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OxCarre Policy Paper 15

Oil Windfalls and Investing to Invest in Central Africa

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For B. Akitoby and S. Coorey (eds.), Oil in Central Africa – Policies for Inclusive Growth.

OIL WINDFALLS AND INVESTING TO INVEST IN CENTRAL AFRICA

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Natural resource rents worldwide now exceed $4 trillion per annum, amounting to some 7 percent of global GDP. Non-renewable resource revenues are a dominant feature of 50 economies with a combined population of 1.4 billion. There are 24 countries for which resources make up more than three quarters of their exports, 13 countries for which resources make up at least 40 percent of their GDP, and 18 countries for which resources make up more than half their fiscal revenue (IMF data 2000-5). Some countries (e.g., Botswana, Malaysia or Chile) have grown fast on the basis of these revenues but others (Nigeria or Cameroon) have not, and have been labeled as countries suffering from the 'resource curse'. Turning our attention to the CEMAC countries, table 1 shows the oil revenue as a percent of GDP for the CEMAC countries.

Table 1: Oil Revenue as a percent of GDP

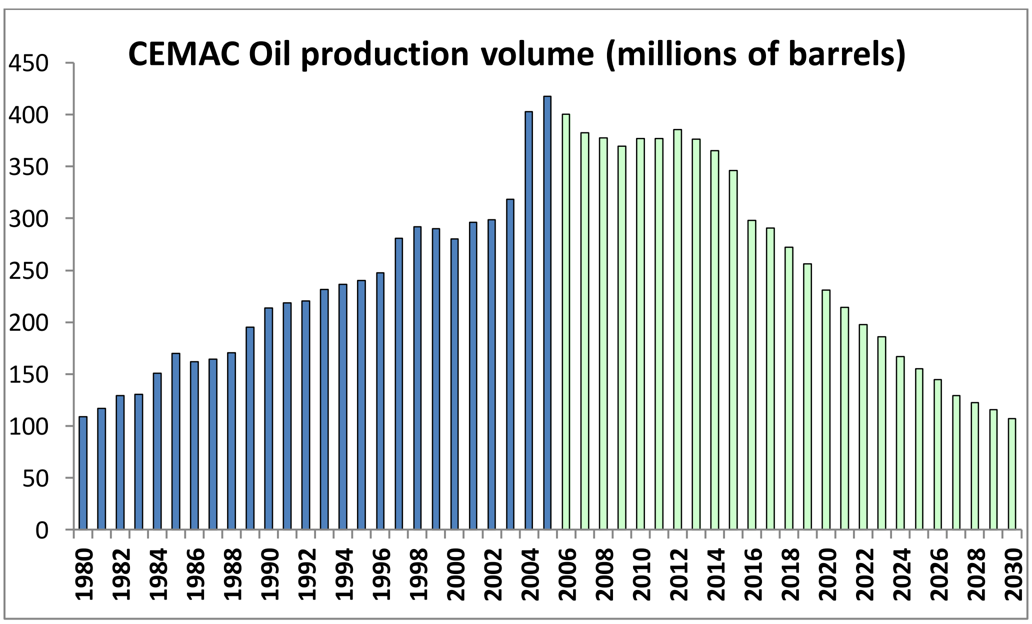
												IMF WEO projection					
	'00	**'01**	**'02**	**'03**	**'04**	**'05**	**'06**	**'07**	**'08**	**'09**	**'10**	**'11**	**'12**	**'13**	**'14**	**'15**	**'16**
Cameroon	5.8	4.8	4.9	4.1	3.9	5.0	6.8	6.4	7.6	4.8	4.5	4.8	5.2	5.4	6.0	5.2	5.0
Central African Republic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	20.8	8.6	17.4	22.7	17.5	16.3	15.9	14.4	13.0
Congo, Republic of	20.3	21.0	18.9	20.8	21.6	31.8	37.9	32.1	40.1	20.7	31.8	37.4	35.8	34.1	29.9	27.1	24.8
Equatorial Guinea	15.3	22.5	22.6	23.2	26.4	31.7	37.5	33.9	34.6	37.1	25.9	25.9	24.5	22.1	20.6	18.6	16.9
Gabon	22.6	21.8	17.7	17.5	16.6	19.8	20.3	17.3	20.9	16.2	15.3	17.1	15.8	15.2	14.4	13.8	13.0
CEMAC	**12.0**	**11.5**	**10.3**	**10.1**	**10.9**	**15.2**	**18.4**	**18.6**	**22.4**	**15.6**	**16.5**	**19.1**	**17.7**	**16.5**	**15.3**	**13.9**	**12.7**

Source: IMF African Department Database and staff estimates

[1] This chapter has benefited from the detailed comments of Bernardin Akitoby, Sharmini Coorey, Cathy Pattillo and Christine Richmond and also from data kindly provided by the African Department of the IMF, especially Mpumelelo Nxumalo and Marcus Poplawski Ribeira. Support from the BP funded Oxford Centre of Analysis of Resource Rich Economies is gratefully acknowledged.

Oil revenue as percent of GDP varies from zero for the Central African Republic to about 17 percent for Gabon, 23 percent for Chad, and 37 percent for the Republic of Congo in 2011. For all these countries figure 1 indicates that CEMAC oil production in millions of barrels has been rising until 2005 and from then on has dropped a bit to 2011 and is projected to fall rapidly during the next two decades. As a result, table 1 shows that CEMAC oil revenue as percent of GDP is projected to fall during the coming years, which is in sharp contrast to a country like Iraq whose oil revenue is projected to last almost forever. This implies that from the point of view of the permanent income hypothesis that, say, Iraq should consume all of their oil windfall whilst the countries of the CEMAC should save a certain fraction to generate sufficient interest on sovereign wealth to finance a sustained increase in consumption. Of course, from a development perspective investing in sovereign wealth (e.g., US Treasury bills with a low rate of interest) seems unlikely to be better than using the oil revenue to pay off foreign debt (on which typically a higher rate of interest to be paid) or invest in domestic infrastructure, education or health projects (with typically a much higher rate of return).

