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Managing (Fiscally) Resource Price Volatility

Exploring Policy Options for the Democratic Republic of Congo

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Abstract

How should resource-dependent countries respond (fiscally) to resource price volatility? This paper studies what determines revenue allocation between a "spend today" strategy and a "save now-spend tomorrow" approach in the context of the Democratic Republic of Congo (DRC). It uses a three-sector model in which public infrastructure investment has tangible benefits for private production and investment while it is also subject to absorption constraints. The paper calibrates the optimal allocation rule between spending today and asset accumulation, by minimizing a social loss function defined in terms of household welfare (measured by consumption volatility) and macroeconomic volatility (measured in terms of fiscal volatility). Sensitivity analysis is also conducted with respect to various key parameters, including the efficiency of public investment. The results indicate that, if properly managed, sovereign fund could contribute significantly to macroeconomic stability in the DRC.

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Managing (Fiscally) Resource Price Volatility: Exploring Policy Options for the Democratic Republic of Congo

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1. Introduction

Many developing countries with large endowments of natural resources face daunting challenge, including macroeconomic volatility and Dutch disease-related phenomena. Despite the economic prospects of discovering natural resources, managing those resources effectively poses a serious challenge. Developing countries have often fallen prey to the *natural resource curse*, essentially in the form of weak institutions, low efficiency of public spending, poor governance, and heightened risks of civil conflicts (van der Ploeg, 2011). Moreover, commodity price volatility creates macroeconomic instability, especially in economies that heavily rely on extractive commodity exports. And sharp inflow of foreign currency associated with resource windfalls may lead to Dutch disease effects, in which nonresource traded goods will be less price competitive on the export market due to currency appreciation.

The natural resource management framework has been dominated by the permanent income hypothesis (PIH) approach. According to the PIH, resource windfalls should be saved in their entirety in the form of financial assets, and to ensure fiscal sustainability the nonresource primary deficit should be limited to the perpetuity value of resource wealth. In turn, given a projection for nonresource revenue, the nonresource primary balance benchmark translates an estimate of the sustainable level of expenditure (Baunsgaard et al., 2012 and Lundgren et al., 2013). However, recent studies questioned the relevance of the PIH for low-income countries[1] as it ignores that these countries are both capital and credit constrained. This suggests to devise more flexible fiscal management frameworks that allow governments to scale up spending financed by resource revenue to meet the urgent infrastructure needs—

[1]See Collier et al. (2010), , van der Ploeg (2011),, International Monetary Fund (2012), Lundgren et al. (2013), and van den Bremer and van der Ploeg (2013).

and other productive sectors, such as education and health—while maintaining fiscal and macroeconomic stability.

Using Agénor's (2016) model, this paper studies the optimal allocation of revenue windfalls between spending now and saving in a sovereign fund in the context of the Democratic Republic of Congo (DRC).[2] Agénor developed a dynamic stochastic general equilibrium (DSGE) model for a small open low-income country where access to public capital is limited. It also incorporates other features, including an explicit account of imperfect access to world capital markets and a direct complementarity effect between public capital and private investment. Simultaneously, public capital is also subject to congestion and absorption constraints, which depend on the relative scale of investment itself and affect the quality and effectiveness of infrastructure spending.

The remainder of the paper is organized as follows. Section 2 presents some background analysis and stylized facts about the resource sector in DRC. Section 3 presents the structure of the model and its steady-state solution. Calibration of the model is discussed in Section 4. The macroeconomic impact of resource price and price and production windfalls, and their implication for the optimal allocation of these windfalls, are discussed in Section 5. Sensitivity analysis is performed in Section 6. The last section summarizes the main results and their implications for macroeconomic policy in DRC.

[2]While Agénor's model considers a hypothetical low-income country, this paper is the first to apply the model to an actual country case.

