption over the medium term; moreover oil-producing SSA countries have extremely low trade elasticity with respect to exchange rate movements. Consequently, changes in the exchange rate over the short term would not significantly alter the projected path of the current account balance.[3]

The paper is organized as follows. We provide a brief review of the empirical literature on assessing the external balance in Section II and background information on the eight oil-producing countries in SSA in Section III to set the context for our analysis. Section IV outlines the models we use to determine external sustainability, the assumptions we employ, and a summary of the overall results; greater detail on each approach is provided in Section V. We draw some conclusions and policy implications in Section VI.

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[3] The impact of exchange rate adjustments on the current account is usually derived from the elasticity of the current account balance to the real exchange. This is the approach taken, for example, in the IMF's Consultative Group on Exchange Rate Issues (CGER) outlined in Lee and others (2008). The CGER was formed in the IMF in the mid-1990s to provide exchange rate assessments for a number of advanced economies from a multilateral perspective.

II. Review of the Empirical Literature

The volume of literature investigating the question of external sustainability (or long-run equilibrium) for advanced and emerging market countries is vast (with important contributions from Williamson, 1994; Debelle and Faruqee, 1996; Edwards, 1998; Chinn and Prasad, 2003; and Cá Zorzi, Chudik, and Dieppe, 2009). The standard methodologies used in the IMF are presented in Lee and others (2008), which is based on the analytical work of the Consultative Group on Exchange Rate Issues (CGER). Lee and others (2008) revised and extended the CGER methodologies to cover emerging market countries through the assessment of (i) external sustainability, which focuses on the difference between the actual current account balance and the balance that would stabilize the net foreign assets (NFA) of a country at some benchmark; (ii) the equilibrium real exchange rate, which is based on medium-term fundamentals (such as NFA, relative productivity differentials between a country's trade and nontrade sectors, and the terms of trade); and (iii) macroeconomic balance, which highlights the difference between the current account projected over the medium term at prevailing exchange rates and an estimated equilibrium current account balance (or current account "norm"). In applying these approaches, nearly all the early empirical work has excluded oil-producing countries.

A few recent papers have, however, tried to adapt these methodologies to the specific features of oil-producing countries. Bems and de Carvalho Filho (2009b) included the non-oil fiscal balance and set the benchmark NFA based on an inter-temporal optimization problem in their analysis of fifteen of these countries, including Nigeria and Cameroon. Morsy (2009) used dynamic panel estimation, instead of pooled ordinary least squares (OLS) and fixed effects estimation, and added proven oil reserves and took account of the maturity of oil production in estimating external sustainability for 28 oil-producing countries using the macroeconomic balance approach. This included five from the SSA region. The paper argued that by adding reserves and accounting for the relative newness of oil production in many of these countries, they could afford to have relatively larger current account deficits.[4]

Thomas, Kim, and Aslam (2008) modified the external sustainability approach by introducing consumption smoothing, estimating an equilibrium external balance by stabilizing the real value of total wealth. Under this framework, countries consume the return on oil- and non-oil wealth with a correction for consumption tilting. No African country was among the six countries studied. Bems and de Carvalho Filho (2009a) added the notion of precautionary saving to consumption smoothing. In this model households accumulate precautionary savings when they face uncertainty over oil prices. Bems and de Carvalho Filho show that for 11 oil-producing countries (including Nigeria), this precautionary motive can account for sizable external saving.

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[4] The higher current account deficits are driven by high oil-related infrastructure investment imports.

Some work has focused on low-income (oil- and non-oil producing) countries to highlight their unique features, including seminal papers by Edwards (1998) and Hinkle and Montiel (1999). Christiansen and others (2009) provide a more recent assessment using the macroeconomic balance approach, taking into account structural and institutional distortions, external financing, and the vulnerability of these countries to external shocks in the derivation of the current account norm. For a sample of 134 low-income countries, this work clearly demonstrated that aid flows, domestic financial liberalization, capital account liberalization, the quality of institutions, shocks, and demographic measures have significant explanatory power over the size of the external balance.

In our review of the empirical literature, we found only two papers that covered the issue of external sustainability for low-income oil-producing countries, with many drawn from the CEMAC region.[5] To establish the optimal long-term external balance for these countries Deléchat and Kireyev (2008) assumed economic agents smoothed consumption over time under a permanent-income framework (based on Milton Freedman's permanent income hypothesis). They showed that CEMAC current account deficits are excessive. Akitoby and others (2011) showed that introducing feedback effects from public investment in the production function and assuming the consumption-smoothing objective of economic agents, results in a somewhat lower sustainable external balance. This work also showed, however, that the actual and projected (by IMF staff) current account deficits for a number of these countries are larger than the "optimal" level suggested by their model.

III. Background

A. Oil Resources and Dependence

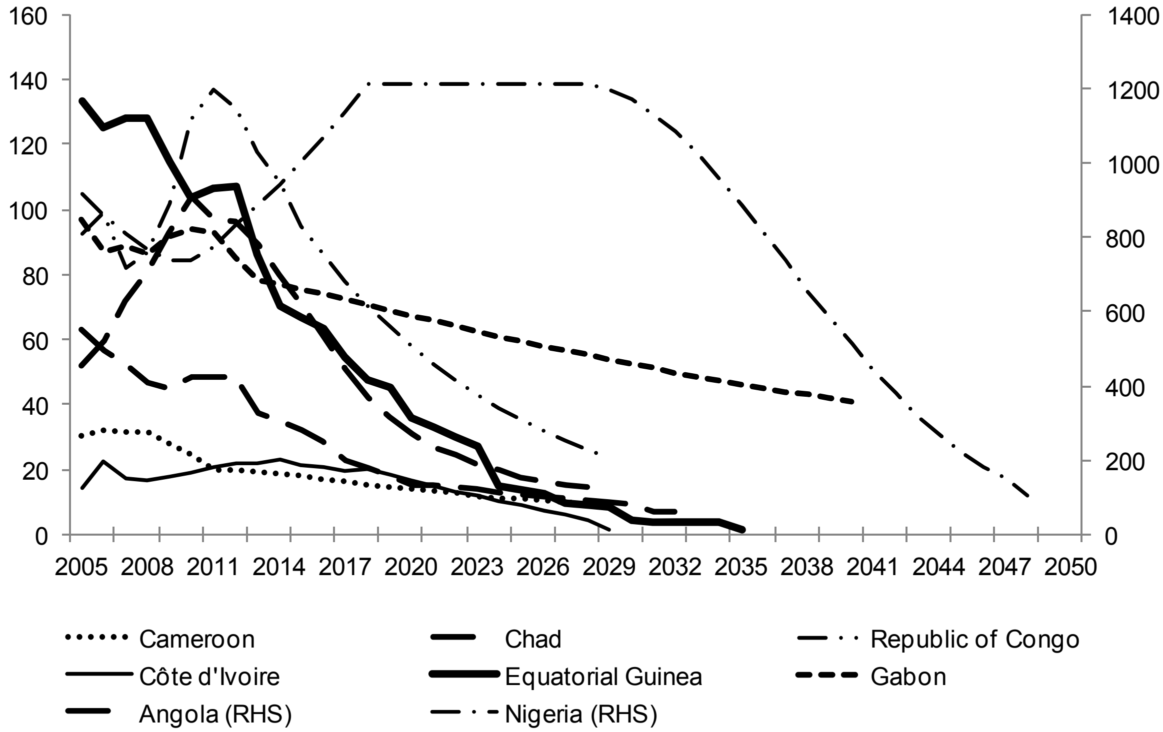
The oil-producing SSA countries are a heterogeneous group with different profiles for oil production and reserves and oil dependence. Proven oil reserves range between 0.3 billion barrels in Cameroon and Cote d'Ivoire to about 33 billion barrels in Nigeria. Nigeria dominates the subregion in this respect, with about 73 percent of SSA's total oil reserves.[6] Annual oil production also varies widely, with a low of about 18 million barrels in 2010 in Cote d'Ivoire to a high of 908 million barrels in Angola. Angola is the largest producer in the subregion accounting for about 44 percent of total production, followed by Nigeria at about 36 percent in 2010. Oil production is expected to peak in most of the countries over the next

[5] CEMAC is the Central African Economic and Monetary Community comprising Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon, and the Republic of Congo.

