

# IMF Working Paper

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## Escaping the Curse of Oil? The Case of Gabon

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**IMF Working Paper**

African Department

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May 2002

**Abstract**

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This paper studies the prospects for sustainable growth and economic development in Gabon, in the face of a severe decline in its main source of income and growth, i.e. oil. A simple Computable General Equilibrium model is used to simulate the development of the non-oil economy under various assumptions. The results of the simulations underline Gabon's dependence on foreign financing—especially private—and its vulnerability to variations in oil prices. The potential role of an income stabilization fund is also discussed.

JEL Classification Numbers: E2, E6, O11, O41, O55, Q32

Keywords: Gabon, growth, oil, diversification, savings, investment, income stabilization fund

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<sup>1</sup> I would like to thank Bernardin Akitoby, Lars Engström, Elliott Harris, Steve Kayizzi-Mugerva, Arend Kouwenaar, Paul Masson, Joseph Ntamatungiro, and Tove Strauss for valuable comments and discussions. Any remaining errors are mine.

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## I. INTRODUCTION

The Gabonese economy has been centered around its production of oil since the oil crises of the early 1970s. Symptoms of Dutch disease are evident from the overexpanded government, the weak industrial tissue and the high degree of urbanization. As in many other resource-dependent economies, the need for diversification is pressing. However, in Gabon this need takes on a particular urgency as oil production—in the absence of new discoveries—is now expected to fall by over one half in the coming five years. The short-to medium-term consequences of the declining oil sector are to a large extent related to an increasingly tight domestic and external financing situation, as illustrated by the following indicators:

- Oil tax revenue constituted nearly 60 percent of total fiscal revenue on average between 1999 and 2001.
- Oil exports made up close to 80 percent of total exports during the same period.
- The overall balance of payments of the oil sector showed a surplus of around 20 percent of total GDP on average in 1999–2001, effectively financing a large savings-investment deficit in the non-oil sector, in addition to substantial repayments of government external debt.

While the oil sector diminishes as a source of financing, the financing needs of Gabon will continue to be high. Social and physical infrastructure is in need of significant improvement, and the public external debt service—claiming over 40 percent of government revenue on average in 2000–01—will continue to be extremely high in the absence of a debt rescheduling.

On a longer-term perspective, the development of the non-oil sector is essential for economic development and poverty reduction. In 2001, the oil sector accounted for approximately two-fifths of total GDP. Furthermore, regardless of the prospects for oil in Gabon, poverty reducing growth would need to be derived from the non-oil sector, given the limited effect the oil industry has on employment and economic activity of the general population in Gabon.

In this paper, an attempt is made to simulate the development of the non-oil economy under various assumptions with the help of a simple Computable General Equilibrium (CGE) model, tailored to capture the most important specificities of the Gabonese economy. Particular attention will be paid to the roles of (i) fiscal consolidation; (ii) private investment; (iii) external financing; and (iv) Gabon's sensitivity to fluctuations in oil prices. The purpose is, in particular, to show that the availability of financing for investment—especially private—is a condition for non-oil growth. The potential role for an income stabilization fund will also be discussed.

## II. RESOURCE DEPENDENCE AND LACK OF DIVERSIFICATION—STYLIZED FACTS

It is often perceived that a rich endowment in natural resources presents a curse rather than a blessing as it can lead to lower growth (Sachs and Warner, 1995 and 2001; Gylfason, 2001 and 2002; and Auty, 2001) and a higher degree of inequality (Leamer and others, 1999), although this is not uncontroversial (Deaton, 1999; and Stijns, 2001). The potential consequences of resource abundance and lack of diversification in general are summarized below.

Large inflows of export earnings from the natural resource sector may result in a real appreciation of the exchange rate, resulting in a contraction (or lack of development) of the non-resource economy and deindustrialization through the Dutch disease effect. The public sector—or state-owned enterprises—often accounts for a dominant part of non-resource activity, in particular if a large proportion of resource rents accrue to the government. Agriculture declines, and migration toward the urban areas ensues. As both industry and agriculture are stifled, consumer goods are typically mostly imported. Dutch disease is not easily quantified, and in fact the real effective exchange rate (REER) does not provide clear indications of the phenomenon in Gabon. The REER actually depreciated slightly in the 1980s and 1990s; the devaluation of the CFA franc in 1994 brought about a major REER depreciation which to a large extent has been maintained since then, despite some erosion owing to higher prices of imports and higher factor costs. Nevertheless, Dutch disease-like crowding out of local industry and agriculture is evidenced by the small shares in non-oil GDP (Table 2). Furthermore, the urbanization ratio of around 70 percent is an indication of the agricultural sector being abandoned in the hope of benefiting from oil rents being distributed mainly in the larger cities.

The significant rents associated with resource exploitation may lead to corruption. The negative effects of corruption on growth are extensively documented (see, e.g., Tanzi (1998) for a survey of the literature). Corruption may have a negative impact on foreign direct investment by adding uncertainty (Wei, 1997), distract efforts away from productive activities (Krueger, 1974) or investment (Murphy, Shleifer, and Vishny, 1993), result in waste of human capital because people in a position to extract rents typically are relatively well educated (Berthélemy and Dessus, 2000), or provide wrong incentives for entrepreneurs (Baumol, 1990). Empirical evidence shows that corruption is particularly prevalent in oil and mineral-rich countries (Leite and Weidemann, 1999). Corruption is also difficult to quantify or even define. Organizations such as Transparency International (TI) calculate indices measuring the perceived degree of corruption in a number of countries, which unfortunately do not including Gabon. Nevertheless, corruption is an undeniable problem in Gabon.<sup>2</sup>

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<sup>2</sup> A small survey (Neumann, 1994) carried out in 1994 by an association of German exporters gave Gabon a 3.13 rating on a TI standardized scale from 0 (most corrupt) to 10 (least corrupt), roughly comparable to Kenya, Cameroon, Senegal, and Côte d'Ivoire but better than in Nigeria and the Democratic Republic of the Congo.

Debt overhang may arise. Future export revenues from resource exports are often implicitly or explicitly collateralized to obtain external loans (Manzano and Rigobon, 2001). A subsequent fall in the terms of trade leaves the borrower with an unsustainable debt burden, hampering productive investment in the future. Gabon's oil resources certainly helped the country gain access to foreign borrowing during the 1970s and 1980s. As oil prices fell in the mid-1980s, Gabon was no longer able to service its debt and has had to resort to repeated Paris Club reschedulings since the late 1980s.

Productivity of capital is often very low. Related to the issues of corruption and debt, a sudden increase in capital inflows—often perceived as permanent—may induce excessive or otherwise inefficient public investment projects either through political pressures to spend rather than to save, bribery involved in obtaining lucrative government investment contracts, or nationalistic pride in a particular project (so-called white elephants). Furthermore, abundance of rents tends to weaken market discipline and efficient use of resources (Auty, 2001). Government investment contracts with the private sector tend to be overpriced—or even fictitious, as the 1999 audit of Gabon's stock of accounts payable showed.<sup>3</sup> Tanzi and Davoodi (1997) showed empirically that corruption led to higher public investment of lower quality. The effect of wasteful—and sometimes exaggerated—investment leads to low total factor productivity (TFP) and the buildup of foreign debt. Gabon's debt was to a large extent accumulated during the 1970s and 1980s as a result of wasteful spending on investment projects—the most prominent of which was the Transgabonais railway (Yates, 1996; and Barro Chambrier, 1990). As Table 1 shows, capital productivity has been very low in Gabon throughout the 1980s and 1990s. Simple growth accounting—assuming constant returns to scale in private and public capital and labor, a private capital coefficient of 0.3, a public capital coefficient of 0.1, and labor growth equal to the growth of the population—leads us to conclude that TFP growth was extremely low, or even negative, in particular prior to the devaluation in 1994.<sup>4</sup>

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<sup>3</sup> As much as 18 percent of government liabilities were cancelled as they corresponded to double, triple or fictitious invoicing; another 29 percent was cancelled, corresponding to debt paid but still recorded as due, or offset against large tax arrears due by suppliers.

<sup>4</sup> The coefficients used to calculate the contribution of capital accumulation and labor growth correspond to those used in the model, see below.

Table 1. Gabon: Growth Accounting, 1980–2001

(In percentage points, annual average)

	1980–93	1994–2001
Contribution to non-oil GDP growth—total	0.5	2.7
Private capital accumulation	2.0	0.9
Public capital accumulation	1.5	0.7
Growth in labor	1.5	1.5
Total factor productivity	-4.5	-0.4

Source: Author's estimates.