2. Background: Resource Sector in DRC

With a GNP per capita of US$380 in 2014[3], DRC is a low-income country endowed with vast natural resource wealth. It has huge mineral resources, including copper, cobalt, zinc, diamond, gold, and coltan. Its copper reserves are estimated to be as large as 70 million tons. Copper reserves of Katanga are the second largest in the world after Chile's. Its cobalt and zinc reserves are estimated to 5 million tons and 6 million tons, respectively. The country has the largest diamond reserves which represent nearly 25 percent of the world total. Major reserves of gold, cobalt, rare earths, cassiterite, and columbite-tantalite (coltan) are located in the eastern parts of the country. The latter two are in high demand by global electronic goods manufacturers. 70 percent of the world's coltan production is in DRC.

DRC has a huge potential to generate hydroelectric power, with an estimated capacity of up to 40 GW (100,000 MW) and could provide electricity to the whole continent. The energy sector has the potential to yield outsize and transformative returns for the country's economic development and broader southern African region as a whole. DRC has the world's second largest tropical forest endowment estimated at 148 million ha and the second largest carbon sink in the world. It represents over 60 percent of the total forest area in the Congo basin.

The country is also endowed with over 80 million ha of fertile, arable land with abundant water resources that is capable of supporting immense agricultural activities. DRS's

[3]Using Atlas method, for details see http://econ.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20452009~menuPK:64133156~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html

river network is considered to be as one of the most extensive in the world and its groundwater resources is considerably widespread.

The extractive sector accounts for about two-thirds of DRC's GDP in 2014, while it represents about 97 percent of export earnings (Table 1). Besides its contribution to GDP, the mining sector provides provincial employment and business opportunities, although in some cases it played a role in fueling conflicts. Overall, mining exerts an ambiguous impact on development.

Table 1
DRC: Contribution of the Natural Resources Sector to DRC's Economy (2000-2014)

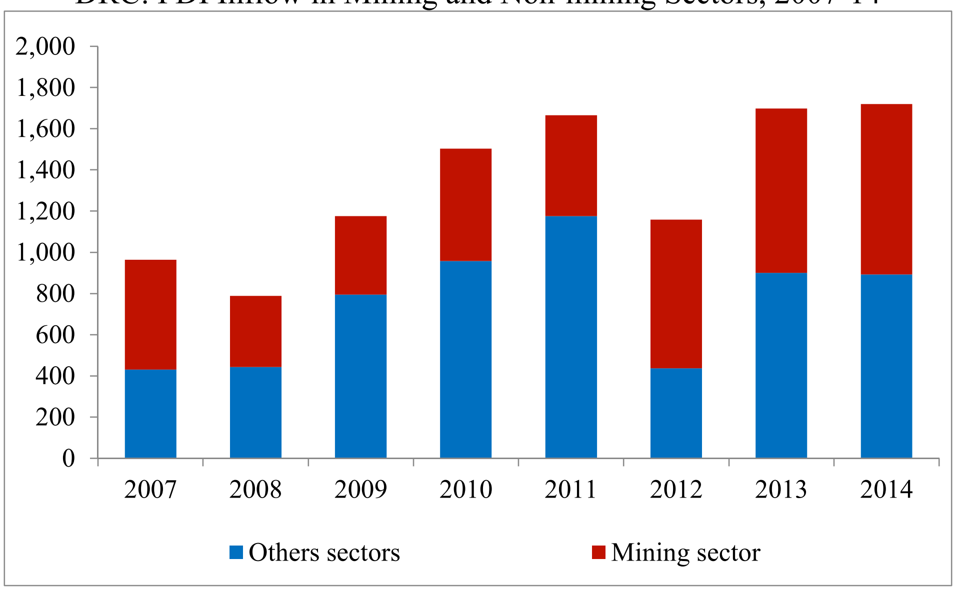
	2000	2002	2004	2006	2008	2010	2011	2012	2013	2014
% of Export Receipts	83.6	15.6	19.9	98.7	98.8	97.7	97.6	98.3	97.8	97.3

Source: Author's calculation based on Government, World Bank, and IMF Database.