[6] In this paper, we limit the analysis to proven oil reserves and do not include natural gas, even though it is increasing in importance in a few countries. Gas reserves are not yet well delineated in the region and production is at an early stage, although they could become a significant part of the sub-regions total hydro-carbon wealth. Likewise, many oil-producing SSA countries are aggressively conducting both on- and off-shore exploration, which could lead to new discoveries of oil and gas and as a result, proven reserves could rise dramatically with implications for the analysis of external sustainability.

few years, and except for Gabon and Nigeria, oil reserves could be exhausted (without further exploration and development) within the next two decades (Figure 1).

Figure 1. Oil Production Profile in 2005–2050 (billion barrels)



Source: Authors' estimates.

Reflecting such different oil profiles, the oil-dependency ratio (the share of the oil sector in GDP) substantially differs among countries, ranging from 1.8 percent of GDP in Côte d'Ivoire to 69.4 percent in the Republic of Congo in 2010. These ratios have changed little over the last five years (Table 1). This is mainly because highly oil-dependent countries such as Angola, Congo, Equatorial Guinea, and Gabon have so far failed to develop the non-oil sector of their economies. This lack of development drives some of our results. In those countries, even the non-oil sector GDP moves in tandem with oil-sector GDP. Non-oil GDP growth rose sharply during rapidly rising oil-price periods (2005–08), while it declined during other years (2009–10) (Table 2). The correlation coefficients between oil sector and non-oil sector growth are high in those countries (at about 0.5 over the period 2005–10). This positive correlation further reinforces the importance of precautionary savings—and the magnitude of such savings—because the total economy is likely to be affected by volatile oil prices.

Table 1. Share of the Oil Sector in Overall GDP in 2005 and 2010 (percent)

	2005	2010
Angola	62.0	45.3
Cameroon	8.4	6.1
Chad	46.8	36.9
Republic of Congo	64.1	69.4
Côte d'Ivoire	2.7	1.8
Equatorial Guinea	82.6	57.4
Gabon	51.8	46.7
Nigeria	38.4	29.1

Source: Authors' estimates.

Table 2. Real GDP Growth in 2005–10 (percent, average annual growth)

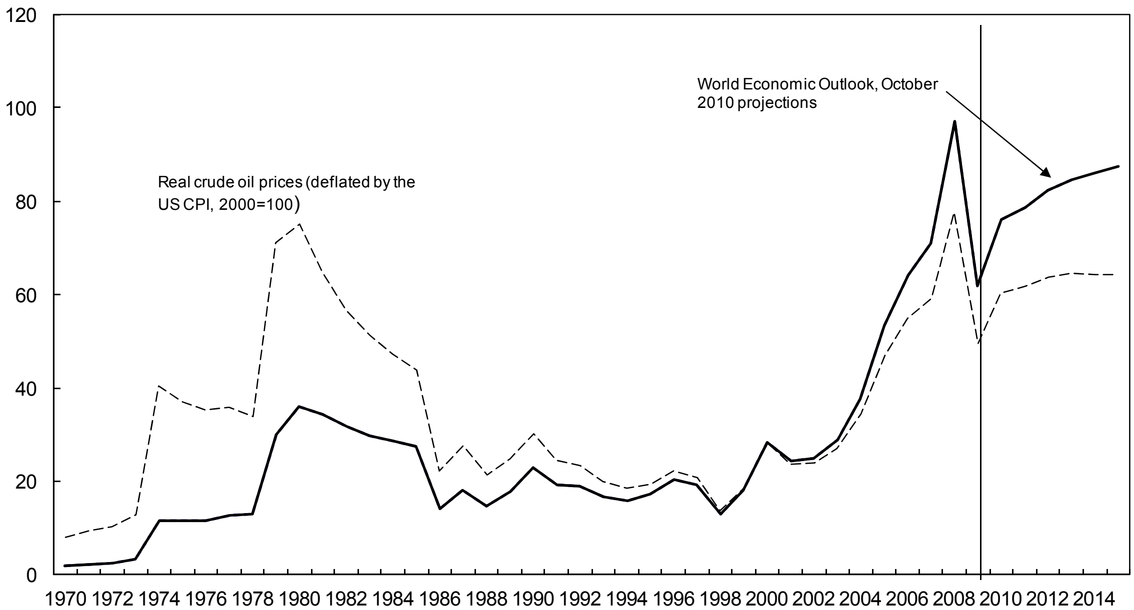
	Oil GDP		Non-oil GDP	
	2005–08	2009–10	2005–08	2009–10
Angola	19.0	-0.6	20.3	6.4
Cameroon	-3.3	-13.4	3.3	3.3
Chad	-7.0	-1.6	5.5	2.2
Republic of Congo	2.0	15.4	5.8	5.2
Côte d'Ivoire	16.0	-4.2	1.5	3.5
Equatorial Guinea	4.8	-6.4	29.5	19.2
Gabon	-1.8	-0.2	4.7	2.9
Nigeria	1.8	6.9	8.9	8.1

Source: Authors' estimates.

B. Recent Developments in the External Balance

The unprecedented rise and subsequent rapid decline in world oil prices directly affected the external balance of oil-producing SSA countries (Figure 2 and Table 3). When world oil prices were high during 2006–08, the overall current account balance moved into surplus in most countries, while it shifted into deficit once the prices declined over the next year (Table 3). The overall balance deteriorated by about 8 percentage points of GDP on average in 2009–10 compared to the period 2006–08, on account of volatile oil exports. The non-oil current account balance on the other hand, actually improved during this period. The non-oil deficit was reduced by an average of about 26 percentage points between 2006–08 and 2009–10.

Figure 2. Nominal and Real Crude Oil (Spot) Prices, US Dollars[1]



Source: IMF, *World Economic Outlook*, October 2010.
[1] The crude oil price is defined as the average of West Texas Intermediate, Brent, and Dubai Fateh crude oil.

Table 3. Non-oil and Overall Current Account Balance, 2001–2015

	Non-oil Current Account (percent of non-oil GDP)				Overall Current Account (percent of total GDP)			
	2001–05	2006–08	2009–10	2011–15	2001–05	2006–08	2009–10	2011–15
Angola	-145.4	-121.2	-96.2	-74.8	-0.4	16.2	-1.9	0.7
Cameroon	-11.6	-12.2	-10.8	-11.3	-3.4	0.4	-3.2	-1.8
Chad	-70.5	-100.3	-99.6	-53.9	-38.0	-11.1	-32.1	-9.7
Rep of Congo	-142.5	-201.3	-164.2	-138.9	-1.4	-2.0	-1.9	5.4
Côte d'Ivoire	1.3	-2.9	0.5	-8.6	2.0	1.3	6.8	-0.2
Equatorial Guinea	-511.5	-305.8	-170.9	-107.7	-20.2	6.8	-9.3	-7.4
Gabon	-53.1	-55.0	-53.5	-49.3	12.3	18.9	15.4	10.8
Nigeria	-50.7	-18.1	-11.9	-19.0	-0.4	20.3	13.2	11.1
Average	-123.0	-102.1	-75.8	-57.9	-6.2	6.4	-1.6	1.1

Source: Authors' estimates.

Based on IMF staff projections reported in the World Economic Outlook over the medium term both the overall and the non-oil current account balances are expected to improve in most of the countries. The overall balance is expected to turn into a surplus on average, while the non-oil deficit is expected to decline by about 18 percentage points of GDP over

2011–15, compared with 2009–10. The improvement is partly driven by fiscal consolidation, which is projected in most countries during this period.

IV. MODELING EXTERNAL SUSTAINABILITY

In this paper we estimate the optimal or "normal" current account balances for Angola, Côte d'Ivoire, Nigeria, Cameroon, Chad, the Republic of Congo, Equatorial Guinea, and Gabon using three methods to provide a meaningful and robust measure to guide policy discussions with these countries. The literature suggests three modeling strategies that can achieve this objective: (i) consumption smoothing, (ii) precautionary saving, and (iii) consideration of macroeconomic balance. The first two models are forward looking and based on the optimizing behavior of a representative agent (a government or social planner), who takes account of future oil production in its intertemporal optimization problem. In comparison, the third approach is backward looking and derives a current account "norm" from macroeconomic fundamentals, although it has the advantage of being parsimonious and is based on simple assumptions.

The key underlying assumptions and data sample used in our analysis are presented in Box 1. These models and our research strategy are described as follows.

Consumption Smoothing

To model the optimal current external account with consumption smoothing, we use the basic formulation provided by Thomas, Kim, and Aslam (2008).[7] Under this approach, only the return on oil and non-oil wealth is consumed, and the optimal non-oil current account balance is financed by "permanent" revenue generated by a country's total wealth. This would allow countries to maintain the real value of the total wealth stock for future generations.