Resource abundance is often associated with neglect of education and health and poor development of human capital. The quality of human capital can be negatively affected by resource abundance through at least three channels; (i) a low degree of diversification provides few opportunities for learning by doing (see below); (ii) easy access to rents may lead authorities to underrate the importance of education for the future (Gylfason, 2001); and (iii) through the corruption channel, high public investment diverts resources away from social spending (Tanzi and Davoodi, 1997). Although public spending on education and health has tended to be rather high in Gabon, results have been disappointing. While the enrollment rate is well over 100 percent for primary school, and just over 50 percent for secondary school, completion rates for both types of schooling are below 50 percent. Furthermore, despite Gabon's relatively high income per capita, health indicators such as life expectancy, infant and child mortality are not significantly better than the average for sub-Saharan Africa.

Financial systems tend to be poorly developed, which hampers growth essentially through the failure to (i) pool risks; (ii) efficiently allocate resources; (iii) mobilize savings; and (iv) facilitate the exchange of goods and services (Khan and Senhadji, 2000).<sup>5</sup> As natural resource endowments take on a high importance—relative to physical capital—for national wealth, the need for financial intermediation decreases (Gylfason, 2002). Moreover, in the

<sup>5</sup> It deserves to be mentioned that some oil-rich countries, such as Kuwait, Qatar, and Saudi Arabia, have relatively well-developed financial systems, as measured by private credit as a percentage of GDP.

case of Gabon, the oil sector is essentially an enclave with very little interaction with the rest of the economy in terms of use of domestic factor and intermediate inputs. Capital and financial services are to a large extent imported from abroad. In addition, saving in the form of foreign bank accounts is not uncommon, diminishing further the need for domestic financial intermediation. Gabon's financial system is extremely shallow in comparison with countries of similar income per capita. In 1999, credit to the private sector as a percentage of GDP was only 10.7 percent (17.2 percent of non-oil GDP), compared to 27 percent for Kenya, 57.5 percent for Mauritius and 69.3 percent in South Africa.

Moreover, there is evidence that diversification in itself has a positive impact on growth. A diversified economy provides more opportunities for positive externalities in the form of learning by doing (see, e.g., Lucas (1993)). The level of diversification may also influence the behavior of investors. A low level of diversification precludes risk-averse agents from diversifying their investments (Acemoglu and Zilibotti, 1997). As a result, they invest in low-risk projects that are also assumed to have a low level of productivity.<sup>6</sup> Empirical evidence of the beneficial impact of diversification on growth can be found in Feenstra and others (1999), and Berthélemy and Söderling (2001).

### III. BRIEF OVERVIEW OF THE NON-OIL ECONOMY IN GABON, 1989–2001

The oil sector, as a share of total GDP has hovered around 30-35 percent—measured in constant 1991 prices—during the last decade (Figure 1.). As oil prices and exchange rates fluctuate widely, the share of oil in total GDP is also shown in current prices. The share of oil in total GDP is significantly higher in the post devaluation period if measured in current prices, as oil prices are set in U.S. dollars. For example the ratio was around 43 percent in 2001 if measured at current prices, compared to 26 percent in 1991 prices.

As is evident from Figure 2, showing a diversification index, no real progress has been made in terms of diversification since the end of the 1980s. The index—measuring the degree of diversification of production within the non-oil sector—is defined as the square of total production, divided by the sum of squares of production by all sectors. Theoretically, the index goes from one in the extreme case when the entire production is concentrated in one sector to infinity if when production are evenly spread over an infinite number of sectors. The diversification index fell slightly mainly due to the increasing weight of the services and government services sectors in conjunction with a continued low share of all industrial sectors.

In concurrence with the expectations from an economy suffering from Dutch disease, agriculture and fishery represent only a relatively small part of the economy despite Gabon's

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<sup>6</sup> Furthermore, indivisibilities on the micro level prevent capital from being spread too thinly. Consequently, poor countries are limited in the number of investment projects they can open. As income rises, investment can be spread over an increasing number of projects. In this setting diversification becomes endogenous and is the factor that drives growth.



significant endowment in arable land and waters rich in fish (Table 2). Prior to the oil crises of the 1970s—which transformed Gabon into an oil dependent economy—Gabon produced significant quantities of coffee and cocoa. Furthermore, industry (wood processing, agro-industry, and other industries) accounts for only about 10 percent of non-oil GDP. Government services make up about 20 percent of non-oil GDP, that is, roughly the size of agriculture, fishery, and industry combined. The bulk of the non-oil economy consists of services (commerce, transportation, tourism, and telecommunications). This is also what has driven growth, in addition to wood processing and other industries in the most recent years. The construction sector depends heavily on public investment projects and has, therefore, been somewhat erratic, following the ups and downs of government finances.

Figure 1. Composition of Total GDP in 1991 Market Prices, 1989–2001

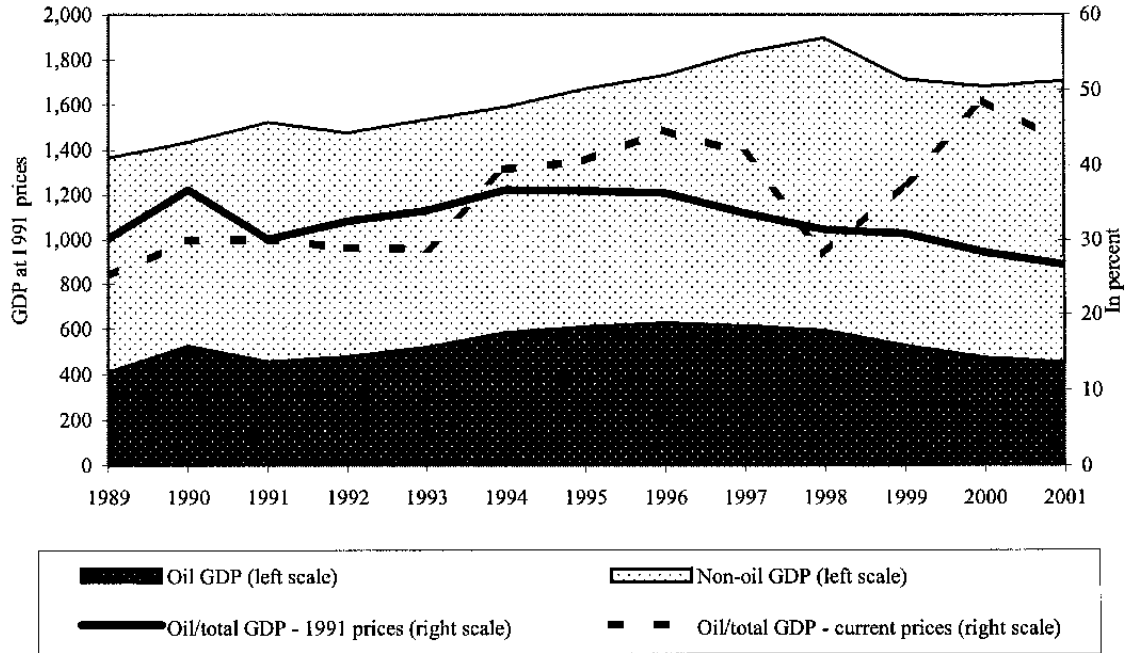
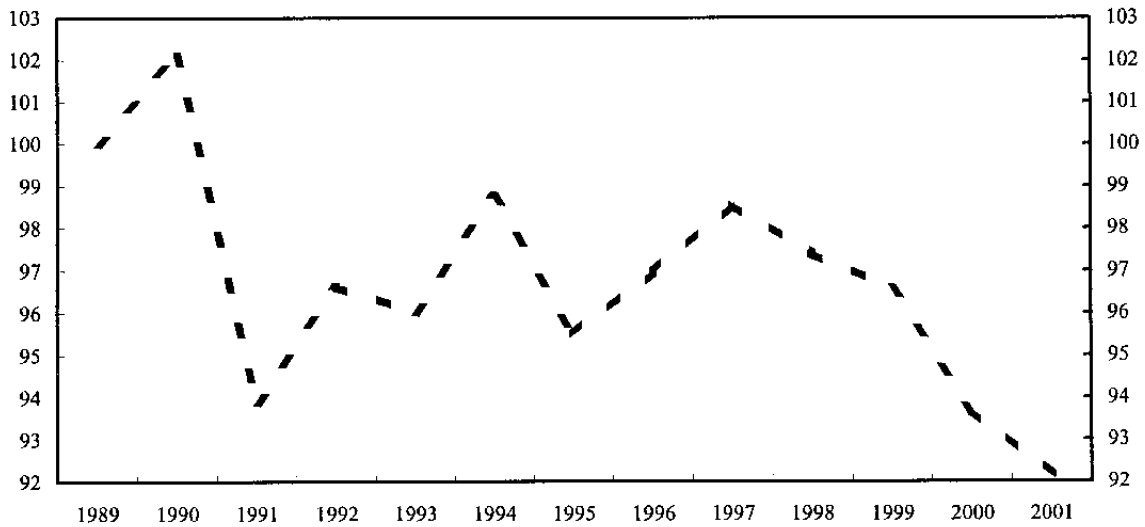


Figure 2. Non-Oil Diversification Index, 1989–2001  
(Index, 1989=100)



Source: Gabonese authorities; and author's calculations.