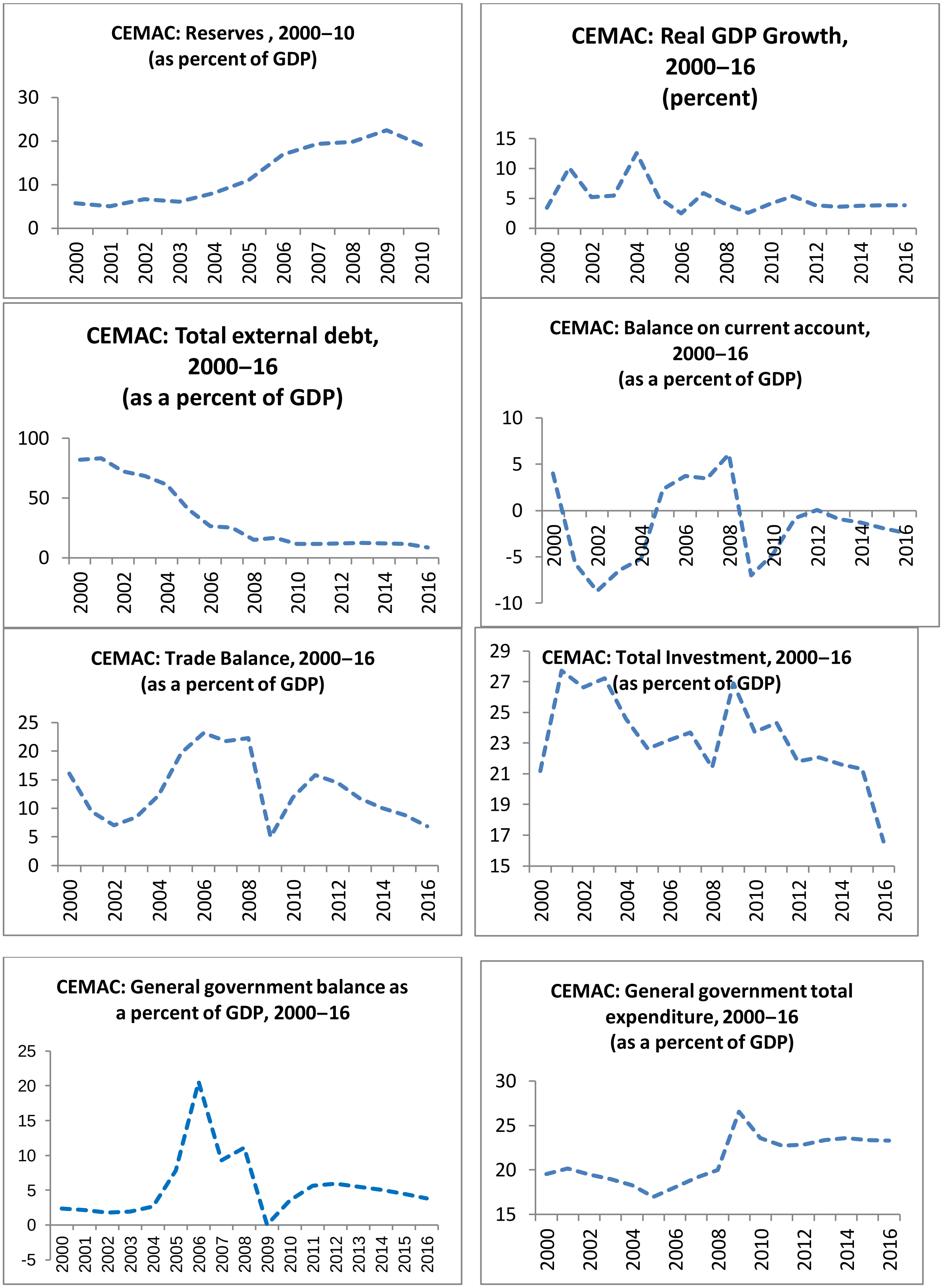
Figure 1: CEMAC oil production



Source: IMF African Department Database and Staff Estimates

Figure 2 is based on the IMF data base including IMF staff projections. It shows that prospects for the CEMAC countries during the coming years are not particularly good even though some reserves have been accumulated in recent years. GDP growth is projected to be flat and very modest and the share of investment in GDP gradually falls. The predictions are for the CEMAC countries imply that the windfall which is projected to continue until 2015/6 is not used so much for investment, but is used to maintain historically high GDP shares of government spending whilst keeping the burden of foreign debt as a

Figure 2: Macroeconomic characteristics of the CEMAC



Source: IMF International Financial Statistics, World Economic Outlook, April 2011, and Staff Estimates percent of GDP fairly low. Trade surpluses are expected to fall as oil revenue flattens out. Despite project surpluses for the trade balance and falling foreign debt, the current account is projected to show modest deficits. Government budgets are also projected to stay in modest surplus.

The key question is whether the CEMAC countries could have harnessed their oil windfalls better and whether they can do better as their streams of oil revenue is expected to decline. After all, controlling for initial income per capita, investments in physical and human capital, trade openness, and rule of law, natural resource dependence (measured by the ratio of natural resource exports to GDP) has a strong and significant negative effect on growth of GDP per capita (column 1, table 1). Ceteris paribus, an increase in the ratio of resource exports to GDP of 10 percentage points depresses average growth in GDP per capita by 1.1 percent per annum. However, there is empirical support for the hypothesis that countries with good institutions receive a positive growth effect from resource dependence, while those with bad institutions are adversely affected. Increasing the ratio of natural resource exports to GDP by 10 percentage points increases average growth by a mere 0.1 percent per annum in countries with good institutions (a weighted index of various indicators measured on a scale from zero to one) but decreases annual growth by 1.43 percent in countries with bad institutions (column 2, table 1). The very small effect of windfalls on growth if institutions are good suggests that the effect of institutions on growth may well be asymmetric in the sense that windfalls hurt economic performance if institutions are poor but do not *necessarily* improve performance if institutions are good. It has also become clear that volatile commodity prices are a key driver of the natural resource curse; natural resource dependence, unrestricted international capital flows, being landlocked and ethnic tensions boost volatility of per-capita growth and thus depress growth prospects (van der Ploeg and Poelhekke (2010).[2]

Table 2: Cross-country empirical evidence for the natural resource curse

Annual growth in real GDP per capita	Sachs and Warner (1997)	Mehlum, Moene and Torvik (2006)
Initial income	-1.76 (8.56)	-1.26 (6.70)
Openness	1.33 (3.35)	1.66 (3.87)
Resource dependence	-10.57 (7.01)	-14.34 (4.21)
Rule of law	0.36 (3.54)	-
Institutional quality	-	-1.3 (1.13)
Investments	1.02 (3.45)	0.16 (7.15)
Interaction term	-	15.40 (2.40)
Number of countries	71	87
Adjusted R^2	0.72	0.71

[2] A detailed survey of the evidence for and causes of the natural resource curse is given in van der Ploeg (2011a).