For the representative household we solve the following maximization problem:

$$\max_{C_t} E_t \sum_{t=0}^{+\infty} \beta^t L_t u(C_t) \quad (1)$$

$$\text{subject to } B_t = (1+n)^{-1}(1+r)B_{t-1} + Y_t - C_t - I_t - G_t - T_t \quad (2)$$

[7] As discussed below, this consumption smoothing is very similar to the deterministic case with precautionary saving. However, we chose to present the two models separately. Consumption smoothing allows more flexibility for setting non-oil productivity growth, which is an important variable for low-income oil-producing countries in assessing external sustainability.

Box 1. Key Underlying Assumptions and Data Sample

- *World oil prices*: The data on world oil prices come from the IMF's Fall 2010 edition of the *World Economic Outlook (WEO)* and are based on the average of West Texas, Intermediate Brent, and Dubai Fateh crude oil. The macroeconomic balance approach does not rely directly on oil prices but it does draw on variables that depend on the evolution of oil prices projected in the WEO. For consumption smoothing we use the WEO's nominal oil price projection of US$80 in 2010, rising to US$87 in 2015, and remaining constant in real terms thereafter. For the precautionary saving approach, we allow the oil price to follow a stochastic (multiplicative error) process, which introduces uncertainty into the model.
- *Oil reserves and production:* This data is based on information used by IMF staff in their WEO projections and does not include gas (because of the lack of missing and consistent data across SSA countries). Because gas production becomes increasingly important for some countries such as Equatorial Guinea and Nigeria, the assumption is somewhat restrictive. York and Zhan (2009) show how the empirical results in this type of sustainability analysis can change significantly if gas reserves are included, because they can extend the life of production and increase the accumulation of wealth over time.
- *Oil trade balance:* The data from the Fall 2010 WEO is used through 2015. For 2016 and beyond, oil income (oil production multiplied by oil price) corrected for domestic consumption is used. We assume domestic consumption is 4 percent of total production based on observable data.
- *Macroeconomic data:* The Fall 2010 WEO is the source of nearly all of the macroeconomic data, except where specific assumptions are used.
- *Data sample:* The consumption-smoothing and the precautionary saving models were calibrated on data from 2005. This date was chosen to minimize distortions from the run-up in oil prices in the second half of the decade, and allowed us to examine in-sample results for the period 2005–09. In the macroeconomic balance approach and current versus permanent income assessment, a regression was estimated using data covering 1993–2009 with not-overlapping four-year average. For all models, we compared our results with the outturns from 2005–09 and IMF staff projection extending over 2010–15.
- *Sample countries:* The consumption-smoothing and the precautionary-saving models covered eight oil-producing SSA countries. For the macroeconomic balance approach, we added 13 non-SSA oil-producing countries. In this way, the results eliminate the specific characteristic of oil-producing SSA countries such as low saving and represents more "normal "optimal current account levels for oil-producing countries more generally. However, for the "current versus permanent income assessment" we use only oil-producing SSA countries to establish the specific characteristics of these countries.

where $L_t = L_0(1+n)^t$ is population per household, growing at the constant rate n. C_t is private consumption, B_t is net foreign assets at the end of period, Y_t is real GDP, I_t is investment, G_t is government consumption, and T_t is net external transfers. β is the real subjective discount rate and r the real return on investment. All variables except for L, β, and r are expressed in per capita terms.

In this model, the utility function takes on a constant relative risk aversion (CRRA) form

$$u(C) = \frac{C^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}} \quad (3)$$

where θ is the consumer risk aversion parameter.

Because dynamic optimization models with CRRA preferences are generally difficult to solve, the model is assumed to be deterministic.[8] As a result the expectation operator is dropped. Then the utility maximization produces the Euler equation

$$\frac{C_{t+1}}{C_t} = \lambda = \beta(1+r)^{\theta} \quad (4)$$

Following Thomas, Kim, and Aslam (2008), we define $\widetilde{Y}_t = Y_t - I_t - G_t - T_t$ for the national cash flow in per capita terms and $1 + \bar{r} = (1+r)(1+n)^{-1}$ for the real interest rate adjusted for population growth. Substituting (2) into the budget constraint produces the optimal consumption

$$C_t^* = (1 + \bar{r} - \lambda)\left[B_{t-1} + (1+\bar{r})^{-1}\sum_{j=0}^{\infty}(1+\bar{r})^{-j}\,\widetilde{Y}_{t+j}\right] = \left(\frac{\bar{r}}{\omega}\right)W_t \quad (5)$$

where $W_t = B_{t-1} + (1+\bar{r})^{-1}\sum_{j=0}^{\infty}(1+\bar{r})^{-j}\,\widetilde{Y}_{t+j}$ is per capita wealth, and $\omega = \frac{\bar{r}}{1+\bar{r}-\lambda}$ is the consumption tilting factor.[9]

After substituting (5) into the budget constraint and rearranging the terms, the optimal current account can be expressed as

$$CA_t^* = \bar{r}B_{t-1} + \widetilde{Y}_t - C_t^* = -\sum_{j=1}^{\infty}(1+\bar{r})^{-j}\Delta\widetilde{Y}_{t+j} - (1-\omega)C_t^* \quad (6)$$

We can break equation (6) into the oil and the non-oil current account balance. The optimal non-oil current account balance, CA_t^{*N}, can be defined as

[8] A stochastic case is discussed in the precautionary approach.

[9] The consumption tilting factor shows the degree of the intertemporal substitution in consumption, i.e., how much individuals are more (or less) willing to sacrifice present consumption for an increase in future consumption. Even in a deterministic case, this factor could exist because individuals have different time preferences of consumption.

$$
\begin{aligned}
CA_t^{*N} &= CA_t^* - CA^o \\
&= -\bar{r}(1+\bar{r})^{-1}\sum_{j=0}^{\infty}(1+\bar{r})^{-j}\,Y_{t+j}^o - \sum_{j=1}^{\infty}(1+\bar{r})^{-j}\,\Delta\tilde{Y}_{t+j}^N + \alpha Y_t^o - (1-\omega)C_t^* \\
&= -\bar{r}W_t^o - PDV_t^N + \alpha Y_t^o - (1-\omega)C_t^* \quad (7)
\end{aligned}
$$

where CA^o is the oil current account and α the share of domestic consumption of oil in total oil production; $\tilde{Y}_{t+j}^N = Y_{t+j}^N - I_{t+j} - G_{t+j} - T_{t+j}$ is the non-oil national cash flow, $W_t^o = 1+\bar{r})^{-1}\sum_{j=1}^{\infty}(1+\bar{r})^{-j}\,Y_{t+j}^o$ is the present value of current and future per capita oil production, and $PDV^N = \sum_{j=1}^{\infty}(1+\bar{r})^{-j}\,\Delta\tilde{Y}_{t+j}^N$ is the present value of future changes in per capital non-oil cash flow.

As equation (7) shows, the optimal non-oil current account consists of four factors: (i) the return on the present-discounted value of current and future oil production, or the return on oil wealth ($\bar{r}W_t^o$); (ii) the present-discounted value of future changes in non-oil cash flows (PDV_t^N); (iii) domestic consumption of oil (αY_t^o); and (iv) a consumption tilting factor ($(1-\omega)C_t^*$), which allows for some trade-offs between present and future consumption.

To estimate the return on oil wealth, we need assumptions for the real return on investment, population growth, and oil production and prices (both taken from the Fall 2010 WEO). The return on investment was set as 2½ percent in line with long term averages used by the US Office of Management and Budget, and UN population growth projections were used for the period 2010–50.[10] Using these assumptions, the return on oil wealth for the eight countries amount to US$3 trillion with an average of 8½ percent of GDP in 2006 (Table 4). The highest is about 18 percent in Gabon and the lowest is 1.1 percent in Côte d'Ivoire.[11]

To calculate a proxy for the present-discounted value of non-oil cash flow (second item in equation 7) the key input is an estimate of long-term growth in the non-oil sector. We examined the historical movements of non-oil cash flows and found that for the eight countries these movements were very volatile and none of the explanatory variables Thomas, Kim, and Aslam (2008) suggested turned out to be statistically significant.[12] Therefore, we

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[10] This is the average of the real discount rate adopted by the US Office of Management and Budget for 10 years and for 30 years in 2010 (see http://www.whitehouse.gov/omb/circulars_a094_a94_appx-c/) The UN data can be found on the internet at http://esa.un.org/unpp/. The population growth rates ranged from a low of 1.3 percent a year for Gabon to 2.0 percent a year for Angola.