Table 2. Gabon: Composition and Growth of Non-Oil GDP, 1990–2001

	1990	1994	1999	2000	2001
	(In percent)				
Share of total GDP	100.0	100.0	100.0	100.0	100.0
Agriculture, fishing	10.8	10.7	9.4	9.6	9.7
Forestry exploitation	2.7	3.0	3.5	3.8	3.8
Mining	6.0	3.1	3.6	3.4	3.1
Agro-industry	3.8	4.0	3.8	3.7	3.8
Wood industry	0.6	0.4	1.3	1.0	1.3
Other industries	4.8	4.5	5.4	5.8	5.8
Electricity and water	3.5	3.6	3.5	3.5	3.5
Construction, public works	6.2	6.6	6.4	5.1	4.6
Transport	10.6	10.7	9.2	9.5	9.6
Services	17.9	17.7	21.2	21.8	22.3
Commerce	13.5	14.3	10.5	10.7	11.0
Financial services	1.3	1.6	1.3	1.4	1.4
Government services	18.3	19.9	20.8	20.7	20.2
	(In percentage points)				
Contributions to real growth	-4.3	0.5	-7.9	0.5	2.7
Agriculture, fishing	-0.3	0.0	0.1	0.3	0.3
Forestry exploitation	0.2	0.2	0.5	0.3	0.1
Mining	-0.4	0.3	-0.2	-0.2	-0.2
Agro-industry	0.2	-0.2	-0.2	0.0	0.2
Wood industry	-0.1	-0.3	0.3	-0.3	0.3
Other industries	0.1	0.1	-0.4	0.4	0.1
Electricity and water	-0.2	0.3	0.2	0.0	0.1
Construction, public works	-0.7	0.1	-3.7	-1.2	-0.4
Transport	-0.2	-0.3	-1.5	0.3	0.4
Services	-0.8	-0.5	-0.8	0.7	1.1
Commerce	-1.6	-0.5	-2.8	0.3	0.6
Financial services	0.2	0.5	-0.3	0.0	0.1
Government services	-0.5	0.9	1.0	0.1	0.1

Sources: Gabonese authorities; and author's estimates.

#### IV. DESCRIPTION OF THE MODEL

The model used for the simulations of the various scenarios is a simple static<sup>7</sup> general equilibrium model, inspired by the 1-2-3 Model developed by Devarajan and others (1994). The analysis that follows focuses on the non-oil sector, while the impact from the oil sector is considered as exogenous. In this respect, the oil sector is treated as an enclave with the only influence on the rest of the economy deriving from two sources: (i) oil tax revenues paid to the government by oil companies; and (ii) provision of foreign exchange. All equations, variables and parameters are presented in Annex II.

Total value added is determined by a standard Cobb-Douglas production function, with constant returns to scale in the two production factors capital and labor:

$$GDP=A*K^aL^{(1-a)}, 0<a<1, \quad (1)$$

where K, L and A represent the stock of private capital, labor, and total factor productivity (TFP), respectively. Total factor productivity is determined as

$$A=TFP*(G/K)^b, 0<b<1, \quad (2)$$

where TFP is a function of variables such as the quality of human capital, the pervasiveness of corruption, the quality of institutions, openness to trade, absence of distortions etc.  $G/K$  represents the availability of public capital relative to private capital. The public capital is the stock of all physical capital paid for by the government, such as roads, sewage systems, telephone lines and other public physical infrastructure. It is assumed that rapid private economic development may have a negative impact on total factor productivity through effects of congestion, unless it is accompanied by a minimum level of public investments (Latreille and Varoudakis, 1996).

Combining equations (1) and (2) renders:

$$GDP=TFP*K^\alpha L^{(1-\alpha-\beta)} G^\beta, \alpha=a-b \text{ and } \beta=b. \quad (3)$$

In other words, by internalizing the effect of the relative availability of public capital, we obtain a production function with constant returns to scale in three production factors—now including public capital. Equation (3) shows the optimal allocation of investment between public and private capital. The marginal productivities of private and public capital are  $\alpha*GDP/K$  and  $\beta*GDP/G$ , respectively. When private capital is relatively scarce, savings are most productively channeled to finance private investment and vice versa. In the present case, the marginal productivity of private capital is equal to that of public capital when  $G/K$  is equal to  $\beta/\alpha$ .

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<sup>7</sup> Strictly speaking, the model would be considered as sequentially dynamic, as stocks carry over from one year to another.

As abstraction is made from intermediate inputs, total production equals non-oil GDP. Firms are assumed to produce one domestic good and one good for export, according to a constant elasticity of transformation (CET) function of relative (tradable/nontradable) prices. On the demand side (either for consumption or investment), consumers choose between a domestic and an imported good, which are imperfectly substitutable following a constant elasticity of substitution (CES, or Armington) function (see Annex II).

Private non-oil savings are assumed to be a constant share of private non-oil income:  
 $S_p = s * Y$ . (4)

This savings function has the disadvantage of not taking into account incentives to save provided by an interest rate. Moreover, as the model is static, it does not take into account agents' potential desire for inter temporal consumption smoothing. The purpose is to keep the model as simple as possible, and the above savings function is likely to be sufficiently close to reality in the context of poorly developed financial systems and in the presence of credit constraints. Government savings is the difference between revenue and current expenditures.

The non-oil economy wide savings—investment balance can be described as:  
 $S_g + S_p = I_g\_nominal + I_p\_nominal + CA + Oil\ tax\ revenue$ , (5)

or expressed differently:

$$I_p\_nominal = S_p + (S_g - I_g\_nominal - Oil\ tax\ revenue) - CA, \quad (5b)$$

where  $S_g$  and  $S_p$  are total savings of the government and the non-oil private sector respectively,  $I_g\_nominal$  and  $I_p\_nominal$  are government and private investment respectively, and  $CA$  is the current account balance of the non-oil sector (all in nominal terms). Note that this specification holds by virtue of the enclave nature of the oil sector, which is assumed to interact with the non-oil sector only through tax payments. Given this specification of savings, private investment is essentially determined by the level of production,<sup>8</sup> the government's non-oil overall balance (represented by the term in parenthesis) and the non-oil current account.

The capital stock is a function of accumulated investments and a depreciation rate. For simplicity, the labor market is passive in the model as nominal wages are assumed to adjust fully to gains in total factor productivity. No labor rigidities are taken into account, and it is assumed that there is an excess labor supply. As a result, the capital-labor ratio is fixed and the unit labor cost remains constant in real terms.

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<sup>8</sup> Income is closely related to production (value added). It is the sum of GDP, government transfers, net factor income and net foreign private remittances in nominal terms, see Annex II.

In the fiscal sector, oil tax revenue is considered exogenous, while non-oil tax revenue is determined endogenously by the level of imports, exports, consumption of domestic goods and private income. Government consumption and transfers, as well as domestic and external financing are exogenous (with the exception of additional domestic financing under certain scenarios, see below). Public investment balances the difference between government savings and available domestic and external financing resources. As investment projects tend to span several years, it would be unrealistic to allow public investment to go below a certain level. Moreover, too low a level of public investment would be politically unfeasible and incompatible with poverty reduction.<sup>9</sup> To take these considerations into account, an exogenous minimum level of investment is imposed, with the potential result that the government may need to raise additional domestic financing if savings and available financing resources do not cover the minimum investment level. This additional domestic financing could, for instance, take the form of government securities,<sup>10</sup> or it may simply consist of running up domestic arrears. In either case, the additional financing results in a decrease in resources available for the private sector, thereby crowding out private investment.

The overall balance of payments of the non-oil sector is determined exogenously by the overall balance of the oil sector and any exceptional financing, such as debt relief—including a potential rescheduling of Paris Club debt, and variation in net foreign assets. The capital account and the flows of factor income and foreign remittances of the non-oil sector are assumed exogenous. As a consequence, the non-oil trade balance adjusts—in response to changes in the real effective exchange rate (REER)—to equilibrate the balance of payments. The nominal exchange rate is set as the numeraire.

## V. CALIBRATION, ASSUMPTIONS, AND RESULTS OF THE BASELINE SCENARIO

The model is calibrated using data for 2000. The CET and CES elasticities— $\Omega$  and  $\sigma$  respectively—are set at 0.6 and 0.9, respectively.<sup>11</sup> The sensitivity analysis displayed in Annex I shows that the model is not very sensitive to the choice of these parameters. The private and public capital coefficients in the production function are set to 0.3 and 0.1, respectively (see below).

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<sup>9</sup> Furthermore, up to a certain point, public and private investment are likely complementary rather than competing for financing resources.

<sup>10</sup> This type of financing—until present, nonexistent in Gabon—is being discussed in the context of the gradual elimination of the statutory advances (i.e., government financing from the central bank) within the CEMAC zone.