The fundamental problem faced by the oil-rich economies of the CEMAC is how to transform their oil wealth into a portfolio of other assets – human capital (education and health), domestic physical capital (both private and public), and perhaps also foreign financial assets – that yield a continuing and growing flow of income to their citizens. The World Bank's (2006) estimates of *adjusted net* saving or *genuine* saving[3] provide a measure of the extent to which many oil-rich countries have failed to do this and the CEMAC countries unfortunately do not appear to be an exception: the oil-rich Cameroon, Republic of Congo and Equatorial Guinea have negative saving rates of -2.5%, -14.6% and -35.7%, respectively; the Central African Republic has no oil, but has a slightly positive genuine saving rate of 0.5%. This suggests that the CEMAC countries were not effectively transforming their oil wealth into productive assets. A country which was successfully transforms its oil reserves into physical, human or financial capital or sovereign wealth does not run down its genuine natural wealth. Unfortunately, it seems that the CEMAC countries have not been successful at this transformation and eyeballing the projections presented in figure 1 suggests that genuine saving rate may have even become more negative in recent years. Indeed, negative genuine saving rates have been quite persistent for large parts of sub-Saharan Africa indicating that these countries have been running down their national wealth.

To address the question of how the oil-rich CEMAC countries can successfully transform their oil wealth into productive assets and harness their oil windfalls for economic development, we will offer a theoretical framework for harnessing oil revenue windfalls.[4] We first discuss the benchmark which corresponds to the orthodox view of putting all the revenue from depleting oil wealth in a sovereign wealth fund. We then proceed by arguing that a case should be made for investing in the domestic economy rather than investing exclusively in a sovereign wealth fund, because many developing economies face the twin problem of capital scarcity and declining efficiency as public investment in physical and human capital (i.e., infrastructure including health and education) is ramped up. We then refine our argument by making the case for 'investing to invest' which is necessary to overcome the absorption problems resulting from Dutch disease and the putty-clay nature of much of private and public capital. Since absorption problems may be most acute in the short run, it may be wise to temporarily park some of the oil revenue in a sovereign wealth until the economy has sufficient capacity to satisfy the boost to demand for investment and consumption goods. Finally, we summarize with a brief policy conclusion.

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[3] These add to the usual definition of saving a measure of education spending to reflect investment in human capital, and subtract depreciation of physical and human capital, the use of natural resources (making special allowances for renewable resources such as fish and forests) and the deterioration in environmental quality (mainly arising from CO_2 and fine particles pollution).

[4] This is based on earlier work (Collier et al., 2009; van der Ploeg and Venables, 2011abc; van der Ploeg, 2011b).

1. Benchmark: Put oil revenue in a sovereign wealth fund

The orthodox policy view has been to save the windfall in a sovereign wealth fund and live of the interest on the fund afterwards (e.g., Barnett and Ossowski, 2003). This view gives rise to the *bird in hand* policy, which leads to no increase in consumption ahead of the windfall and a gradual buildup of consumption during the windfall. After the windfall, the sovereign wealth fund is gradually depleted which leads to a gradual withering away of the earlier increases in consumption. If future oil revenue can be used as collateral for borrowing, one obtains the *permanent income* policy which amounts to borrowing ahead of the windfall and paying off the debt and accumulating a sovereign wealth fund sufficient to sustain a permanent increase in consumption during the windfall. Although the bird in hand policy is often advocated on grounds of prudence, the volatility of consumption compared with the permanent income policy leads to large welfare losses.

To illustrate the permanent income rule and how much of the oil windfall to save and how much to consume, we thus suppose that households receive exogenous production income Y and government transfers or citizen dividends T and have no access to the international capital market, so that their consumption is $C = Y + T$. All foreign assets A are held by the government and earn a return equal to the world interest rate r. The economy's budget constraint is thus given by:

(1) $$\dot{A} = rA + N + Y - C = rA + N - T, \quad A(0) = A_0,$$

where N is the size of the exogenous oil windfall. The first part of (1) says that the current account must equal the increase in assets of the nation; the second part indicates that the government surplus equals the increase in government assets. The size of the sovereign wealth fund of this economy is thus indicated by A. The present value of the oil windfall plus sovereign wealth should cover the present value of government transfers. Alternatively, we have:

(2) $$Y_P(t) + N_P(t) + rA(t) = r\int_t^\infty e^{-r(s-t)}C(s)ds, \quad N_P(t) + rA(t) = r\int_t^\infty e^{-r(s-t)}T(s)ds,$$

where the permanent values of production income and the oil windfall are given by, respectively, $Y_P(t) \equiv r\int_t^\infty e^{-r(s-t)}Y(s)ds$ and $N_P(t) \equiv r\int_t^\infty e^{-r(s-t)}N(s)ds.$ In situ oil wealth is N_P/r. Private utility is:

(3) $$\int_0^\infty \frac{C(t)^{1-1/\sigma} - 1}{1-1/\sigma} e^{-\rho t} dt,$$

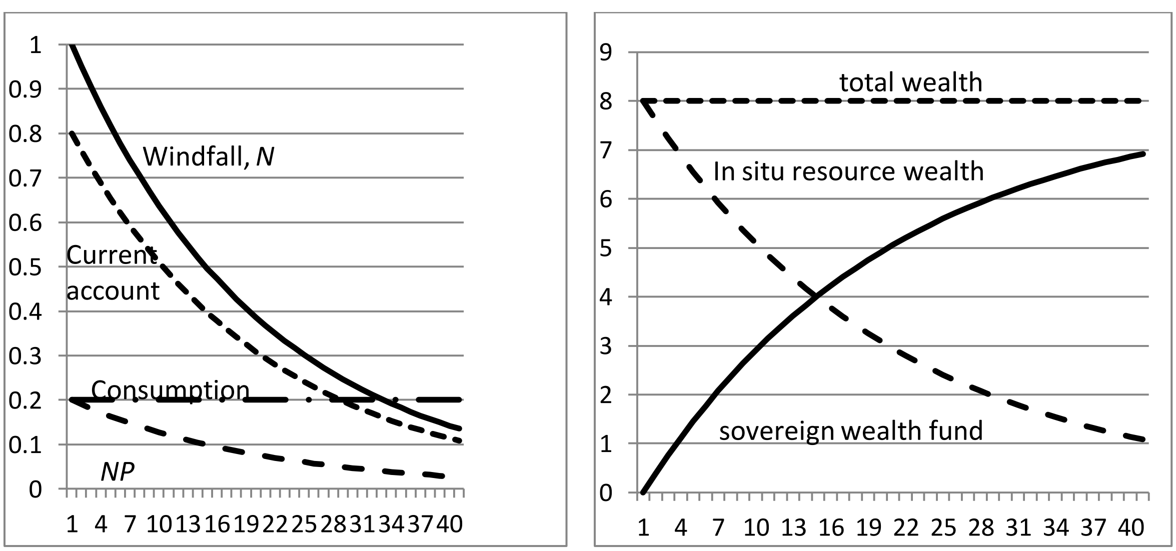
where $\rho = r > 0$ is the rate of time preference and $\sigma > 0$ is the coefficient of intertemporal substitution. The government chooses the time paths of government transfers and saving to maximize private utility (3) subject to the budget constraints (1) and (2). This yields optimal consumption and government transfers:

$$(4) \qquad C = Y_P + N_P + rA, \quad T = N_P + rA - (Y - Y_P).$$

Government transfers and thus private consumption respond to the permanent and not the actual oil windfall. This is achieved this by borrowing ahead of a windfall, saving during the windfall, and financing the sustained increase in transfers and consumption after the windfall by the interest on the accumulated sovereign wealth fund. The government surplus and current account thus respond to the temporary component of the windfall, $\dot{A} = N - N_P + Y - Y_P$. The non-windfall primary deficit $(N - \dot{A})$ is driven by the permanent component of the windfall.

If oil revenue declines exponentially at an annual rate of 10 percent and $r = 0.025$ (as indicated by the solid line in the left panel of figure 3), one fifth of the windfall is the permanent component, which is consumed (as indicated by the flat long-dashes-and-dots line in the left panel of figure 3), and four fifths is saved in sovereign wealth and shows up in temporary current account surpluses (as illustrated by the short-dashes in the left panel of figure 3). We also see that as oil wealth is depleted (as indicated by the declining long-dashes line in the right panel of figure 3 or the falling permanent oil income line indicated by *NP* in the left panel of figure 3), the permanent-income rule builds up corresponding sovereign wealth (as indicated by the rising solid line in the right panel of figure 3) to leave total wealth unaffected (as indicated by the flat short-dashed line in the right panel of figure 3). This way one ensures a sustained increase in the consumption of citizens.

Figure 3: Permanent income prescription for a temporary windfall



The orthodox bird-in-hand and permanent-income policy rules are popular and may be suited to the interests of mature oil rich economies, but are wholly unsuitable for the countries of the CEMAC. In developing economies the separation theorem, which states that domestic investment decisions should be completely independent of domestic saving and windfalls of foreign exchange, is simply not valid as they are face capital scarcity and are not well integrated into world financial markets (van der Ploeg and Venables, 2011c). For developing economies, we thus need to depart from the partial equilibrium framework and confront the arduous task of harnessing oil revenue for growth and development. Before we turn to that, we discuss the problems of capital scarcity and the inefficiency caused by ramping up public investment in physical and human capital in developing economies.

2. Two big obstacles: capital scarcity and inefficiencies from ramping up public investment

The CEMAC countries face two big obstacles for economic development and any strategy for harnessing oil windfalls must tackle these obstacles. The first obstacle is that these countries are badly integrated into international capital markets. Borrowing for domestic investment, typically, requires payment of a much higher interest rate than the world interest rate. This is pity, since there are many public investment projects, both physical infrastructure and human capital such as education and health, which could generate a much higher rate of interest than the world interest rate. To capture this, we draw on previous empirical work that finds that the interest premium increases with the degree of capital scarcity and decreases with the ability to pay as measured by the size of the oil windfall (Akitoby and Stratmann, 2008). We have estimated a semi-elasticity of the natural log of the spread with respect to the debt-GNI ratio of 1.9. This implies that a 10%-point increase in the debt-GNI ratio pushes up the interest differential by 6.9%-points if the economy starts out with a debt-GNI ration of 100 percent (or 1.3%-points if it starts off with zero foreign debt). In as far as oil income is part of GNI, it makes it easier for the country to service its debt and thus credit worthiness will be higher.[5] In earlier work we have showed that this empirical finding implies that is necessary to depart from the permanent-income policy by hiking up consumption less strongly, using the remainder of the windfall to alleviate capital scarcity and gradually boost investment in the domestic economy, and thus speed up the process of economic development (van der Ploeg and Venables, 2011a).[6] We will in section 3 use these ideas to examine the

[5] Our cross-country empirical evidence suggests a very weakly significant direct positive effect of natural resource exports on interest rate spreads indicating, if anything, that resources *worsen* credit worthiness. This may be due to the adverse impacts of resources on governance, political stability and the risk of conflict.

[6] The oil windfalls of some CEMAC countries yield substantial revenue, but are declining. Hence, the CEMAC oil windfalls are insufficient to pay off the whole external debt and remove the problem of capital scarcity altogether.

optimal public investment paths after an oil windfall in a framework which also deals with the second obstacle.

The second obstacle for economic development is that using an oil windfall to rapidly scale up public investment runs into the problem of absorption constraints. Due to capacity, institutional, legal and training constraints, it takes time to efficiently implement public investment projects, both in infrastructure and human capital. As public investment can be half or more of total investment in developing economies, this is a serious constraint on potential growth. It takes a long time to recognize, implement and realize a public investment project, especially if it is a larger project. For example, making a large part of land suitable for modern agriculture, which requires investments in large-scale irrigation, may require many years of negotiation with local chiefs to get permission to use the land for this purpose. It may take years before the bureaucracy, local government and national government agrees to undertake a particular project. There may also not be sufficient capacity to supply the necessary investment goods. For all these reasons, not all the amount of money that is spent on public sector investment will result in increases in the public sector capital stock and public investment will be more costly in the early stages of economic development when interest rates are high. Recent studies suggest that of spending on public investment only 40 to 60 percent gets delivered and leads to effective accumulation of public sector capital and low-income countries such as the CEMAC countries are likely to be at the lower end of this range (Dabla-Norris et al., 2011). This can seen from the so-called public investment management index (the *PIMI*), which is defined as the ratio of the part of public investment that yields effective public sector capital accumulation to total spending on public investment. The *PIMI* data are obtained from asking survey questions about the effectiveness of project appraisal, selection, implementation and evaluation in many countries. The *PIMI*s that result from these detailed country-level data are then aggregated for 40 low-income, 31 middle-income and all these 71 countries and presented in table 3 for the period 2007-10. Table 3 indicates that on average only about half of public investment effort translates into productive public capital.