[11] Note that these estimates do not take into account the return on existing assets that these countries may have accumulated in the past.

[12] Thomas, Kim, and Aslam (2008) ran a second-order autoregressive process on the change in real non-oil cash flow per capita with country dummies and the change in real oil wealth as regressors.

Table 4. Oil Wealth and Annual Return

	Present Value of Oil Wealth in bn USD	Annual Return in percent of 2006 GDP
Angola	801	8.0
Cameroon	30	1.5
Chad	55	2.1
Congo	128	15.1
Côte d'Ivoire	27	1.1
Equatorial Guinea	114	6.9
Gabon	148	18.1
Nigeria	2,365	15.3

Source: Authors' estimates.

assume non-oil cash flow to be zero over the long term (in terms of its present discounted value). This is a strong assumption, particularly for countries with a small oil sector; however, it is not extreme. Thomas, Kim, and Aslam (2008) assumed that four out of six countries in their analysis were in the same position. In our robustness tests (below) we show how this assumption affects the results.

The final components of the consumption-smoothing model are domestic oil consumption and the consumption tilting factor (the last two elements in equation 7). We assume domestic consumption is constant at about 4 percent of GDP—the share used in Thomas, Kim, and Aslam (2008)—because of the lack of reliable data in sample of countries.[13,14] The consumption tilting factor is assumed to be zero as in the other studies.

Optimum Precautionary Savings

In this approach, we follow the methodology of Bems and de Carvalho Filho (2009a) who introduce a precautionary-saving motive to consumption smoothing to estimate a sustainable external current account. The model allows for two solutions: a deterministic solution with no uncertainty over the price of oil (consumption smoothing component), compared with a stochastic outcome driven by uncertainty about the price of oil (precautionary saving component). In the discussion below, we focus on the precautionary component only,

[13] Thomas, Kims, and Aslam. (2008) base this share on the historical average of several oil-producing countries where reliable data is available.

[14] Thomas, Kim, and Aslam (2008) examined Venezuela, Kuwait, Malaysia, Russia, Saudi Arabia, and United Arab Emirates. Domestic consumption ranged between 0 (United Arab Emirates) and 5.3 percent (Malaysia) of total GDP. Deléchat and Kireyev (2008) estimated Cameroon’s domestic consumption using the difference between production and exports and this amounted to only 0.7 percent.

because we presented the current account norm under consumption smoothing in the previous section.

In its simplest form, the representative agent derives utility from consuming the resource, subject to an economy-wide resource constraint. The representative agent solves a self-insurance problem, in which it can accumulate foreign assets to diversify itself away from the volatile exhaustible (oil) resource. As expected, the deterministic solution is similar to the above results for consumption smoothing. Meanwhile, precautionary saving is defined as the difference between the path of the external current account under certainty, compared with the path allowing for stochastic movements in oil prices and savings for self-insurance.

Bems and de Carvalho Filho (2009a) present the model in the following way.[15] A representative agent maximizes its utility as

$$\max_{\{ct,bt+1\}} \quad E_0 \sum_{t=0}^{+\infty} \widetilde{\beta^t}\, U(c_t) \quad (8)$$

Subject to

$$c_t + (1+n)b_{t+1} = (1+r)b_t + p_t z_t + y_t \quad (9)$$

$$p_{t+1} = ((1-\rho)\bar{p} + \rho p_t)\varepsilon_{t+1} \quad (10)$$

$$\lim_{s\to+\infty} \left(\frac{1+n}{1+r}\right)^s b_s = 0 \quad (11)$$

Where C_t is aggregate consumption, β a subjective discount factor, Y_t output, L_t labor input, A a measure of productivity, B_t the stock of net foreign assets as of the end of period $t\text{-}1$, r the risk-free rate of return, n labor growth, Z_t the quantity of the resource extracted, p_t the oil

[15] A representative household in this model is assumed to have constant relative risk aversion preferences (CRRA) described as follows

$$\sum_{t=0}^{+\infty} \beta^t L_t U\left(\frac{C_t}{L_t}\right)$$

where

$$U\left(\frac{C_t}{L_t}\right) = \frac{\left(\frac{C_t}{L_t}\right)^{1-\sigma}}{1-\sigma} \text{ for } 0<\sigma<1 \text{ or } \sigma>1$$

$$U\left(\frac{C_t}{L_t}\right) = \log\left(\frac{C_t}{L_t}\right) \text{ for } \sigma=1$$

C_t is aggregate consumption, β a subjective discount factor, σ the degree of risk aversion and inter-temporal elasticity of substitution.

price, and $\bar{p}$ unconditional mean of p_t. $\tilde{\beta} \equiv \beta(1+n)$ and b_0 and p_0 are given. Small letters are expressed in terms of effective units of labor; for example $y_t = \frac{Y_t}{AL_t}$.[16]

The model provides a deterministic solution when $\varepsilon_t = 0$, that is, when oil prices follow a long run trend. In contrast, a stochastic solution is presented when $\varepsilon_t > 0$, that is, when oil prices are trendless over the long term. While the deterministic case has a closed form solution, the stochastic case does not and needs to be solved numerically.[17] For simplicity, the non-oil sector in the model grows at the same pace as the labor force. This is in line with the historical per capita output growth in countries with natural resources and facing the so-called "resource curse."

To estimate the model, we employ a common set of parameters across our eight-country sample. The initial values are detailed in Table 5 and key assumptions are as follows: (i) the discount rate is set at 4 percent; (ii) the curvature in the constant return utility function, which shows risk averseness of consumers is 2; and (iii) the log of the relative price of oil follows a multiplicative error process with mean 1, $\rho < 0.9$, $\sigma_\varepsilon = 0$, and the initial value of $p_{2005} = 53.5$.[18] Initial values for net foreign assets and oil revenue as a share of GDP, growth in the labor force, and the oil production profile are based on IMF staff estimates, whereas the average annual growth of labor between 2010 and 2050 are based on the UN's *World Population Prospects* database.[19] The model was solved forward from 2005.

Table 5. Country-Specific Initial Values and Parameters (units indicated)

	Labor Force Growth (percent)	NFA/GDP (percent)		Oil GDP/GDP (percent)		Oil Reserves (bn brls)		Lifetime of Oil Estimate
		2005	2010	2005	2010	2005	2010	
Angola	2.0	17.3	18.9	62.0	45.3	11.1	7.1	2028
Cameroon	1.5	5.7	16.3	8.4	6.1	0.4	0.3	2028
Chad	2.2	4.7	17.5	46.8	36.9	0.8	0.4	2032
Congo	1.5	14.5	56.2	64.1	69.4	1.9	1.3	2029
Côte d'Ivoire	1.8	8.2	11.7	2.7	1.8	0.4	0.3	2029
Equatorial Guinea	1.9	28.6	32.4	82.6	57.4	1.6	0.9	2035
Gabon	1.3	11.9	14.1	51.8	46.7	2.4	1.8	2040
Nigeria	1.5	27.8	24.3	38.4	29.1	37.6	32.8	2048

Sources: Authors' estimates; and UN World Population Prospects.

[16] This problem can be solved only when (1+n)/(1+r)>1. This condition is satisfied under the baseline and for the sensitivity tests.

[17] The model confirms that the level of consumption under uncertainty is lower than with certainty in the earlier period. However, in the later period, consumption becomes higher with uncertainty than without as savings are accumulated and interest income grows.

[18] Bems and de Carvalho Filho (2009a) estimated ρ and σ_ε using annual data during 1970–2006.

[19] http://esa.un.org/unpp/.

Macroeconomic Balance Approach

In contrast to the first two methods, the macroeconomic balance approach does not rely on optimizing behavior of economic agents. Instead, as explained in detail in Lee and others (2008) this is an empirically based method that calculates what is statistically "normal" in the sample. The current account and exchange rate are derived in the following steps: (i) estimating an equilibrium relationship between current account balances and a set of fundamentals using panel econometric techniques; (ii) calculating for each country, the current account norm that comes from imputing the medium-term projections for the fundamentals into the panel regression; and (iii) deriving the real exchange rate adjustment that would close the gap between the estimated current account norm and the underlying current account.