<sup>11</sup> Akitoby (1998) used a CET elasticity of 0.95 and a CES elasticity ranging from 0.75 to 0.9 in his application of a CGE model for Benin. Devarajan and others (1994) set both elasticities to 0.6 in a model applied to Sri Lanka. Go (1994) tested and used a CET elasticity of 0.6 and a CES elasticity of 0.5 in an application on the Philippines.

The assumptions for the exogenous variables are made in a manner to focus the analysis on capital accumulation of the private sector with public capital as a complementary production factor. This is in no way intended to diminish the importance of total factor productivity (TFP) growth.<sup>12</sup> However, the focus will be on savings and investment, for the following reasons: (i) Gabon faces a severe liquidity constraint in the short to medium term, as the declining oil production inevitably will put pressure on the fiscal balance, while the declining surplus on the oil current account will necessitate alternative sources for investment financing; and (ii) finding alternative engines for growth to replace oil implies significant structural change which is costly and requires substantial investment.<sup>13</sup> Although in the case of Gabon, the *volume* (rather than the *quality*) of investment can hardly be blamed for the poor growth performance in the past, but given the difficult financial situation, it could easily become the key constraint in the future.

Total factor productivity (TFP) is assumed to grow at a constant rate of 1.5 percent per year.<sup>14</sup> The initial (1980) capital stock was calculated using the Harberger method (Harberger, 1978). According to this method, under constant returns to scale the capital stock in year  $t-1$  can be approximated by the investment in year  $t$  divided by the sum of the long-

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<sup>12</sup> In fact, TFP has a doubly positive effect on growth. Besides the direct effect on production, it can be assumed to influence capital accumulation by (i) enhancing incentives to invest; and (ii) by securing higher domestic savings, as income rises with the level of TFP and production. Nevertheless, capital accumulation has often been identified as the driving factor for long term growth, although this point of view is not unchallenged. Sala-i-Martin (1997) argued that investment was one of the few variables that was consistently found to have a positive and significant impact on growth. See also De Long and Summers (1991) for the importance of investment for growth. The lack of investment is often quoted as one of the major problems in Africa (Fischer, Hernández-Catá, and Khan, 1998; Hernández-Catá, 2000). See also Young, 1995 on the respective roles of capital accumulation and productivity for the East Asian countries. In contrast, Hsieh (1998) claimed that Young's and others' conclusions were inconsistent with observed movements in factor prices. Devarajan, Easterly, and Pack (2001) found no relationship between slow growth and low investment rates in Africa. Easterly and Levine (2001) found empirical evidence that productivity growth, and not factor accumulation, was the main variable explaining the difference in growth across countries.

<sup>13</sup> In the same vein, Amin Gutiérrez de Piñeres and Ferrantino (1997) found that diversification (and, hence, structural change) may actually be associated with negative growth in the short term, as structural change is a costly process. This further justifies the focus on savings and investment.

<sup>14</sup> This corresponds roughly to the rate of growth in TFP in East Asian countries as well as in well performing African economies in the 1970s and 1980s (Berthélemy and Söderling, 2001).

term growth rate of value added and the rate of depreciation.<sup>15</sup> The 2000 public capital stock was estimated from public investment series, and based on the assumption that the 1980 stock was zero.<sup>16</sup>

Current debt obligations of the government are known and in the Baseline scenario Gabon is assumed to obtain additional public external financing corresponding largely to the financing gap in the Fund staff's medium-term macroeconomic framework of March 2002.<sup>17</sup> Net external financing in the four medium-term scenarios below includes government investments in the Fund for Future Generations (FFG) corresponding to 10 percent of oil revenues.<sup>18</sup> As these funds are assumed to be placed abroad, the FFG amounts to a capital outflow. Domestic financing takes into account the phasing out of statutory advances (government financing from the central bank) within the CEMAC.

World prices of exports and imports are assumed constant. Oil revenue is based on a decline in oil production from 13.6 million tons in 2000 to 6.1 million tons in 2007—corresponding to the most recent projections by the Gabonese authorities. Projected oil prices and exchange rates correspond to the January 2002 WEO assumptions. The assumed improvement in the efficiency in non-oil tax collection is illustrated in Table 3. Government current expenditure is assumed to decrease by 7 percent annually in real terms between 2001 and 2007. Minimum public investment is set at the level of 2000 in real terms.

Table 3 shows the simulation results for key variables under the Baseline scenario. The assumed slow but steady increase in net foreign assets corresponds to the Fund staff's latest (March 2002) medium term macroeconomic framework. Known outcomes of exogenous variables for 2001 have been taken into account in the simulation. For example, net private capital flows were sharply negative in 2000 and 2001, to a large extent due to extraordinary events, such as significant payments of domestic arrears and debt by the government, which allowed government suppliers to pay foreign debt obligations and also translated into a

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<sup>15</sup> Strictly speaking, this approximation is only valid in the absence of total factor productivity (TFP) growth, but with reasonably long investment series (and, weak TFP growth as in the case of Gabon), this tends not to matter much. For example, halving the assumed 1980 capital stock reduces the estimate of the 2000 level by only 10 percent.

<sup>16</sup> Again the impact of the assumed level of the 1980 stock on the estimated 2000 level is minor.

<sup>17</sup> The model incorporates specific terms for new external financing, including for refinancing of existing debt service comparable to those obtained under the most recent Paris Club reschedulings.

<sup>18</sup> FFG is an income stabilization fund envisaged to smooth the fall in income induced by the declining oil production (see further below).



certain amount of capital flight. This explains the significant volatility in the balance of payment and the REER in 2000–02.<sup>19</sup> For 2002–07, the net private capital flows are assumed to increase gradually—by and large following the assumptions in the medium–term macroeconomic framework of the IMF.

The path of the current account balance is nearly the mirror image of oil fiscal revenues, as the non-oil current account compensates for the fall in oil production and exports. In order for this to happen, the real effective exchange rate (REER) must be depreciated sharply, which would thereby shift production incentives towards export and consumption towards domestic goods. Non-oil exports grow on average 6.9 percent per year in real terms, somewhat faster than GDP.

GDP grows steadily throughout the forecast period at an average rate of 5.3 percent. The Baseline scenario incorporates the assumption that an increasing part of private investment is financed by private capital flows, including foreign direct investment (FDI), mitigating the required improvement in the non-oil current account. On balance, private investment remains stable around 22 percent of non-oil GDP. Public investment remains above the minimum level (corresponding to the level observed in 2000) throughout the simulation period but declines somewhat in the later years, as oil revenues decline. The increasingly tighter fiscal situation is assumed to be mitigated by a significant reduction in current expenditure in conjunction with an increased efficiency in tax collection.

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<sup>19</sup> The REER is the equilibrating variable in the model. As the model is static, any shock is fully taken into account in one year, which may result in significant variation in the REER on a year-to-year basis. It is, however, the trend which is more relevant to analyze.

Table 3. Gabon: Overview of Key Variables and Parameters  
Under the Baseline Scenario, 2000–07

(In percent, unless otherwise indicated)

	2000	2001	2002	2003	2004	2005	2006	2007
Real non-oil GDP (index, 2000=100)	100.0	104.2	110.2	115.5	121.5	128.3	135.7	143.7
Real non-oil GDP growth		4.2	5.8	4.9	5.2	5.5	5.8	5.9
Private investment (percent of non-oil GDP)	17.7	21.9	22.1	21.0	21.3	22.0	22.6	21.8
Public investment (percent of non-oil GDP)	6.6	9.7	7.6	10.7	9.0	7.4	6.9	8.7
Private savings rate	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
TFP growth		0.0	1.5	1.5	1.5	1.5	1.5	1.5
REER 1/	100.0	88.9	102.2	107.0	117.8	127.1	132.6	134.9
Change in REER (+ = depreciation)		-11.1	15.0	4.6	10.2	7.9	4.3	1.7
Oil tax revenue/non-oil GDP	52.7	45.1	27.8	23.7	20.0	15.8	12.5	10.8
Non-oil tax revenue/non-oil GDP	25.4	26.2	28.0	29.4	29.9	30.6	31.2	31.7
Apparent tax rate - import taxes 2/ 3/	16.6	16.6	18.0	18.8	19.3	19.5	19.6	19.7
Apparent tax rate - export taxes 2/	6.3	6.3	6.8	7.1	7.3	7.3	7.4	7.4
Apparent tax rate - indirect taxes 2/	8.9	8.9	10.3	11.2	12.0	12.8	13.5	13.9
Apparent tax rate - direct taxes 2/	5.1	5.1	5.9	6.4	6.9	7.4	7.8	8.0
Non-oil current account/non-oil GDP	-25.6	-34.9	-22.8	-21.2	-17.7	-14.0	-10.6	-8.5
Real non-oil exports (index, 2000=100)	100.0	98.9	110.4	117.5	128.4	139.5	150.0	159.8
Real non-oil imports (index, 2000=100)	100.0	118.0	107.9	108.0	102.4	99.5	100.5	104.4
Net external government financing/non-oil GDP	-3.1	-10.9	-7.0	-3.2	-5.8	-6.6	-7.7	-7.6
Net external private financing/non-oil GDP	-17.0	-9.9	1.8	4.1	8.5	8.4	9.1	9.2
Change in net foreign assets/non-oil GDP (- = increase)	-7.4	6.9	-3.4	-1.7	-2.9	-2.3	-1.7	-1.2

Source: Author's projections.