DRC's enjoyed remarkable economic performance in the 2000s, supported by sound policies, and structural reforms. Real GDP growth accelerating at an annual average rate of more than 7 percent over the past five years. In 2014, DRC posted a record high growth of 9 percent and is one of Africa's most rapidly growing economies. DRC growth was more than four percentage above the average of the Sub-Saharan African countries and it was the second fastest African economy, with an average GDP growth of 7.6 percent in 2010-2015. Mineral production and related investments are the main drivers of this robust growth, although economic activity is strengthening in other sectors, such as agriculture. Between 2010 and 2014, copper production doubled to reach 1 million tons. Copper and cobalt production account for more than 80 percent of exports of goods.

DRC is well integrated in the global economy, with total trade reached 95 percent of GDP by 2014. Despite a slight drop in 2008, foreign direct investment (FDI) remained around 5 percent of GDP in (Figure 1). Mining is the most integrated sector with the global economy, as its output is almost completely designated for exports. Correspondingly, when demand falls, this sector contracts, with dire consequences for suppliers and DRC's economy as a whole.

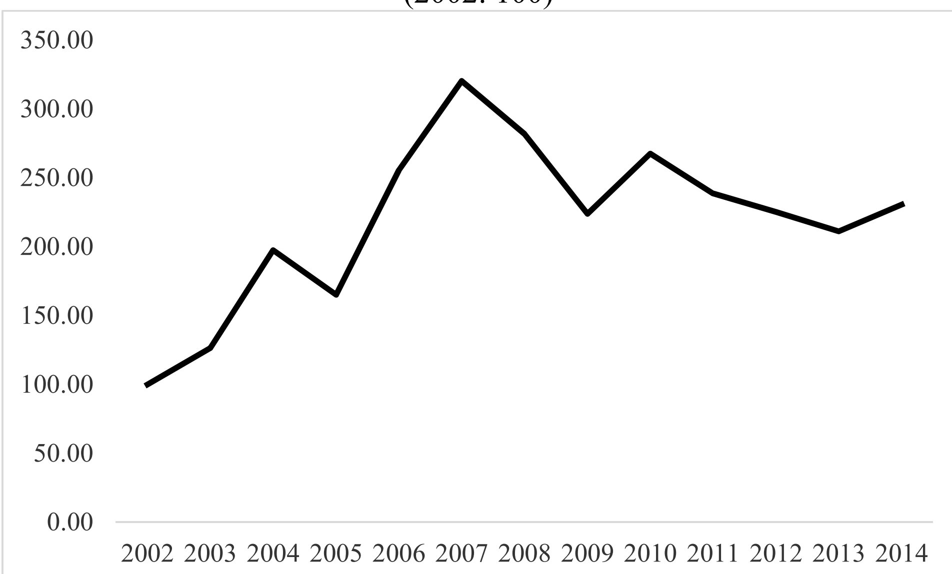
Figure 1
DRC: FDI Inflow in Mining and Non-mining Sectors, 2007-14



Source: Author's calculation based on Government, World Bank, and IMF Database

DRC's economic structure makes it more prone to exogenous shocks, reflected in high terms of trade volatility (Figure 2). Thanks to their low marginal costs, large mines remained open in 2009 when copper and cobalt prices collapsed. The sharp decline in the 2009 growth rate is due to a contraction in artisanal mining, since miners could no longer sell their products to small-scale smelters. The marginal cost of smelters was around US$4,000 per ton and they were closed when the price dropped well below US$3,000 per ton. In sum, while large-scale mines are important for economic growth, artisanal mining continues to be important for employment.[4] Prospects for linkages and value additions of the mining sector, need to be utilized effectively. The 2013 World Development Report (World Bank, 2013) shows that extractive industries tend to have weak linkages, with dismal impact on employment of 1 to 2 percent of total workforce.

Figure 2
DRC: Terms-of-Trade Index
(2002: 100)



Source: Author's calculation based on World Bank Database.