To emphasize the important characteristics of oil-producing countries we make several modifications to the work of Lee and others (2008). First, we add non-oil fiscal variables to the panel regression to separate the fiscal effects of oil revenue and fiscal policy on the current account and the lagged current account balance to reflect intergenerational transfers of oil income as suggested in Bems and de Carvalho de Filho (2009b).[20] Second, we run the panel regression on only oil-producing countries, compared with larger panels including both oil and non-oil countries used for example, in Lee and others (2008) and Bems and de Carvalho de Filho (2009b).[21] By limiting the sample to SSA and other oil-producing countries, we attempt to estimate the current account that reflects the normal position of the average oil-producing country—something that has not been done in previous empirical work. Third, we do not include economic crises and financial center variables in our panel regression as they do not appear to be particularly relevant for oil-producing countries.[22]

Economic theory and the empirical literature lead to the following robust determinants of the current account balance over the medium term.

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[20] We use four-year averages of these variables to avoid the volatility these variables display.

[21] We trade off the benefits of a larger panel to focus on the particular characteristics of oil-producing countries. Our sample of these countries include Algeria, Bahrain, Indonesia, Iran, Kazakhstan, Kuwait, Libya, Norway, Oman, Qatar, Russia, Saudi Arabia, Syria, United Arab Emirates, and the eight countries from sub-Saharan Africa. We are grateful to Rudolph Bems and Irineu de Carvalho Filho for sharing their data on the countries outside of the SSA.

[22] In Lee and others (2008), the variable for economic crises is a dummy for the Asian crises (1997–2004), which drastically reduced access to international financial markets for those countries. Since SSA oil-producing countries do not enjoy such access, this crisis variable is superfluous. The variable for the financial center is a dummy that represents the regional financial centers such as Belgium, Hong Kong SAR, Luxemburg, and Singapore. The financial centers are hubs for international financial flows and tend to run substantial current account surpluses. Because none of oil-producing countries plays such a role, this variable is also superfluous.

- *Non-oil fiscal balance*: The higher the current account balance is expected to be the higher is government saving. Although the non-oil fiscal balance excludes direct oil revenue, it still reflects the movement of oil prices and sector activity because part of oil revenue is received through indirect or nontax measures (royalties/dividends) and is spent on tradable goods by the government. The measure of the fiscal balance is the non-oil balance of the central government, expressed as a ratio to GDP. In the panel regression, the non-oil fiscal balance is calculated as deviations from the average of those of the euro area and the United States, as a proxy for oil-producers' trading partners (for which complete data is not available). The expected sign of this variable is positive.

- *Demographics*: The current account balance is expected to improve with a higher share of economically active and independent population. For the estimation, two variables, the old-age dependency ratio and population growth, were used as a proxy.[23] Population growth is presumed to capture the young-age dependency ratio (which cannot be used directly since it naturally correlates with the old-age dependency ratio). In the panel regression, the variables are calculated as deviations from the average of those of the Euro area and the United States, as a proxy for oil-producers' trading partners (for which complete data is not available). The expected sign of these variables is negative.[24]

- *NFA (net foreign assets)*: The current account balance can improve or worsen with higher NFA. NFA can affect the current account balance through two channels: (i) on the one hand, higher NFA creates more investment income and improves the current account balance; and (ii) on the other hand, countries with higher NFA can also run a deficit for a certain period by drawing down their net foreign assets. In the panel regression, NFA at the end of the previous year as a ratio to GDP was used because the first effect depends on the initial level of NFA of the base year. The expected sign of this variable is ambiguous.

- *Lagged current account*: The current account balance is expected to improve with a higher current account in the previous period, if there is persistence. The current account surpluses/deficits are known to be persistent for a certain period in some

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[23] The old-age dependency ratio is calculated as the ratio of the population above 65 years old to the population of 15–64 years old.

[24] As Lee and others (2008) note the impact of the demographic profile on the current account could be different among countries, depending on the characteristics of the retirement system and the development of financial markets. It is not, however, possible to accurately estimate this impact for all countries; consequently the deviations from trading partners are used to try to capture the main differences.

countries (elaborated in Milesi-Feretti and Razin, 1996). The expected sign of this variable is positive.

- *Oil current account balance*: The current account balance is expected to improve with higher oil revenue (as a result of both higher prices and production). Countries with a larger volume of oil exports tend to have a higher current account surplus. In the estimation, the oil balance is expressed as a ratio to GDP. The expected sign of this variable is positive.

- *Economic growth*: The current account balance is expected to improve with higher income and to deteriorate with higher economic growth. Low-income countries require larger investment for development and would therefore register a deficit. On the other hand, among countries with similar levels of income, countries with higher growth record a worse current account balance in order to meet strong import demand. In the regression, we use the growth of real per capita GDP and the ratio of per capita PPP income to the US level. The expected signs of growth and income are negative and positive, respectively. In the panel regression, these variables are calculated as deviations from the average of those of the euro area and the United States, as a proxy for oil-producers' trading partners (for which complete data is not available).

To assess the extent to which national consumption decisions are made based on current versus permanent oil income, we also run a separate regression that includes the return on oil wealth in the set of fundamental variables listed above following the work of Thomas and Bayoumi (2009).[25] In this assessment, the non-oil current account balance represents national consumption decisions because it is driven by imports, and there is a relatively small share of non-oil exports in these countries. Hence, the regression describes how national consumption (the non-oil current account) is affected by current and permanent oil-related explanatory variables (oil balance and the return on oil wealth). The non-oil fiscal balance is also included as an oil-related explanatory variable in this analysis because it reflects the public sector's response to current and permanent oil income.[26] The sum of the oil-related coefficients should equal (minus) unity if oil revenue is fully reflected in the non-oil current account as Thomas and Bayoumi (2009) demonstrate. We undertake this analysis only for the oil-producing SSA countries to determine their specific characteristics.

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[25] The methodology for estimating the return on wealth is outlined in the section above on consumption smoothing, although we further modify this calculation by correcting for population growth and netting out domestic consumption, as proposed by Thomas and Bayoumi (2009).

[26] The public sector response to oil income should be assessed together with the regression of the non-oil fiscal balance on oil income variables. However, we did not pursue this analysis: as section V shows, in oil-producing SSA countries, the non-oil fiscal balance is insignificant as an explanatory variable.

V. Estimates of Long-term External Sustainability

Overall, the baseline estimates of long-term external sustainability using the three models detailed above produce results in line with those focusing on fiscal sustainability (see in particular, York and Zhan, 2009), suggesting that governments in oil-producing SSA countries must save more. We understand that these estimates have wide margins of uncertainty, in part because they are based on rather heroic assumptions. However, we also believe they are robust to the extent that different models produce similar outcomes—although with varying magnitudes—based on the available information and initial conditions.

Consumption smoothing. The optimal external current account surplus for the eight countries was significantly above the actual level, from the point of view of consumption smoothing (Table 6 and Figure 3). This approach produced the largest current account surpluses of the three methods, ranging from about 7 percent of GDP in Côte d'Ivoire to 76 percent of GDP for Equatorial Guinea as of 2006. The higher optimal current account balances for Equatorial Guinea, Congo, and Chad reflect their high oil dependency; and consequently, the need to save more to smooth out consumption after oil reserves are exhausted. Compared with middle- and high-income oil-producing countries, those in the African sub region appear to need to save more, that is, run higher current account surpluses, because of their comparatively smaller reserves and shorter time horizons for oil production.