Table 3: Public Investment Management Index (*PIMI*) by income group

	PIMI	Appraisal	Selection	Implementation	Evaluation
Low income	0.47	0.21	0.28	0.30	0.20
Middle income	0.57	0.21	0.30	0.28	0.22
All countries	0.51	0.21	0.29	0.29	0.21

Source: Dabla-Norris et al. (2011)

The *PIMI* captures the four stages of the investment process: (i) project appraisal; (ii) project selection; (iii) project implementation; and (iv) project evaluation. Since not all spending on public investment results in public capital, it can be calculated that the *PIMI*-adjusted measure of public capital is only 30 percent of GDP compared with 71 percent for the unadjusted measure of public capital in low-income countries (Dabla-Norris et al., 2011). The big falls in adjusted public capital in low-income countries is due to the low efficiency of new investments; in middle-income countries it has been offset by large investment efforts. This contrasts sharply with the rise in the unadjusted measure of public capital. Interestingly, despite much of sub-Saharan Africa including the CEMAC countries having very high investment rates, many projects have not delivered the results for growth and welfare that were expected (e.g., Tabova and Baker, 2011). But if the efficiency-adjusted measure of public sector capital is used, cross-country empirical evidence suggests that public capital is a significant determinant of economic growth (Gupta et al., 2011).

In line with table 3, we suppose that the public investment management index (*PIMI*) is roughly 0.47. As the rate of public sector investment is ramped up, the efficiency of public investment deteriorates (cf., Berg, et al., 2011). To capture this, we introduce internal costs of adjustment for public investment and calibrate the adjustment cost coefficient in such a way that the economy replicates the investment rates and *PIMI* of the low-income countries. We can do this, because internal costs of adjustment of public investment also capture the increasing cost occurred when rapidly scaling up public sector investment (van der Ploeg, 2011b). This captures that absorption problems frustrate rapid economic development when scaling up public investment. Internal costs of adjustment and the *PIMI* also generate bigger returns on public investment and thus a more realistic calibration of the model to developing economies. We calibrate our model to the low-income countries and section 3 shows the optimal way of harnessing a temporary windfall in a small economy suffering from capital scarcity.

3. Capital scarcity: use oil revenue to boost public investment

In the developing countries of the CEMAC the aforementioned separation theorem does not hold. Optimal public investment does depend on available finances and thus on the size of the oil windfall. It would thus be a serious mistake for the CEMAC countries to put all oil revenue in a sovereign wealth fund when domestic investment needs are so high. To illustrate the differences between a strategy designed to harness oil revenue of economic development and a permanent-income rule, we offer some policy simulations of the same temporary oil windfall discussed in section 1. These policy simulations assume again that the world interest rate and discount are 2.5 percent, and in addition assume that the depreciation rate of public investment is 2.5 percent per annum (corresponding to an expected lifespan of public projects of 40 years), a production elasticity of public capital of 0.17 (as the ballpark estimate reported in Bom and Ligthart (2010)), shares of labor and private capital in value added of 0.7 and 0.3, respectively, and an elasticity of intertemporal substitution σ equal to 0.5. Furthermore, the policy simulations suppose a PIMI of 0.47 and a semi-elasticity for the debt-GNI ratio on the natural log of the interest spread of 1.9 as discussed in section 2. For sake of concreteness, we suppose that the economy starts off with an initial debt-GDP ratio of 100 percent and an initial public sector capital stock equal to 30 percent of GDP, and that the current size of the oil windfall is equal to current GDP. We suppose that all private capital is foreign direct investment for which the world rate of interest is the main determinant.

For public investment, the much higher domestic rate of interest is the main determinant. The public investment rate is given by $I/S = (q-1)/\phi$, where I is public investment, S is the efficiency-adjusted stock of public capital, q is the value of public investment and $\phi = 34.4$ is the adjustment cost parameter which is calibrated to fit a *PIMI* of 0.47. Total spending on public investment includes internal adjustment costs and is given by $J = I + 0.5\,\phi\, I^2/S$. In the steady state we have a *PIMI* of $I/J = 1/(1+0.5\phi\delta) = 0.70,$ but in the early stages of development only 47 percent of investment outlays are delivered as current public investment rates (I/S) are much higher. The value of public investment q follows from the arbitrage equation, which says that the increase in private output plus the reduction in internal adjustment costs resulting from a marginal increase in the efficiency-adjusted public capital must equal the rental charge plus the depreciation charge minus the expected rate of change in the value of public capital.

Maximizing utility (3) subject to the equations describing asset dynamics and public capital dynamics, $\dot{S} = I - \delta S,$ yields the following two optimality conditions (see for more detail van der Ploeg (2011b)):

(5) $$\dot{C} = \sigma C\left[\Pi\left(\frac{D}{ES^{\beta}+N}\right) + \Pi'\left(\frac{D}{ES^{\beta}+N}\right)\frac{D}{ES^{\beta}+N}\right], \quad C(0)\text{ free},$$

(6) $$\dot{q} = \left[r^{*} + \Pi\left(\frac{D}{ES^{\beta}+N}\right) + \Pi'\left(\frac{D}{ES^{\beta}+N}\right)\frac{D}{ES^{\beta}+N} + \delta\right]q - (1-\alpha')\beta ES^{\beta-1} - \frac{1}{2\phi}(q-1)^2 - \beta ES^{\beta-1}\Pi'\left(\frac{D}{ES^{\beta}+N}\right)\left(\frac{D}{ES^{\beta}+N}\right)^2, \quad q(0)\text{ free},$$

whilst the reduced-form debt and public capital dynamics are given by

(7) $$\dot{D} = \left[r^{*} + \Pi\left(\frac{D}{ES^{\beta}+N}\right)\right]D + C + \frac{1}{2\phi}(q^2-1)S - ES^{\beta} - N, \quad D(0) = D_0,$$

(8) $$\dot{S} = \left[\frac{1}{\phi}(q-1) - \delta\right]S, \quad S(0) = S_0,$$

where non-oil output is given by the production function $Y = E'K^{\alpha'}S^{\beta'}, \quad 0 < \alpha' = 0.3 < 1, \quad \beta' = 0.17 > 0,$ with K indicating private capital (FDI) or, equivalently, the reduced-form production function $Y = ES^{\beta}$ with $E \equiv E'^{\frac{1}{1-\alpha'}} \left(\frac{\alpha'}{r+\mu} \right)^{\frac{\alpha'}{1-\alpha'}}, \quad \beta \equiv \frac{\beta'}{1-\alpha'} > \beta',$ and μ indicating the depreciation rate of private capital.