The foregoing discussion demonstrates DRC's dependence on natural resources, which means that price fluctuations of its exports can be major sources of economic volatility

[4]According the World Bank (2008), artisanal mining production in DRC was estimated at 90 percent in 2008 and the number of persons directly and indirectly dependent on this activity was estimated at 8 to 10 million, about 14-16 percent of DRC's population.

as evidenced by the recent fall in commodity prices.[5] In this context, an important question is whether a sovereign wealth fund (SWF) would help to mitigate volatility. SWFs are state-owned investment vehicles investing in real and financial assets.[6] An important advantage of SWFs, given their long-term investments nature with low leverage, is their long-term stabilizing effect on a country's future income. This could be particularly important for DRC, given its overreliance on natural resources.

3. Structure of the Model

Consider a three-sector open economy producing a non-renewable resource (identified with superscript R), a nonresource tradable good (identified with superscript T), and a nontradable good (identified with superscript N). The world price of a unit of the nonresource tradable good is unity and purchasing power parity (PPP) holds for these goods. Thus, assuming that the nominal exchange rate is fixed and normalized to unity, prices measured in foreign currency are equivalent to relative prices expressed in units of the tradable good. Nonresource tradables and nontradables are produced competitively. The nontradable good is a perishable and then is pure consumption good, whereas the nonresource tradable good can be either consumed or invested. Private investment falls on nonresource tradables only, whereas public investment consists of both nonresource tradables and nontradables. Both households and the government spend on tradables and nontradables and can borrow from

[5] The end of commodity prices super cycle compounded by an expected drop in production of copper following the recent decision by Glencore to suspend its production for 18 months starting in end-August 2015 in DRC and Zambia, is putting a toll on DRC's macroeconomic performance. DRC GDP growth slows to 6.9% in 2015 from 9% in 2014 and may not exceed 2.7% in 2016. The production of oil and mining has declined by 8.6% in the first half of 2016 compared to 2015.

[6] For a recent review of the literature on sovereign wealth funds, see Alhashel (2015). Gelb and Halland (2014) discuss the pros and cons of a country's SWF being directly involved in domestic development finance.

world capital markets. In line with the evidence for many low-income countries, labor is perfectly mobile across sectors. In contrast, private capital (which is used in the production of both nonresource tradables and nontradables) is imperfectly mobile in the short run—due to costs to reallocating physical assets across production sectors—and perfectly mobile in the long run.

3.1 Resource Production and Prices

Resource output, Y^R, is a flow endowment owned by the government; its extraction requires no use of factor inputs. It is not consumed domestically and follows an exogenous deterministic process:[7]

(1) $Y^R/\underline{Y}^R = (Y^R_{-1}/\underline{Y}^R)^{\rho YR} \exp(\varepsilon^{yR}),$

where $\underline{Y}^R$ is the steady-state value of Y^R, $\rho YR \in (0,1)$ measures the degree of persistence, and ε^{yR} is a normally distributed random shock with zero mean and a constant variance.

The real resource price, p^R, relative to the foreign-currency price of nonresource tradables, is exogenously determined outside the home country and denominated in foreign currency. It also follows an exogenous deterministic process:

(2) $p^R/\underline{p}^R = (p^R_{-1}/\underline{p}^R)^{\rho pR}\exp(\varepsilon^{pR}),$

[7]In what follows the time subscript t is omitted when there is no risk of confusion.

where $\underline{p}^R$ is the steady-state value of p^R, $\rho pR \in (0,1)$ measures the degree of persistence, and ε^{pR} is again a normally distributed random shock with zero mean and a constant variance.