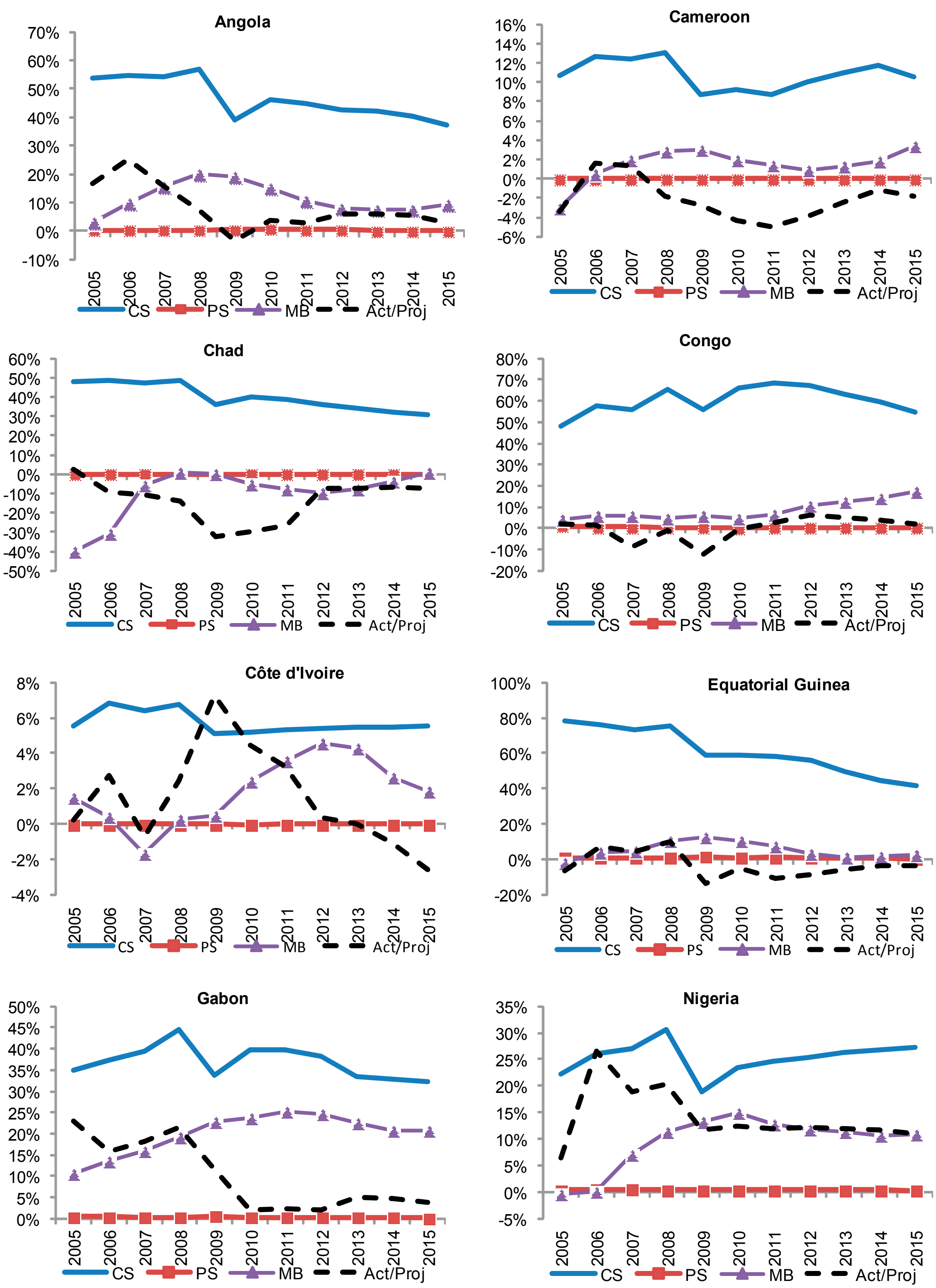
Table 6. Optimal Level of Current Account Balance Under Different Methodologies, 2006 (percent of GDP)

	Consumption Smoothing	Precautionary Saving	Macro Balance Approach	Actual
Angola	54.4	1.0	9.8	25.2
Cameroon	12.7	0.0	0.5	1.6
Chad	48.6	0.0	-30.7	-9.0
Congo	57.5	0.7	5.9	1.5
Côte d'Ivoire	6.8	0.0	0.4	2.8
Equatorial Guinea	76.0	0.9	3.7	7.1
Gabon	37.4	0.5	13.7	15.8
Nigeria	26.0	0.6	0.1	26.5

Source: Authors' estimates.

Precautionary saving. In this section, we focus on the precautionary saving component only as the previous section discussed consumption smoothing. The results are shown in Table 6 and Figure 3. As expected, the estimated precautionary saving for all eight countries is positive and largest for those countries with high dependency on oil (Angola, Congo, and Equatorial Guinea). In comparison, countries with low oil-dependency ratios have projected

Figure 3. Optimal Level of Current Account Balance, 2005-15
(percent of total GDP, CS=consumption smoothing, PS=precautionary saving, and MB=macroeconomic balance)



Source: Authors' estimates.

saving levels that are very low—less than 0.03 percent of GDP in 2006 for Cameroon and Côte d'Ivoire. For both high- and low-oil dependent countries, precautionary saving declines over time alongside the reduction in oil production. In Equatorial Guinea, for example, precautionary saving peaks in 2011 at about 1½ percent of GDP and declines steadily to 0.7 percent in 2015.

It is important to note that our estimates of precautionary saving for the eight oil-producing SSA countries are low when compared with middle- and high-income countries presented in Bems and de Carvalho Filho (2009a). Once again, this reflects the comparatively smaller oil reserves and shorter time horizons for oil production of these eight countries, compared with other oil producers.[27] Through shorter time horizons for oil production, the share of households' total wealth exposed to uncertainties over the price of oil declines, resulting in less incentive for precautionary saving. This model defines an optimal current account as a combination of the consumption-smoothing component and the precautionary-saving component. The consumption-smoothing component is high and similar in magnitude to "standard" consumption smoothing models as shown above, although the model settings are somewhat different.[28, 29] Consequently, the combined optimal current account in this approach is even further away from the actual.

Macroeconomic balance approach. In contrast to the optimizing behavior assumed under consumption smoothing and precautionary saving, the macroeconomic balance approach is backward looking. In this context, it is not surprising that the normal (or optimal) current external account arising from this analysis is most similar to the actual outcomes for most countries (Table 6 and Figure 3). The panel regressions are shown in Table 7a. Columns 1 and 2 of that table report on the pooled regression suggested by Lee and others (2008), along with fixed effects estimates (columns 3 and 4), and a specification using the non-oil current account balance (defined as the current account balance net of oil exports, but including oil-

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[27] In six of the eight SSA oil-producing countries, oil reserves (not including gas) could be exhausted over the next 20 years without further exploration and development; this compares with projections of 100 years for middle- and high-income oil producers.

[28] In the standard consumption-smoothing approach (i.e., no uncertainty over oil prices), the source of non-oil growth is restricted to the labor force. Consequently, Bems and de Carvalho Filho (2009a) run a sensitivity analysis focusing on non-zero productivity growth, which requires the risk-free rate to be set rather high. We believe this constraint is overly restrictive for our set of countries because productivity growth in the non-oil sector could substantially change and, consequently, affect the sustainable external balance.

[29] The estimates of the precautionary-saving component depend on the consumption-smoothing component in this model. Therefore it is not entirely consistent to extract only the precautionary saving component from this model and compare it with the standard consumption smoothing. Having said that, the estimates of the consumption-smoothing components from the two models are very similar, and their comparison is meaningful for policy discussion purposes. For 2006, for example, the difference between the two methods is only 3.7 percentage points on average across the oil-producing SSA countries.

related imports) as the dependent variable (columns 5 and 6). The latter regressions were run only on the data of SSA countries because comparable data for other oil-producing countries were not available. For comparison, we also show the results from Bems and de Carvalho Filho (2009b) (columns 7 and 8) for middle- and high-income countries.

The fit of all regressions is reasonably good and the coefficients are broadly similar to those of Bems and de Carvalho Filho (2009b). In the pooled estimation, most of the coefficients have the correct sign and are statistically significant. To determine the normal current account level shown in Table 6 and Figure 3 above, we focus on the pooled results shown in column 1 of Table 7a, which has the best fit (in terms of R-squared). The pooled regression provides a better indication than the fixed effects when we examine the normal current account level because it does not reflect the country-specific characteristics.

The fixed effects estimates, on the other hand, shed more light when we examine the magnitude of the impact of each explanatory variable because it takes consideration of country specific characteristics. In column 3, we find that the impact of a 1 percentage point increase in old-age dependency and population growth worsens the current account balance by about 1 percent of GDP, respectively; a 1 percentage point increase in the oil balance improves the current account balance by about 0.4 percent of GDP; and a 1 percentage point increase in relative income improves the current account balance by about 0.4 percent of GDP. These estimates are somewhat larger in magnitude than those found by Bems and de Carvalho Filho (2009b) and indicate some interesting findings for oil-producing countries. The high coefficient on relative income is often used to provide support for large investment needs in low income countries. The positive coefficient of the lagged current account balance suggests that the current account balance demonstrates persistence in line with the findings in other countries.