1/ REER is defined as the local currency market price of imports (including import taxes) divided by the price of the domestic good.

2/ The apparent tax rate is defined as tax collected divided by the theoretical tax base.

3/ Import taxes do not include VAT on imports, which is treated as indirect tax.

## VI. ALTERNATIVE SCENARIOS: VULNERABILITY TO NEGATIVE EXTERNAL SHOCKS

In what follows, three different scenarios shall be analyzed and compared to the baseline scenario described above: (i) a scenario where oil prices are 10 percent lower than in the baseline scenario for all years (henceforth referred to as the Oil Shock scenario); (ii) a scenario assuming no debt rescheduling (No Debt Relief scenario); and (iii) a scenario with the same shortfall in foreign financing as the preceding scenario, but in the form of less private capital flows (Less FDI scenario).<sup>20</sup>

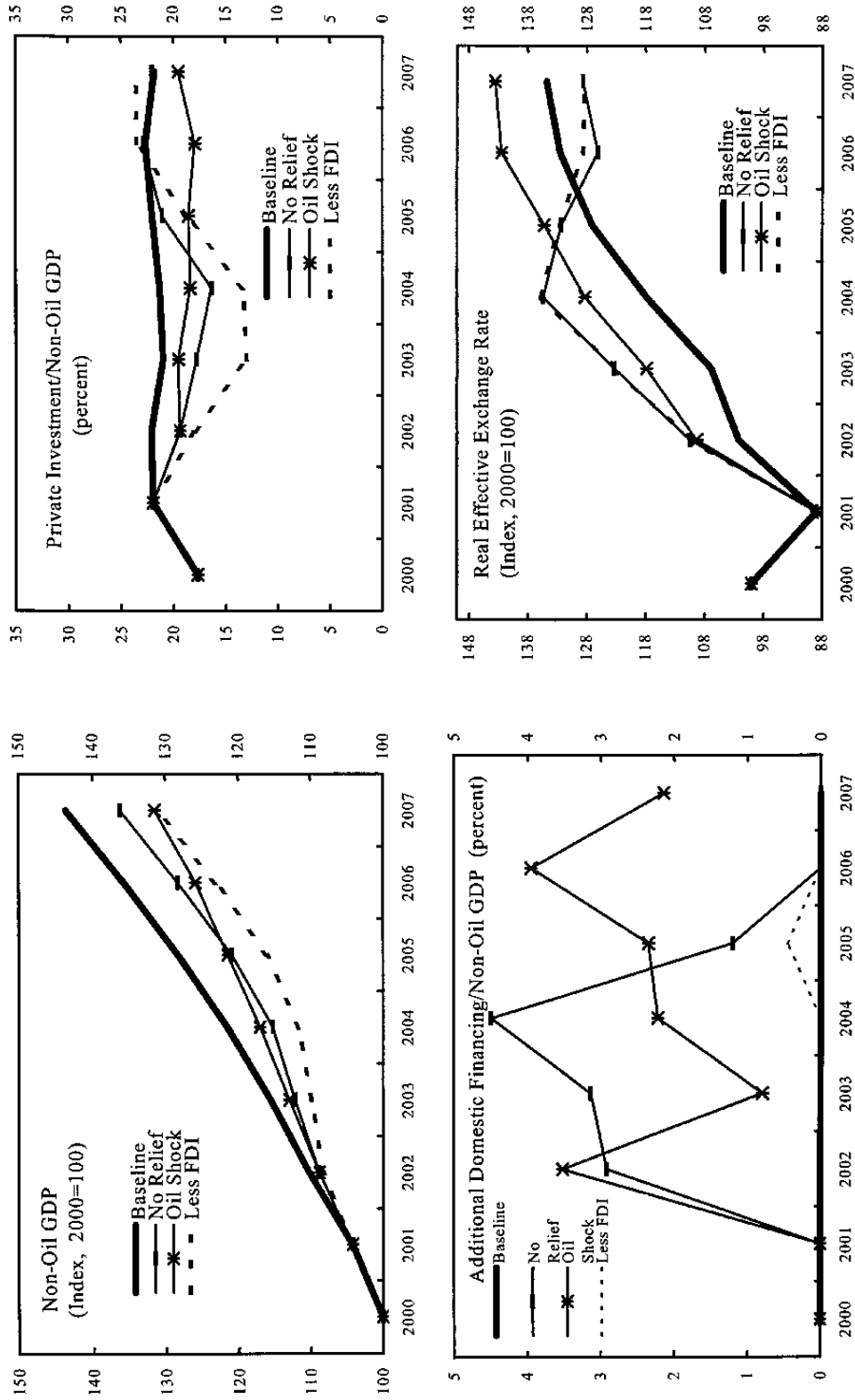
Figure 3 shows the outcome of GDP, private investment, the real effective exchange rate (defined as the price of imports divided by the price of the domestic good), and the additional domestic financing requirement in the four scenarios. The No Debt Relief scenario highlights the difficult fiscal situation faced by Gabon. To maintain a minimum level of public investment in the absence of debt relief, there is a substantial need for additional domestic financing, although limited to the period of the foregone rescheduling.<sup>21</sup> Moreover, the vulnerability to fluctuations in the price of oil is illustrated by the Oil Shock scenario. Under this scenario, the need for additional domestic financing is maintained throughout the simulation period as the assumed fiscal consolidation effort is not sufficient to compensate for the fall in oil tax revenues. Under both scenarios, the domestic borrowing (or accumulation of domestic arrears) by the government results in a significant drop in private investment compared to the Baseline scenario, and an adverse impact on growth. Table 4 shows that growth under the No Debt Relief scenario is on average about 0.8 percentage points lower than under the baseline scenario in the medium term, while the corresponding figure for the Oil Shock scenario is about 1.3 percentage points.

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<sup>20</sup> Net financing from a rescheduling is first positive under the consolidation period and then becomes negative as the country begins repaying principal (in addition to interest) on the consolidated amount. The equivalent flow of FDI is not entirely realistic. Nevertheless, this profile is kept for the sake of comparability between the two scenarios.

<sup>21</sup> The consolidation period of a potential debt rescheduling is assumed to be mid-2002 to mid-2005.

Figure 3. Scenario Overview, 2000-07



Source: Author's projections.

Under the Less FDI scenario, growth is even lower than under the No Debt Relief scenario, although the amounts of foregone foreign financing are equal. This is because private capital finances private investment directly, whereas a rescheduling finances government investment.<sup>22</sup> Figure 3 shows clearly that private investment falls even further under the Less FDI scenario than under the No Debt Relief scenario. The stronger negative impact on growth is a result of the private to public capital ratio being below its optimal level, making private investment more productive than public investment (Table 4). Note that this is a result of the assumed private and public capital coefficients ( $\alpha = 0.3$  and  $\beta = 0.1$ , respectively) in conjunction with the estimated levels of private and public capital.<sup>23</sup> Nevertheless, a private capital coefficient of 0.3 is relatively conservative<sup>24</sup> and it appears reasonable to assume that priority should be given to private investment, while maintaining a minimum level of public investment in infrastructure.<sup>25</sup>

As oil exports fall, the non-oil current account needs to improve, which requires a significant REER depreciation in all scenarios. The cumulative REER depreciation in the medium term is the largest in the oil shock scenario. Under the two scenarios assuming a shortfall in foreign financing, the REER depreciates sharply during the years corresponding to the consolidation period of the foregone debt rescheduling, after which it appreciates again as the negative shock is temporary.

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<sup>22</sup> A fall in private capital flows may be a response to weakened business incentives for private investors. The model does not directly capture investment incentives, but failure to improve the business climate can reasonably be assumed to have a negative effect on investment, induce capital flight and reduce FDI.

<sup>23</sup> Changing  $\alpha$  to 0.2, for example, would imply that the ratio was at its optimal ratio already close to the beginning of the forecast period, leaving no difference in private and public capital productivity.

<sup>24</sup> A private capital coefficient for the manufacturing industry in Cameroon was robustly estimated at 0.3 by Söderling (2001).

<sup>25</sup> Empirical evidence indicating a higher productivity of private investment relative to public investment in Africa can be found in Ghura (1997) and Ghura and Hadjimichael (1996).