Equation (7) is the upward-sloping Keynes-Ramsey rule (also known as the Euler rule) for the growth in consumption responding to the gap between the social interest rate and the rate of discount. Note that growth in consumption responds positively to the interest premium on debt, $\Pi(D/Y), \Pi' > 0,$ so that it is optimal to consume less and pay off debt. Of course, the interest premium on debt should not be taken too literally, but should be seen as a metaphor for capital scarcity.[7] Equation (8) is the arbitrage equation for public investment which states that the social user cost of public capital consisting of the social interest charge plus depreciation charge minus the expected rate of increase in the social value of public capital must equal the marginal product of public capital plus the marginal reduction in adjustment costs.

Equations (5)-(8) fully describe the model of capital scarcity, public investment and windfall revenue management. They can be solved with a multiple shooting algorithm. Of course, the policy simulations can easily be done for each CEMAC country with the specific coefficients and parameters describing their oil windfall, but the qualitative features will be like the ones we are about to discuss. One caveat should be made: the simulations set out with a relatively large government debt whilst the CEMAC countries have almost no government debt. The simulations are thus meant to be purely illustrative with government debt not indicating so much the burden of government debt but rather the extent of the capital scarcity problem many developing countries face. A proper calibration to the CEMAC countries must be left for another occasion or one should refer to the more careful empirically calibrated analysis of Berg et al. (2011).

Figure 4 presents the simulations, where the dashed lines indicate the no-windfall paths and the solid lines the paths with a temporary windfall. The difference between the solid and the dashed lines indicate the effects of the windfall. We see from figure 4 that the oil windfall speeds up the process of economic development, because the efficiency-adjusted public capital stock and thus production rise much more quickly towards their unchanged steady-state values. The temporary public sector investment boom is

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[7] Using the empirical estimate of 1.9 for the semi-elasticity of the natural log of the spread with respect to the debt-GNI ratio (van der Ploeg and Venables, 2011), we specify $\Pi(d) = 10^{-4} \exp(6.294) \;\exp\; 1.9d \;\; -1$ for the interest spread schedule where 6.294 is the mean log of the spread. This implies that a 10%-point increase in the debt-GNI ratio pushes up the interest differential by 6.9%-points if the economy starts out with a debt-GNI ration of 100 percent (or 1.3%-points if it starts off with zero foreign debt).

triggered by a temporary spike in the value of public sector capital fuelled by the oil-induced boom in demand. This also leads to a temporary boost to consumption. The public investment boom has three noticeable features. First, on impact the social value of capital jumps and thus the rate of public investment jump up discretely and thus the *PIMI* jumps down on impact discretely.[8] Second, ramping up public investment worsens absorption constraints and increases the inefficiency of public investment (see the substantial and persistent falls in the *PIMI* triggered by the windfall-induced investment boom). Third, net government assets (i.e., the value of public capital, qS, minus sovereign debt) are *not* predetermined, because the shadow value of public capital jumps up on impact from 2.36 to 3.19. Although it is a small initial jump in the value of net government assets, the initial jump from 2.36 to 3.19 in the value of public capital is considerable.

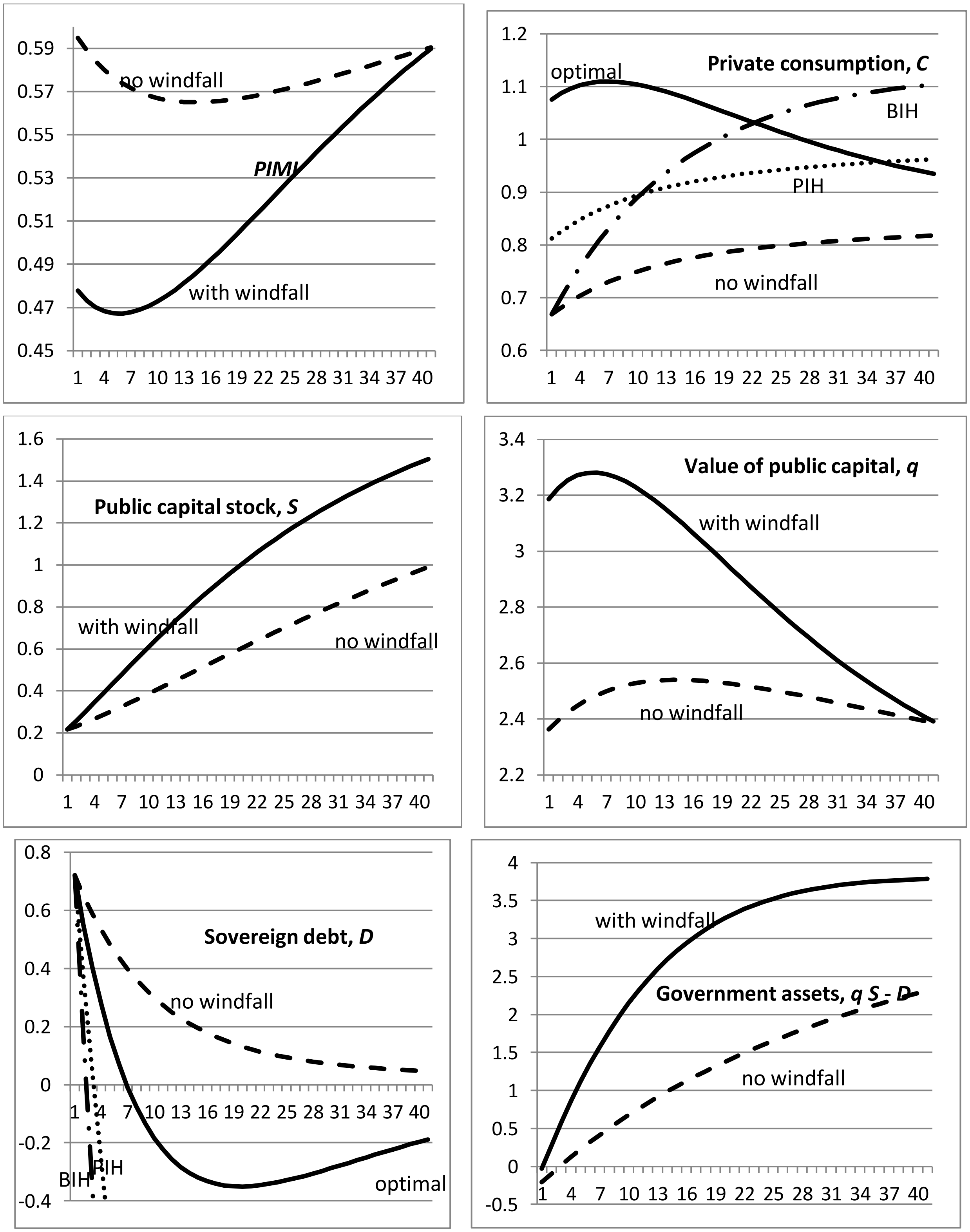
The boom in public sector investment is associated with bigger government surpluses. This results in more rapid and substantial drops in sovereign debt which rapidly turn into sovereign wealth. This brings down interest spreads and the cost of borrowing, which gives the government more scope to hand out transfers to its citizens and to ramp up public sector capital despite the lower efficiency of public sector investment. An interesting feature of the no-windfall simulations reported in figure 4 is that the shadow value of public capital, q, and thus the public sector investment rate, $(q-1)/\phi$ (which is thus proportional to q), and the *PIMI* overshoot. This reflects an initial phase in the development process where the value of public capital and the investment rate rise, and the PIMI falls before these movements are reversed further along the development path. In the windfall simulations private consumption overshoots as well, so that in the initial phases consumption is kept low and rises gradually in order to make room for a rapid rise in public investment.