We also use fixed effects estimation to examine the non-oil current account behavior of oil-producing SSA countries (shown in columns 5 and 6 of Table 7a). The findings are in line with expectations, except for the unexpected negative and significant coefficient on the oil balance variable. This implies that the non-oil current account deteriorates as the oil balance improves. This counterintuitive result could be explained by a couple of factors: (i) in oil-producing SSA countries, non-oil GDP is highly correlated with oil GDP, so higher oil production stimulates the non-oil sector, draws in imports, and leads to a worsening of the non-oil trade balance; and (ii) higher oil production increases imports of oil-related investment, goods, and services. The negative sign on the lagged non-oil current account balance suggests that the non-oil current account balance does not demonstrate persistence. This is in contrast to the usual finding of strong persistence in the current account balance in other countries. The positive sign on net foreign assets implies that higher NFA generates more investment income, leading to an improvement of the non-oil current account balance.

The result of the current versus permanent oil income assessment proposed by Thomas and Bayoumi (2009) is presented in Table 7b. Column 1 reports the regression for all oil-producing SSA countries while column 2 presents only those of "heavily oil-dependent" countries. In the former regression, among the oil-related variables (oil balance, the return on oil wealth, and non-oil fiscal balance) the only statistically significant explanatory variable is the current oil balance and its coefficient is close to unity. A similar result is obtained in the second regression, although the coefficient on the current oil balance is slightly higher. These results confirm the impression that national consumption decisions in oil-producing SSA countries are based on current oil income, without regard to permanent income—as suggested very strongly in the work of others, including York and Zhan (2009). Simply put, these countries may not be sufficiently forward looking in their consumption behavior. These results also explain why the optimal current account level derived under consumption smoothing is far from the actual outcomes and projections.

A. Robustness of the Results

In this section we assess the robustness of the empirical estimates of the optimal current account balance and the sensitivity to different model parameters and assumptions. We find that the optimal current account balance with consumption smoothing is more sensitive to the initial conditions than a model with precautionary motives.

In the model for consumption smoothing we allowed for a higher return on investment, higher world oil prices, and non-oil cash flow, and compared the results against the baseline (Table 8). As expected, the sensitivity tests confirm that the optimal current account balance could decline significantly if the environment were benign (Table 8). The price of oil has a strong influence on the sustainable balance. This implies, for example, that if the value of the asset rises more of it could be consumed, leading to a deterioration of the current external account, other things being equal. Along the same lines, if the returns from exploitation (investment) or non-oil cash flow increase, consumption should also be brought forward in time. This would lead to a worsening of the current account. In other words, if these countries can increase the return on investment or raise non-oil cash flow, for example, through public investment as Akitoby and others (2011) argue, the current external account balance may move toward the optimal level.

The lack of forward-looking or optimizing behavior on the part of the group of oil-producing SSA countries is reinforced by this sensitivity analysis. The estimated current account balance under fairly extreme assumptions (rate of return above 4 percent, a doubling of oil prices, or significant non-oil cash flow) is more or less around the levels observed in 2006.

Table 7a. Macroeconomic Balance Approach: Panel Regressions[1]

	Pooled Estimation		Fixed Effects Estimation				Bems and de Carvalho Filho (2008)[2]	
	Current Account		Current Account		Non-oil Current Account			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Non-oil fiscal balance	0.239*	0.638***	0.077	0.261	-0.318	0.433	0.385	0.202
	(0.12)	(0.15)	(0.17)	(0.20)	(0.25)	(0.33)	(0.011)	(0.229)
Old-age dependency	-1.127***	-1.331***	-1.092	-4.081***	-0.771	-3.742	-0.175	-0.153
	(0.25)	(0.40)	(1.19)	(1.23)	(1.62)	(2.52)	(0.091)	(0.106)
Population growth	-4.270***	-3.949***	-1.043	-0.096	2.916	-3.087	-1.430	-1.260
	(0.90)	(1.20)	(1.04)	(1.15)	(2.87)	(3.79)	(0.874)	(1.210)
Lagged current account	0.683***		0.462***		0.845***		0.593	
	(0.09)		(0.10)		(0.17)		(0.043)	
Lagged net foreign assets		0.004		-0.022		0.023		-0.009
		(0.01)		(0.02)		(0.04)		(0.010)
Oil balance	0.193**	0.416***	0.449***	0.489***	-0.595***	-0.839***	0.462	0.553
	(0.07)	(0.09)	(0.11)	(0.12)	(0.14)	(0.20)	(0.062)	(0.094)
Output growth	0.0581	-0.968***	0.129	-0.281	0.085	-0.390	-0.031	-0.381
	(0.23)	(0.25)	(0.23)	(0.23)	(0.29)	(0.44)	(0.093)	(0.139)
Relative income	5.80E-03	-0.0436	0.430**	0.458**	0.581	0.354	0.074	0.121
	(0.03)	(0.04)	(0.19)	(0.22)	(0.37)	(0.53)	(0.031)	(0.036)
Observations	81	80	81	80	32	31	501	501
R-squared	0.717	0.507	0.872	0.847	0.981	0.963	0.738	0.545

[1] Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1
[2] Estimates for middle- and high-income oil-producing countries.
Source: Authors' estimates.

Table 7b. Current Versus Permanent Oil Income Assessment: Determinants of Non-oil Current Account[1]

	Oil-producing SSA Countries	Heavily Oil Dependent Countries, excluding Equatorial Guinea[2]
	(1)	(2)
Non-oil fiscal balance	0.297	0.295
	(0.17)	(0.34)
Old-age dependency	-3.809*	-5.101
	(1.97)	(4.86)
Population growth	-6.084	-25.460
	(4.22)	(28.71)
Lagged net foreign assets	0.009	-0.010
	(0.04)	(0.04)
Oil balance	-0.947***	-1.022***
	(0.12)	(0.26)
Output growth	-0.411	0.148
	(0.47)	(0.73)
Relative income	0.573*	0.495
	(0.29)	(0.73)
	0.006	-0.072
Return of oil wealth	(0.04)	(0.24)
Observations	31	16
R-squared	0.924	0.918

[1] Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1

[2] Heavily oil dependent countries are Angola, Republic of Congo, Gabon, and Nigeria.

Source: Author's estimates.

Table 8. Robustness Tests: Consumption Smoothing Approach—Optimal Non-oil Current Account Balance Under Different Assumptions (percent of 2006 GDP)

	r=4%	r=10%	Oil Price = BL*1.5	Oil Price =BL*3	Non-oil Cash Flow Growth=0.5	Non-oil Cash Flow Growth=1%	Baseline	Actual
Angola	-25.2	-73.8	-8.0	-20.0	-23.8	-44.5	-4.0	-40.1
Cameroon	0.7	-3.5	1.8	-0.4	-15.4	-34.0	2.5	-8.2
Chad	-8.2	-31.0	0.8	-2.4	-18.9	-40.5	1.9	-53.4
Congo	-29.5	-69.0	-18.7	-41.4	-29.0	-47.5	-11.1	-67.4
Côte d'Ivoire	1.1	-2.5	2.4	0.7	-15.9	-35.4	2.9	-3.9
Equatorial Guine	-16.4	-49.5	-6.3	-16.6	-22.0	-41.9	-2.9	-77.3
Gabon	-28.8	-52.7	-23.2	-50.4	-31.0	-48.5	-14.1	-28.6
Nigeria	-26.0	-42.3	-18.9	-41.8	-29.1	-47.6	-11.3	-5.3

Source: Authors' estimates.