Table 4. Gabon: Scenario Summary

(In percent, unless otherwise indicated)

	2000	2001	2002	2003	2004	2005	2006	2007
<b>Non-oil GDP growth</b>								
Baseline		4.2	5.8	4.9	5.2	5.5	5.8	5.9
No debt relief		4.2	4.4	3.1	2.8	4.9	6.1	6.2
Oil shock		4.2	4.5	3.8	3.6	3.8	3.6	4.4
Less FDI		4.2	4.0	1.4	1.6	3.9	6.1	6.6
<b>Private capital stock/public capital stock ratio 1/</b>								
Baseline	1.80	1.84	1.90	1.90	1.94	2.00	2.08	2.11
No debt relief	1.80	1.84	1.90	1.95	2.00	2.09	2.13	2.12
Oil shock	1.80	1.84	1.90	1.97	2.03	2.10	2.16	2.25
Less FDI	1.80	1.84	1.87	1.84	1.84	1.91	2.03	2.10
<b>Non-oil current account/non-oil GDP</b>								
Baseline	-25.6	-34.9	-22.8	-21.2	-17.7	-14.0	-10.6	-8.5
No debt relief	-25.6	-34.9	-19.4	-14.4	-10.5	-11.0	-11.9	-9.9
Oil shock	-25.6	-34.9	-20.2	-17.4	-14.6	-12.1	-8.4	-6.8
Less FDI	-25.6	-34.9	-19.4	-14.7	-11.0	-11.5	-12.5	-10.2
<b>Primary balance/non-oil GDP</b>								
Baseline	39.4	30.6	20.5	17.2	18.5	19.1	19.1	17.9
No debt relief	39.4	30.6	23.0	23.6	22.8	21.2	16.9	15.6
Oil shock	39.4	30.6	17.3	17.1	16.8	17.4	15.3	16.7
Less FDI	39.4	30.6	21.9	19.7	21.9	21.1	20.7	19.0
<b>Public investment/non-oil GDP</b>								
Baseline	6.6	9.7	7.6	10.7	9.0	7.4	6.9	8.7
No debt relief	6.6	9.7	6.1	5.9	5.7	5.4	8.8	10.6
Oil shock	6.6	9.7	6.0	5.8	5.6	5.4	5.2	5.0
Less FDI	6.6	9.7	7.1	9.5	6.7	5.7	5.3	7.6
<b>REER (Index, 2000 = 100)</b>								
Baseline	100.0	88.9	102.2	107.0	117.8	127.1	132.6	134.9
No debt relief	100.0	88.9	110.4	123.3	135.4	132.4	126.1	128.7
Oil shock	100.0	88.9	109.3	117.8	128.3	135.3	142.4	143.5
Less FDI	100.0	88.9	110.4	123.3	135.9	132.7	128.7	128.4
<b>Change in the REER (+ = depreciation)</b>								
Baseline		-11.1	15.0	4.6	10.2	7.9	4.3	1.7
No debt relief		-11.1	24.2	11.7	9.8	-2.2	-4.7	2.0
Oil shock		-11.1	23.0	7.8	8.9	5.4	5.3	0.7
Less FDI		-11.1	24.2	11.7	10.2	-2.3	-3.0	-0.2

Source: Author's projections.

1/ Optimal private to public capital stock ratio = 3.

## VII. SAVING FOR THE FUTURE—A LONGER-TERM PERSPECTIVE

In this subsection, the potential effects of an income stabilization fund are analyzed and different modalities for the implementation of such a fund are discussed. The simulations that follow are for illustrative purposes only, and should not be regarded as forecasts, as a simple static model such as the present one is far from sufficient to capture all of the important considerations involved. The purpose of this section is to demonstrate that the decision of whether a stabilization fund makes sense is not simply a question of whether the return on public investment is higher or lower than the return on investments in the Fund for Future Generations (FFG). Furthermore, it will be argued that the analysis of the choice between a domestically or an externally invested FFG needs to go beyond the simple comparison of rates of return. The following discussion is not intended to be exhaustive. Some caveats are highlighted at the end of the section.

Assuming that the productivity of public investment is relatively low, and that a high return can be found on certain investment vehicles, there may be a case for an income stabilization fund like the FFG, which would cushion the impact of the fall in oil revenue by saving a given share of oil revenues for the future. An improvement in the productivity of public investment over time could provide an additional argument for spending public resources later rather than immediately. In terms of the model used here, the marginal productivity of public capital increases with the ratio of private to public capital. Intuitively, investment in infrastructure makes more sense the more the private sector is developed and the more infrastructure is utilized by the industry.

When contemplating the design of a potential savings fund such as the FFG, an important question is whether assets should be saved abroad or domestically. As indicated above, access to foreign financing will play a crucial role for investment and growth in the non-oil sector in Gabon in the medium term. Investing FFG resources in foreign securities would imply a capital outflow, the medium-term effect of which would be analogous to a foreign financing shortfall analyzed under the No Debt Relief scenario above, that is, a drop in investment and growth etc. However, the longer-term outcome may be positive if returns on foreign securities are significantly higher than domestically available securities or savings accounts. On the other hand, investment is assumed to be constrained by savings and identified capital flows. Rather than placing FFG funds abroad—albeit in relatively high return assets—channeling these resources to finance private investment may prove more beneficial if the effect on non-oil growth is taken into consideration.

The simulation period is extended to 2012, in order to allow for the use of savings which are accumulated during 2002–07. Three scenarios will be examined: (i) one with a large FFG placed in foreign securities (called the External FFG scenario); (ii) the same FFG but placed domestically (Domestic FFG scenario); and a scenario without FFG (No FFG scenario). Foreign securities are assumed to render an 8 percent return, while a domestic FFG gives a low return of 1.5 percent. In the following scenarios, assumptions on the fiscal consolidation effort and the associated transfers to the FFG have purposely been exaggerated, in order to

get larger differences between scenarios.<sup>26</sup> Exogenous variables for the period beyond 2007 are obtained essentially by extrapolation.

Figure 4 shows the net cumulative cash flow from the FFG to the government under the three scenarios. Under the two scenarios with an FFG, interest and dividends from the FFG is assumed to be reinvested into the fund. During 2002-07, savings are made in the fund, which are withdrawn during the following five years. In all cases, the fund is completely exhausted at end-2012. It is clear that the higher rate of return in the External FFG can make an important difference in terms of resources available towards the end of the simulation period. The cumulative (undiscounted) difference between the External FFG and the Domestic FFG exceeds CFAF 300 billion or nearly one-fifth of 2000 non-oil GDP.<sup>27</sup>

However, determining which is the preferable arrangement is less obvious from a stand point of economic growth (Figure 5). Under the External FFG scenario, growth is initially slower than under the No FFG scenario as funds are placed abroad—constituting a capital outflow limiting resources available for investment. Growth is stronger during the second half of the simulation period as the accumulated assets in the FFG are used to increase public investment. Although External FFG appears less favorable than No FFG in Figure 5, this conclusion is sensitive to assumptions on the marginal productivity of public capital and on the return on the External FFG investments.

The Domestic FFG is, however, clearly more advantageous than the other scenarios, as it provides both an immediate boost to growth and long-term benefits in terms of higher income per capita. The additional resources set aside by the FFG are channeled to the private sector, thereby raising private investment. As private investment is assumed more productive than public investment, growth is initially significantly stronger than under the No FFG scenario. Furthermore, compared to the No FFG scenario, the ratio of private to public capital grows significantly faster during the initial years, rendering public investment more productive in later years. In addition, since non-oil GDP grows faster initially under the Domestic FFG scenario, the tax base grows accordingly, thereby contributing to the consolidation of the fiscal stance while still allowing for some increase in public investment.

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<sup>26</sup> 30 percent of oil revenues are assumed to be saved in the FFG, made possible by an annual reduction of current government spending of 25 percent during 2001-07 in real terms. Care was taken to avoid making the FFG large to the point where the government would be forced to raise additional domestic financing, in which case the FFG might have a directly negative effect, or cancel part of the positive effect, on private investment.

<sup>27</sup> Transfers under the No FFG scenario is zero every year for obvious reasons.