4. Using oil for investing to invest is much better than the permanent-income or bird-in-hand rule

Oil windfalls can alleviate capital scarcity and thus boost public investment. This is in sharp contrast to the separation result that prevails in the permanent-income rule discussed in section 1, which is relevant for countries that are well integrated into world capital markets and do not suffer from capital scarcity. The permanent-income rule is a partial-equilibrium rule, since no account is taken of the effects of the oil windfall on wages, prices and exchange rates and quantity variables. The optimal policy rule does take account of general-equilibrium interactions, albeit that it is a one-sector model and thus only relative *intertemporal* prices (i.e., the interest rate) matters whilst relative *intratemporal* prices (such as the real

[8] If there are also adjustment costs in changing the rate of public investment (rather than adjustment costs for the stock of public capital), there would be no discrete jumps on impact in public investment or the *PIMI*.

Figure 4: Harnessing windfall with capital scarcity and rising cost of ramping up public investment



Key: Dashed = no windfall; solid = optimal; dotted = PIH rule; dashed-dotted = BIH rule exchange rate or the relative price of non-tradables) do not play role (see section 5 for a brief discussion of the effect of oil windfalls on relative intertemporal prices and Dutch disease effects).

Figure 4 also compares the optimal investing-to-invest rules (indicated by solid lines) with the permanent-income rule (indicated by the dotted lines in the private consumption and sovereign debt panels). Under the permanent-income rule the increment in private consumption equals the permanent value of the windfall at the time the windfall starts, i.e., 0.144. Over time the return on in-situ oil wealth (i.e., the permanent value of the oil windfall) falls while the increase in interest income on the balance of the sovereign wealth fund rises by an equivalent amount until it has reached 0.144 – see the right panel of figure 3. However, the enormous boost to sovereign wealth under the permanent-income rule does not boost economic development, since public capital, private capital inflows and non-oil production are assumed exogenous under this application of the permanent-income rule. The oil windfall under the permanent-income rule does sustain a permanent boost to government transfers and thus to consumption, but fails to put oil funds into public investment.

During the initial phases, the optimal strategy (see the solid lines in figure 4) puts much less in sovereign wealth or paying off government debt and thus leads to a much bigger increase in private consumption than the permanent-income rule (indicated by the steeply falling dotted line in the left-bottom panel of figure 4). After about 35 years the consumption increment under the optimal strategy falls below that under the permanent-income rule. The optimal strategy thus permits much more consumption upfront and leads to a boost in public capital rather than putting much needed revenue in a sovereign wealth fund. Application of the permanent-income rule to developing countries such as those in the CEMAC is far from optimal, does not boost development, and does not serve the interests of citizens.

The dashed-dotted lines in figure 4 show the impact on consumption and sovereign wealth if the bird-in-hand rule is used (again not taking account of the general-equilibrium) interactions. Now all windfall revenue is accumulated into a sovereign wealth fund, and no transfers and boosts to private consumption are allowed until sovereign wealth is accumulated. The withdrawal rate is 4 percent from the balance of the fund (as in Norway). Consumption does not jump on impact and rises only gradually. Eventually it reaches a higher value of private consumption than under the permanent-income rule before falling back to the no-windfall path in the very long run. The bird-in-hand rule performs even worse than the permanent-income rule. It does not offer any prospect for improved economic development and gives bigger consumption increments than the permanent-income rule only after ten years and higher consumption increments than the optimal rule only after 23 years before dropping off to zero in the very long run.

The celebrated Hartwick rule states that any depletion of subsoil oil assets must be exactly offset by accumulation of other assets such as sovereign wealth and public, private or human capital. In other words, genuine saving must be zero. Indeed, for the permanent-income rule figure 3 indicates that the optimal accumulation of sovereign wealth exactly equals the decline in oil wealth, so that genuine saving is indeed zero. In contrast, the bird-in-hand rule which is more conservative than the permanent-income rule in that it only consumes a fraction of the stock of accumulated wealth. The bird-in-hand rule therefore has excessive accumulation of sovereign wealth which gives rise to *positive* genuine saving increments. However, developing economies with capital scarcity and increasing costs of ramping up public investment require *negative* genuine saving increments to speed up the process of growth and development so that the positive increment in net assets (public capital minus sovereign debt) at each point of time is less than the negative increment in subsoil wealth.

Another reason for negative genuine saving is anticipation of better times which occurs if oil exporters anticipate either future reductions in the costs of extracting oil or future increases in the world oil price. It is then better to borrow on the international capital market and postpone oil depletion so that oil can be extracted more cheaply or fetch a higher price. There is then genuine dissaving equal to the sum of expected extraction cost reductions and expected capital losses on subsoil oil wealth.

The simulations presented in figure 4 are meant to be an illustration of the main *qualitative* policy message: it is better to have an investing-to-invest policy than a naïve application of the permanent-income or bird-in-hand rule for developing countries facing capital scarcity and big domestic investment needs. To get a better *quantitative* understanding of the policy message for the CEMAC countries, at least three adjustments need to be made. First, it is better to take account of the country characteristics of each member state of the CEMAC when designing the optimal policy response. For example, the Central African Republic has no oil at all. Second, the size and duration of the windfall for each oil-rich CEMAC country may vary and will generally be a factor four or so smaller than the windfall reported in figure 4. Although this will make the effects on growth correspondingly smaller, the effects for the country will still be substantial. Third, and most important, a clear distinction must be made between *capital scarcity* and *sovereign debt*. Although figure 2 indicates that the CEMAC countries have little sovereign debt, they still suffer from capital scarcity as the interest rate that has to be made on domestic investment projects as well as the potential return on such projects is, typically, much higher. Hence, the policy messages derived from figure 4 also apply to a capital-scarce country with almost no sovereign debt. What is required to capture this adequately is that the functional specification of the interest rate premium is modified to $\Pi = \Pi\left(\frac{D}{Y+N} + \Delta\right), \Pi' > 0,$ where the constant $\Delta > 0$ indicates capital scarcity reflected in an interest premium even in the absence of sovereign debt.