Table 9. Robustness Tests: Precautionary Approach—Optimal Current Account Balance
(mean in the period between 2005 and the end of oil production, percent of non-oil GDP)

	Angola		Cameroon		Chad		Congo, Republic		Côte d'Ivoire		Equatorial Guinea		Gabon		Nigeria	
	CS[5]	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS
Baseline (BL)[1]	**123.6%**	**0.9%**	**4.0%**	**0.0%**	**31.7%**	**0.1%**	**96.1%**	**1.2%**	**2.1%**	**0.0%**	**162.7%**	**1.4%**	**40.1%**	**0.2%**	**29.2%**	**0.4%**
Parameters																
Higher risk averseness (σ=8)	123.6%	2.3%	4.0%	0.0%	31.7%	0.1%	96.1%	2.4%	2.1%	0.0%	162.7%	4.4%	40.1%	1.4%	29.2%	1.0%
Difference with baseline	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	2.9%	0.0%	1.1%	0.0%	0.5%
Higher discount rate (β=10%)	83.6%	4.0%	2.8%	0.0%	22.6%	0.5%	63.9%	3.3%	1.4%	0.0%	118.5%	3.6%	24.4%	1.6%	15.2%	1.2%
Difference with baseline	-40.1%	3.1%	-1.2%	0.0%	-9.2%	0.4%	-32.3%	2.1%	-0.7%	0.0%	-44.2%	2.2%	-15.8%	1.4%	-14.0%	0.7%
Higher labor growth (BL+1%)	140.6%	0.7%	4.6%	0.0%	36.7%	0.0%	110.3%	0.3%	2.5%	0.0%	192.6%	1.5%	48.4%	0.3%	36.1%	0.3%
Difference with baseline	16.9%	-0.2%	0.6%	0.0%	4.9%	-0.1%	14.2%	-0.9%	0.4%	0.0%	29.9%	0.1%	8.3%	0.0%	6.9%	-0.2%
Initial values																
Higher NFA[2]	123.7%	0.4%	4.1%	0.0%	32.1%	0.2%	96.5%	0.8%	2.3%	0.0%	163.8%	1.2%	40.4%	0.3%	29.4%	0.5%
Difference with baseline	0.1%	-0.5%	0.2%	0.0%	0.4%	0.1%	0.4%	-0.4%	0.2%	0.0%	1.1%	-0.2%	0.3%	0.1%	0.2%	0.1%
Higher share of non-oil GDP[3]	34.3%	0.1%	1.9%	0.0%	11.1%	0.0%	25.6%	0.0%	1.1%	0.0%	24.6%	0.0%	13.2%	0.2%	11.4%	0.1%
Difference with baseline	-89.3%	-0.9%	-2.0%	0.0%	-20.6%	-0.1%	-70.5%	-1.2%	-1.0%	0.0%	-138.1%	-1.4%	-27.0%	0.0%	-17.8%	-0.4%
Higher initial oil price[4]	117.7%	0.8%	3.8%	0.0%	30.4%	0.2%	91.3%	0.2%	2.0%	0.0%	156.4%	1.3%	37.8%	0.4%	27.2%	0.2%
Difference with baseline	-5.9%	-0.1%	-0.2%	0.0%	-1.3%	0.1%	-4.8%	-1.0%	-0.1%	0.0%	-6.3%	-0.1%	-2.3%	0.2%	-2.0%	-0.2%
Memorandum																
2010 initial values	60.0%	0.1%	2.9%	0.0%	20.7%	0.0%	118.0%	1.3%	1.4%	0.0%	41.9%	0.1%	30.9%	0.5%	19.3%	0.2%
Difference with baseline	-63.6%	-0.8%	-1.1%	0.0%	-11.0%	-0.1%	21.9%	0.1%	-0.7%	0.0%	-120.8%	-1.3%	-9.2%	0.2%	-9.9%	-0.2%

[1]Under the baseline, risk averseness(σ)=2 and discount rate (β)=4%. The table shows the mean during the projection period.
[2]NFA is increased by 10 percentage points of non-oil GDP from the baseline.
[3]The share of the oil sector is halved from the baseline.
[4]Oil price is increased by US$ 10 in 2006 in terms of the value of 2005.
[5]CS and PS stand for consumption smoothing and precautionary saving components respectively.
Source: Authors' estimates.

To assess the sensitivity of the results from the model with precautionary saving we estimate external sustainability with different parameters and initial conditions. Table 9 presents the results when we allow for higher risk aversion, changes in the discount rate, and growth in the labor supply, compared with the baseline shown above. As expected, less appetite for risk leads to higher precautionary saving but the consumption-smoothing component remains constant.[30] If the (subjective) discount rate also rises, precautionary saving rises but the consumption-smoothing component declines. For example, when the discount rate is raised from 4 percent to 10 percent, the precautionary-saving component triples in most countries while the consumption-smoothing component declined by about 34 percent in terms of the average of the assessed period. Two forces are at work here: a higher discount rate reduces the present value of oil wealth, which reduces the optimal consumption-smoothing component; at the same time, a higher discount rate also increases the return on oil wealth and the incentive to increase precautionary saving. Consequently, the overall optimal current account is lowered as the impact on the consumption-smoothing component overtakes that of the precautionary-smoothing component. In contrast, growth in the supply of labor would result in a higher consumption-smoothing component and less incentive for precautionary saving. For example, a 1 percentage point increase in the growth of labor supply would halve the precautionary-saving component in some countries but increase the consumption-smoothing component by about 17 percent in terms of the average of the assessed period. Because the consumption-smoothing component is much bigger than the precautionary-saving component, the overall optimal current account level is increased.

Initial values for key variables that vary widely also affect sustainability under this framework.[31] When we change the starting values for net foreign assets, the share of non-oil GDP and the initial oil price, the optimal current account is dramatically shifted. If the share of the non-oil sector is increased, both precautionary saving and consumption smoothing are reduced and the estimate of the sustainable current account could be lowered substantially compared with the baseline. If net foreign assets were as much as 10 percentage points of GDP higher than the baseline, the behavior under consumption smoothing and precautionary saving is also changed. Also, higher oil prices from the beginning of the simulation would lead to a decline of the sustainable current account.

In summary, the robustness tests show that the results of this model are sensitive to the initial conditions, particularly the share of the non-oil sector but less sensitive to the model parameters. However, the conclusions are robust to these changes; namely that under varying assumptions and model parameters, oil-producing SSA countries should accumulate further precautionary savings to guard against uncertainties about the price of oil.

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[30] In the model (equations 8-10), risk version is determined by the curvature of the utility function. In the baseline, we used 2 as the parameter, compared with 8 in the “more” risk-averse scenario.

[31] As discussed in Section III.A above, the oil extraction profile can vary significantly.

VI. Conclusions

By their very nature, estimates of long-term external sustainability are subject to wide variability and uncertainty. In this paper, we elaborate on the sources of this variability and uncertainty through estimates of long-term sustainability based on different models; we believe that we can establish a clearer view of the current situation compared with where the eight SSA oil-producing countries—Angola, Cameroon, Chad, Côte d'Ivoire, Equatorial Guinea, Gabon, Nigeria, and Republic of Congo—might want to be.

The actual current account balance in these eight countries could be considered "close" to the optimal only if we are looking through the rear-view mirror. This is suggested by the results of the macroeconomic balance approach, which is a backward-looking analysis. It also indicates that the countries have had backward looking policies in the past and now need to shift to forward-looking policies. There is also a sense of urgency, because without new discoveries the time horizon for oil production is dwindling.

Indeed, the results from the consumption-smoothing and the precautionary-saving models show clearly that these countries are not sufficiently forward looking—even under varying assumptions and model parameters. The current versus permanent oil income assessment reinforces the view that national consumption decisions in these countries are not based on the notion of permanent oil income but instead on current oil income. Our estimates show that these countries must achieve higher external current account balances than middle- and high-income oil-producing countries, because they are far from sustainable, and they have relatively short time horizons for oil production. This result complements the fiscal sustainability analysis, for example, elaborated in York and Zhan (2009). In this regard, we would also stress the importance of ensuring the consistency of any analysis between fiscal and external sustainability. A divergence can exist between them because of the wedge created by the relatively high level of private-sector participation in the oil sector in SSA oil-producing countries. In short, private-sector saving and investment decisions matter and can influence the results.

It should be noted, however, that our conclusions are subject to important caveats and, therefore, the benchmarks we present should be considered indicative. In particular, none of the three approaches explicitly recognizes the potential growth of the non-oil sector. The prospects in this sector could have, however, significant bearing on the view of external sustainability. Front-loaded public investment in economic infrastructure (transportation, energy, water, and other public utilities) would help develop the non-oil sector, leading to diversification of the sources of growth and a broadening of the export base beyond oil. As elaborated above, such investments can raise the return on investment, spur non-oil growth, and change the key parameters used to drive the results in all three models. In this context, the view of long-term external sustainability could be dramatically shifted.

Notwithstanding these caveats, we believe our findings could help influence the policy dialogue with these eight countries. Several issues are worth exploring. First, with volatile world oil prices and relatively short time horizons for oil production, these countries should be more forward looking when making trade-offs about public investment, saving, and consumption of their exhaustible resource. Here, an appropriate benchmark for the sustainable external current balance is a significant input. To address this, we provided three standard methodologies and presented the caveats when assessing the benchmarks. Second, such benchmarks should take account of the external shocks these countries face, as well as the sensitivity of the scenarios to model parameters and initial conditions. These involve important elements of judgment and heavily influence policy decisions; the return on investment (and subsequent growth in the non-oil sector) is a case in point. Finally, there is an important link from fiscal sustainability to external sustainability—a link these countries should not ignore.

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