Figure 4. Accumulated Cash Flow from FFG, 2000-12  
(In billions of CFA francs)

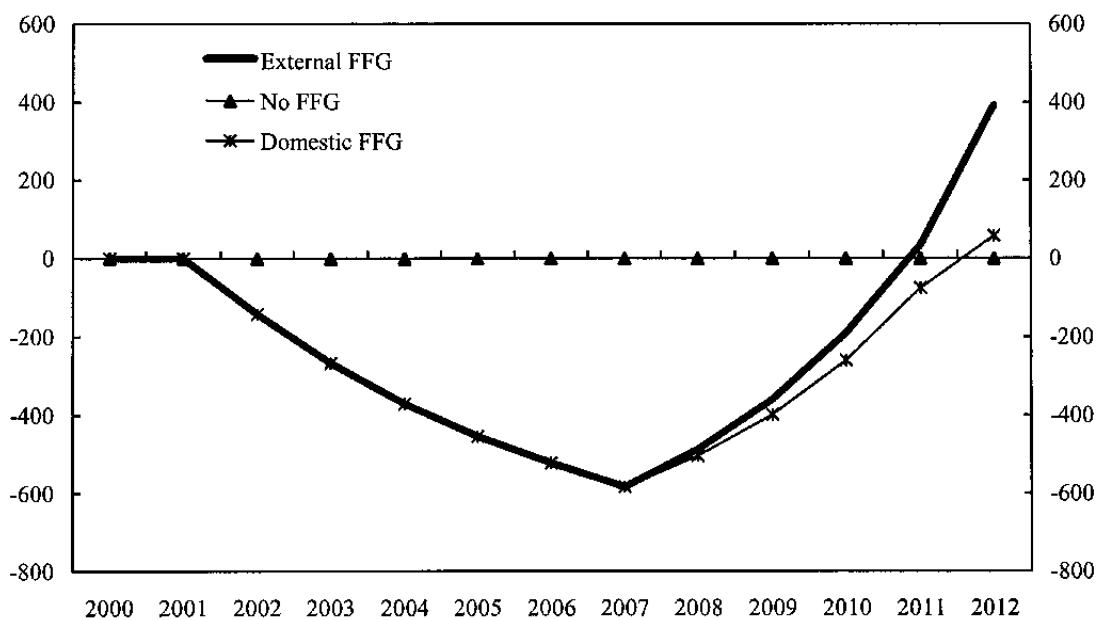
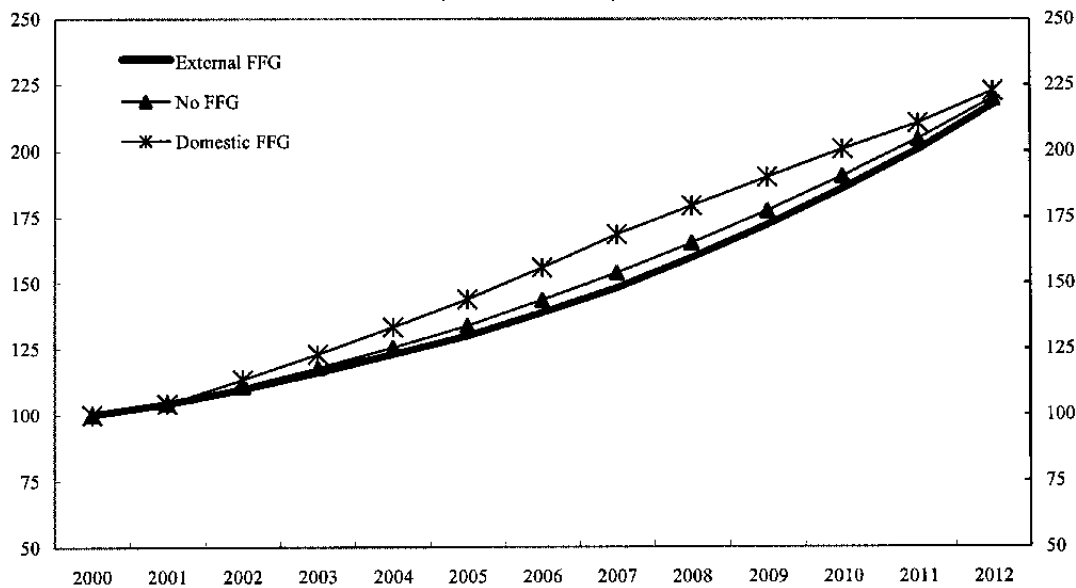


Figure 5. Non-Oil GDP, 2000-12  
(Index, 2000=100)



Source: Author's projections.

Although the results from the simulations above are indicative only, it appears that a FFG invested domestically is preferable under the following conditions: (i) private investment is more productive than public investment; (ii) the private sector has limited access to foreign financing and private investment is therefore hampered by an expansionary fiscal policy, and capital outflows, including (large) public ones; and (iii) government savings invested domestically can be channeled to finance private investment.

Several caveats exist, however, in particular regarding point (iii). It is not clear that government savings in the domestic banking system would in fact be recycled into new credit so as to boost private investment, given the imperfections in the financial sector in Gabon.<sup>28</sup> A more direct way of allowing the private sector to benefit from government savings would be to accelerate the repayment of domestic debt or arrears. This would require working out a transparent and fair system of repayment, so as to avoid unequal treatment of creditors. Another caveat, mentioned earlier, is that additional funding to the private sector would not necessarily lead to an increase in investment, in case incentives to invest are weak.

### VIII. CONCLUSIONS AND POLICY IMPLICATIONS

The development of Gabon's non-oil economy depends critically upon the ability to mobilize financing for investment. As oil production declines, prompting structural change in the economy, the need for both private and public investment will take on increasing importance. At the same time, Gabon faces an extremely difficult financial and external situation, with a large improvement in the non-oil savings—investment balance needed to compensate for the shrinking surplus on the oil current account, in conjunction with a continued high debt service burden. This improvement in the non-oil current account necessitates a significant adjustment of the real effective exchange rate (REER).

Moreover, foreign financing will take on an increasingly important role to allow, in particular the private sector, to maintain a sufficient level of investment. The simulation results show that the failure to obtain additional foreign financing for the government—for example in the form of a debt rescheduling—would have serious implications for growth and development in the medium term. A shortfall in private capital inflows (such as foreign direct investment) would have an even stronger negative effect on growth, as private investment can reasonably be assumed to have a stronger impact on output than public investment.

It is evident that Gabon is vulnerable to changes in world oil prices, further emphasizing the need for diversification of the economy. A fall in oil revenue would have a direct impact on the government's ability to maintain necessary public investment. If the fall would be large, and the government would be unable to adjust by reducing current expenditure, the weakened

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<sup>28</sup> For instance, lack of viable projects or asymmetric information may induce banks not to lend.

financial stance of the government would risk affecting the private sector negatively through the crowding out of financing for investment.

The merits of an income stabilization fund—intended to smooth the impact of the falling oil revenues—have been examined in this study. Although further analysis is needed, it is clear that the discussion of whether and how such a fund should be implemented needs to go beyond a simple comparison of rates of return on various investment alternatives. If private investment is relatively more productive than public investment, there is a case for government savings to be channeled to the private sector rather than to be invested abroad, in spite of potentially higher returns on foreign securities.

There are clear policy lessons to be learned from these findings:

- Fiscal consolidation is key to sustaining a minimum level of public investment without crowding out the private sector.
- In order to secure external financing in the future, Gabon needs to continue its efforts to normalize relations with the international community. This would entail continued fiscal consolidation, improvements in governance, and the implementation of a comprehensive poverty reduction strategy.
- An income stabilization fund is likely to be most effective if some of the saved resources are recycled domestically to finance private investment. In this regard, it is crucial to find a transparent and fair solution to the problem of channeling government savings to the private sector.
- The required significant depreciation of the real effective exchange rate (REER) in the medium term emphasizes the need for proper REER management, including government policies that support flexibility in the prices of factors and goods.
- Investment incentives also need to be supported by government policies. Probably the most important component of private investment incentives is a sound business environment. This would require a decrease in the role of the state in the economy, an improvement in the business climate, and a strong stance against corruption.

## Appendix 1. Sensitivity Analysis

	2000	2001	2002	2003	2004	2005	2006	2007
<b>Non-oil GDP (2000=100)</b>								
CET=0.6, CES=0.9	100.0	104.2	110.2	115.5	121.5	128.3	135.7	143.7
CET=0.6, CES=0.6	100.0	104.1	110.1	115.5	121.6	128.4	136.0	144.1
CET=0.9, CES=0.9	100.0	104.2	110.2	115.6	121.5	128.2	135.7	143.6
<b>Real exports (2000=100)</b>								
CET=0.6, CES=0.9	100.0	98.9	110.4	117.5	128.4	139.5	150.0	159.8
CET=0.6, CES=0.6	100.0	97.3	110.7	118.4	130.7	142.9	154.2	164.5
CET=0.9, CES=0.9	100.0	97.4	110.5	118.1	130.3	142.5	153.6	163.9
<b>Real imports (2000=100)</b>								
CET=0.6, CES=0.9	100.0	118.0	107.9	108.0	102.4	99.5	100.5	104.4
CET=0.6, CES=0.6	100.0	116.8	108.1	108.7	104.1	102.0	103.6	107.9
CET=0.9, CES=0.9	100.0	116.9	108.0	108.4	103.8	101.7	103.2	107.4
<b>REER (2000=100)</b>								
CET=0.6, CES=0.9	100.0	88.9	102.2	107.0	117.8	127.1	132.6	134.9
CET=0.6, CES=0.6	100.0	85.9	102.8	108.9	122.9	134.9	141.9	144.9
CET=0.9, CES=0.9	100.0	90.4	102.2	106.3	115.4	122.8	127.1	128.9
<b>Non-oil tax revenue (CFAF bn)</b>								
CET=0.6, CES=0.9	376.8	436.6	460.4	499.8	508.6	527.4	556.9	593.2
CET=0.6, CES=0.6	376.8	441.4	459.5	497.1	502.7	519.4	547.7	583.3
CET=0.9, CES=0.9	376.8	431.9	460.7	501.9	515.9	539.7	572.8	611.3

Note: CET indicates the CET elasticity,  $\Omega$ . CES indicates the CES elasticity,  $\sigma$ .