5. Absorption problems and Dutch disease: temporarily park oil revenue in a fund

No absorption problems arise if public capital can be imported from abroad or if airports, roads, etc. are delivered by foreigners (as the Chinese have often done in Africa and Brazil). However, for most developing economies of the CEMAC this is not an option as most investment goods will have to be produced at home. One needs nurses to train nurses, teachers to train teachers, roads to make further roads, and not all of these jobs can be done by importing Chinese labor and capital. Furthermore, there will be political pressure to create jobs for local people. So given that oil windfalls will be geared towards domestic consumption and investment, they will boost demand and put pressure on the non-traded sectors to expand and thus lead to hikes in the price of non-tradables and reallocation of labor and capital from the traded to the non-traded sectors (Corden and Neary, 1982). The bird-in-hand policy and the permanent-income policy fail to deliver an optimal response to such Dutch disease effects as they are derived from a partial-equilibrium framework and do not take account of changes in real interest rate or exchange rates. It may be optimal to smooth the appreciation of the real exchange over time and thus have a small, long-lasting rather than a large, temporary decline of the traded sectors. Allowing for habit persistence in preference allows for some 'addiction' to high levels of public spending even after the windfall has ceases, and may help to explain the volatile behavior of real exchange rates.

The optimal public investment and real exchange rate strategy in a fully specified general-equilibrium, two- or three-sector model of a small open economy must take account of capital scarcity and a rising cost of public investment. The optimal response should also take account of the need to 'invest to invest'. Developing countries need teachers to train teachers, nurses to train nurses, and roads to make roads. Home-grown capital produced by the non-traded sector rather than imported from abroad is thus needed for successful economic development, but such capital takes time to deliver and leads to a different set of temporary absorption problems in the non-traded sector. In such a setting it is optimal to *temporarily* park some of the oil windfall in a sovereign wealth fund until the non-traded sectors are able to deliver the investment goods necessary for economic development (van der Ploeg and Venables, 2011b). Tackling the problem of scaling up investment, as discussed in sections 2 and 3, implies that more oil revenue has to be parked temporarily in a sovereign wealth fund.

Detailed policy simulations are reported in van der Ploeg (2011b). They show that the price of non-tradables jumps up on impact of the news of the oil bonanza. Over time, as labor shifts from the traded to the non-traded sector, the capacity of the non-traded sector expands. The stock of public capital expands and, as the demand for non-tradables is met, the initial appreciations of the real exchange rate are undone. The absorption constraints resulting from Dutch disease are more severe if a greater part of consumption and public investment has to be produced at home. It then takes much longer for the economy to move along its development path. Again, the efficiency of public investment is reduced considerably as public investment is ramped up, which aggravates the absorption constraints resulting from Dutch disease, and the windfall is also used to bring down sovereign debt more quickly. The oil bonanza increases both consumption of non-tradables and tradables, but output of tradables falls considerably to make room for a boost to non-tradables output. The oil windfall finances the resulting current-account deficits and the more rapid reduction in sovereign debt.

Given a putty-clay technology for public capital, public investment can be done in either the non-traded or the traded sector but public capital cannot be shifted between sectors once installed. The only way the non-traded sector can expand if all capital is used in the tradables sector is for the traded sector to gradually wind down its stock of public sector capital stock via wear and tear and thus bring down its stock of private capital and release labor which can then move to the non-traded sector. This adjustment mechanism also leads to temporary appreciations of the real exchange rate and a gradual reallocation of workers from the traded to the non-traded sector, but the root cause of it is wholly different if public sector capital is only used in the non-traded sector as in the simulations of figure 4. Whether the Dutch disease dynamics is primarily driven by winding down capital in the traded sector or by increases in the price of non-tradables and sectoral relocation depends on whether the traded or the non-traded sector is capital intensive. A detailed analysis of these two adjustment mechanism of Dutch disease, i.e., gradual accumulation of home-grown capital versus the gradual erosion of capital in the trade sector, is much more fully analyzed within a comprehensive theoretical model in van der Ploeg and Venables (2011b).

6. Conclusion

It would be unwise for the oil-producing countries of the CEMAC to put their already declining oil windfalls in a sovereign wealth fund according to a permanent-income or bird-in-hand rule. The main concern of the CEMAC countries is to boost economic development, not to engineer a sustained increase in consumption financed out of interested on US Treasury bills. The CEMAC countries main challenges are to deal with, on the one hand, the problem of capital scarcity, and, on the other hand, the problem of declining inefficiency of investment projects in public infrastructure, health and education as public investment projects are scaled up using what is left of the oil bonanza in these countries. It is far better for the CEMAC countries to use their oil bonanza to gradually ramp up public investment, tolerating a temporary fall in the efficiency of public investment, and gradually boost the efficiency-adjusted stock of public capital and non-oil output. As a result of this strategy wages and consumption rise in the initial phases of economic development much more than under the permanent-income or the bird-in-hand rules. The optimal policies for harnessing the oil bonanza require negative genuine saving so that the positive increment in net assets (public capital minus sovereign debt) at each point of time is less than the negative increment in subsoil oil wealth.

In practice, absorption constraints are aggravated as private demand and especially public sector demand have a strong bias for non-traded products. This results in appreciation of the real exchange rate and Dutch disease. Nevertheless, this optimal harnessing strategy yields a sustained increase in private consumption and non-oil gross national product. The bigger the component of public capital that has to be home grown, the bigger the absorption constraints. This is the challenge of ‘investing to invest’.

Important inputs into the decision-making process can be obtained from financial programming models and from full-scale empirically calibrated dynamic stochastic general equilibrium models of oil-rich developing economies. This allows a richer derivation of optimal policy proposals for managing oil windfalls, especially on how much of the windfall to consume upfront, how much sovereign debt to redeem or sovereign wealth to accumulate and most importantly how much investment in public infrastructure, health and education to undertake, and how the optimal response is affected by changes in the real exchange rate and Dutch disease effects. The crucial point is that the prevalence of macroeconomic and microeconomic absorption constraints in ramping up investment in public infrastructure and human capital requires oil-rich, developing countries to temporarily park part of their oil windfall in a sovereign wealth fund.

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