## Appendix 2. Details on the Model Specification

### A. Derivation of the Optimal Production and Consumption Baskets

The share of production of exported goods as compared to domestic goods is determined by a CET function, rendering the optimization problem for the firm:

$$\text{Max } Px * \text{GDP} = Pd * D + Pe * E, \quad (\text{A.1})$$

under the condition

$$\text{GDP} = At * [bt * E^{\rho t} + (1-bt) * D^{\rho t}]^{1/\rho t} \quad (\text{A.2})$$

where  $E$  is exports,  $Pe$  is the export price received by the producer,  $D$  is the domestic good with the relevant price  $Pd$ ,  $\text{GDP}$  is total production (value added) of the composite good,  $Px$  is the price of the composite good, and  $At$ ,  $bt$  and  $\rho t$  are parameters.

The solution to the optimization problem is

$$E/D = (((1-bt)/bt) * (Pe/Pd))^{\Omega}, \quad \Omega = 1/(\rho t - 1), \quad 0 < bt < 1, \quad \rho t > 1.$$

In a similar manner, the optimal consumption basket is determined by minimizing:

$$Pq * Qd = Pd * D + Pm * M, \quad (\text{A.3})$$

under the condition

$$Qd = Aq * [bq * M^{\rho q} + (1-bq) * D^{\rho q}]^{1/\rho q},$$

where  $Qd$  and  $M$  are total demand and imports respectively, with their respective prices  $Pq$  and  $Pm$ , and  $Aq$ ,  $bq$  and  $\rho q$  are parameters. The solution is

$$M/D = ((bq/(1-bq)) * (Pd/Pm))^{\sigma}, \quad \sigma = 1/(1-\rho q), \quad 0 < bq < 1, \quad \rho q < 1. \quad (\text{A.4})$$

As  $Pe$  and  $Pm$  are exogenous,  $Pd$  will adjust to balance supply and demand for the domestic good.

**B. Equations**

**Real sector—real terms**

Real non-oil GDP (=production)	$GDP_{no}$	$=TFP*(K^{\alpha}*L^{(1-\alpha-\beta)}*G^{\beta})$
Private capital stock	$K/L$	$=K_0/L_0$
Public capital stock	$G$	$=(1-\delta)*G_0+I_g$

Supply of composite good	$Q_s$	$=A_q*((b_q*M^{\rho_q}+(1-b_q)*D_s^{\rho_q})^{(1/\rho_q)})$
Demand for composite good	$Q_d$	$=C_p+C_g+I_p+I_g$

Private non-oil consumption	$C_p$	$=(1-s-ty)*Y_{no}/P_t$
Private non-oil investment	$I_p$	$=K-(1-\delta)*K_0$

**Real sector—nominal values**

Non-oil private income	$Y_{no}$	$=P_x*GDP_{no}+FSp*neer+RE*neer+P_q*TR_g$
Private non-oil savings	$EqSp$	$=s*Y_{no}$

**Fiscal sector—real terms**

Public investment	$I_g$	$=(T+Grants*neer-P_t*C_g-TR_g*P_q+F_g*neer+DomFin-I_{ext}*neer+AccDomArr)/P_k$
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**Fiscal sector—nominal values**

Tax revenue	$T$	$=tm*neer*pwm*M+tq*P_q*Q_s+ty*Y_{no}+te*neer*pwe*E+Orev$
Government savings	$S_g$	$=T-C_g*P_t-TR_g*P_q-I_{ext}*neer$
Additional domestic financing	$AccDomArr$	$=IF((T+Grants*neer-P_t*C_g-TR_g*P_q+F_g*neer+DomFin-I_{ext}*neer-IgMin*Pk)>=0,0, -(T+Grants*neer-P_t*C_g-TR_g*P_q+F_g*neer+DomFin-I_{ext}*neer-IgMin*Pk))$

**Prices**

Sales price of composite good	$P_t$	$=(1+tq)*P_q$
Non-oil GDP deflator	$P_x$	$=(P_e*E+P_d*D_s)/GDP_{no}$
Price of capital good	$P_k$	$=P_t$
Price of composite good	$P_q$	$=(P_m*M+P_d*D_s)/Q_s$
Exchange rate	$neer$	$=100$
Export price in domestic currency	$P_e$	$=(1-te)*neer*pwe$
Import price in domestic currency	$P_m$	$=(1+tm)*neer*pwm$

**External sector—real terms**

Exports	$E/D_s$	$=(1-bt/bt)*(P_e/P_d)^{\omega}$
Imports	$M/D_d$	$=(bq/(1-bq))*(P_d/P_m)^{\sigma}$

**Equilibrium conditions**

Savings-investment equilibrium	0	$=P_k*(I_p+I_g)-(S_p+S_g-(C_{Ano})*neer-Orev)$
Production equilibrium	0	$=GDP_{no}-A_t*((bt*E^{\rho_t}+(1-bt)*D_s^{\rho_t})^{(1/\rho_t)})$
Domestic good equilibrium	0	$=D_d-D_s$
Composite good equilibrium	0	$=Q_d-Q_s$
Non-oil current account	0	$=pwe*E-pwm*M+RE+Grants+FSp+Fsg-(C_{Ano})$

1/ Suffix 0 indicates value from one year earlier.

2/ This equation is included as a check only, since it is implied by Walras law.

**C. Variables**

<b>Exogenous</b>		<b>Endogenous</b>	
<b>Real sector—real terms</b>		<b>Real sector—real terms</b>	
		Real non-oil GDP	<i>GDPno</i>
		Private capital stock	<i>K</i>
Total factor productivity	<i>TFP</i>	Public capital stock	<i>G</i>
		Labor	<i>L</i>
<b>Fiscal sector—nominal values</b>		Supply of composite good	<i>Qs</i>
Government oil revenue	<i>Orev</i>	Demand for composite good	<i>Qd</i>
Domestic financing, net	<i>DomFin</i>	Supply of domestic good	<i>Ds</i>
		Demand for domestic good	<i>Dd</i>
<b>Fiscal sector—real terms</b>		Private non-oil consumption	<i>Cp</i>
Government consumption	<i>Cg</i>	Private non-oil investment	<i>Ip</i>
Government transfers	<i>TRg</i>	<b>Real sector—nominal values</b>	
Minimum public investment	<i>IgMin</i>	Non-oil private income	<i>Yno</i>
<b>External sector—nominal foreign currency terms</b>		Private non-oil savings	<i>Sp</i>
Interest on external debt (public)	<i>Iext</i>	<b>Fiscal sector—real terms</b>	
Interest rate, external debt	<i>int</i>	Public investment	<i>Ig</i>
Net public external borrowing	<i>Fg</i>	<b>Fiscal sector—nominal values</b>	
Net private non-oil external borrowing	<i>Fp</i>	Tax revenue	<i>T</i>
Foreign remittance, net	<i>RE</i>	Government savings	<i>Sg</i>
Foreign grants	<i>Grants</i>	Additional domestic financing	<i>AccDomArr</i>
Oil overall balance	<i>OBoil</i>	<b>Prices</b>	
Non-oil net private factor income	<i>FSp</i>	Sales price of composite good	<i>Pt</i>
Non-oil net private factor income	<i>FSp</i>	Non-oil GDP deflator	<i>Px</i>
Non-oil current account	<i>CAno</i>	Price of domestic good	<i>Pd</i>
Import tariff rate	<i>tm</i>	Price of capital good	<i>Pk</i>
Export tax rate	<i>te</i>	Price of composite good, excl. tax	<i>Pq</i>
Indirect tax rate	<i>tq</i>	Nominal effective exchange rate	<i>neer</i>
Direct tax rate	<i>ty</i>	Export price in domestic currency	<i>Pe</i>
World export prices	<i>pwe</i>	Import price in domestic currency	<i>Pm</i>
World import prices	<i>pwm</i>	<b>External sector—real terms</b>	
<b>Ratios</b>		Non-oil exports	<i>E</i>
Private non-oil savings rate	<i>s</i>	Non-oil imports	<i>M</i>

**D. Parameters**

Private capital coefficient	$\alpha$	0.30
Public capital coefficient	$\beta$	0.10
Elasticity <i>CET</i>	$\Omega$	0.60
Elasticity <i>CES</i>	$\sigma$	0.90
Scale for <i>CET</i>	$A_t$	2.39
$\rho$ <i>CET</i>	$\rho_t$	2.67
Share for <i>E CET</i>	$b_t$	0.83
Scale for <i>CES</i>	$A_q$	1.95
$\rho$ <i>CES</i>	$\rho_q$	-0.11
Share for <i>M CES</i>	$B_q$	0.38
Depreciation rate	$\delta$	0.05



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