3.2 Nonresource Production

Nonresource production consists of nonresource tradables, Y^T, and nontradables, Y^N. The production function for both goods requires labor, private capital, and public capital:

$$(3) \quad Y^T = (L^T)^{\beta T}(K^{PT})^{1-\beta T}(K^I/K^P)^{\omega},$$

$$(4) \quad Y^N = (L^N)^{\beta N}(K^{PN})^{1-\beta N}(K^I/K^P)^{\omega},$$

where L^i, with $i = N,T$, is employment in sector i, K^{Pi} the private capital stock in sector i, K^P the economy's total stock of private capital, K^G the stock of public capital, $\beta N, \beta T \in (0,1)$, and $\omega > 0$. In these equations public capital is partially rival and subject to congestion, as measured by the aggregate private capital stock.[8] In addition, equations (3) and (4) assume the elasticity of output with respect to (congested) public capital is the same in both sectors.

Profit maximization yields

$$(5) \quad w = \beta T(Y^T/L^T), \qquad r^{KT} = (1-\beta T)(Y^T/K^{PT}),$$

[8]See Agénor (2012, Paper 1) for a discussion of congestion effects and alternative ways of measuring them in models with public capital.

$$(6) \quad zw = \beta N(Y^N/L^N), \qquad zr^{KN} = (1-\beta N)(Y^N/K^{PN}),$$

where w is economy-wide wage rate (measured in terms of foreign currency), which is the same in both sectors given the assumption of perfect labor mobility, r^{Ki} is the rental rate of capital in sector i, with i = N,T, and $z = 1/P^N$ is the real exchange rate.

3.3 Households

Consumption decisions follow a two-step process: households first determine the optimal path of total consumption over time, C, and then allocate that amount at each moment in time between spending on nonresource tradables and nontradables.

The representative household's lifetime utility is

$$(7) \quad U = E_t \sum_{s=0}^{\infty} \Lambda^s \{(1-1/\varsigma)^{-1}(C_{t+s})^{1-1/\varsigma} - [\eta_L/(1+\psi)](L_{t+s})^{1+\psi}\},$$

where E_t is the expectations operator, $\Lambda \in (0,1)$ is a discount factor, $\varsigma > 0$ the intertemporal elasticity of substitution, ψ the inverse of Frisch elasticity of labor supply, and $\eta_L > 0$ a preference parameter which captures the disutility of work.

The stock of private capital evolves according to

$$(8)\quad K^P = (I^P_{-1})^{\varphi K}(K^I_{-1}/K^P_{-1})^{1-\varphi K} + (1-\delta^P)K^P_{-1} - \Gamma(K^P,K^P_{-1}),$$

where I^P is private investment, $\delta^P \in (0,1)$ a constant rate of depreciation, $\varphi K \in (0,1)$, and $\Gamma(K^P,K^P_{-1})$ an adjustment cost function. As in Agénor (2016), gross private investment must be combined with (congested) public capital to generate effective private investment, in order to capture a *direct* complementarity effect between private investment and public capital. This effect operates independently of the effect of public capital on the rate of return of private capital, as captured in equations (5) and (6).

The capital adjustment cost function takes the standard quadratic form

$$(9)\quad \Gamma(K^P,K^P_{-1}) = 0.5\kappa(K^P/K^P_{-1} - 1)^2K^P_{-1}, \qquad \kappa > 0.$$

The flow budget constraint of the representative household is given by

$$(10)\quad D^P_{+1} = (1+r^W)D^P - (1-\tau^{NR})(Y^T+z^{-1}Y^N) - \psi^R(1-\tau^R)P^RY^R + C + I^P + T^L,$$

where D^P is household foreign-currency debt, r^W the cost of borrowing abroad, $\tau^{NR} \in (0,1)$ the tax rate on nonresource income, T^L lump-sum taxes, $\tau^R \in (0,1)$ the share of resource revenues going to the government (with $1-\tau^R$ therefore representing the share going to private agents, both residents and non-residents), and $\psi^R \in (0,1)$ the share of these resource revenues going to domestic households.

In the first stage of the optimization process, households maximize (7), subject to (8), (9), and (10). The first-order conditions are[9]

$$\text{(11a)} \quad E_t(C_{+1})^{-1/\varsigma} = C^{-1/\varsigma}/\Lambda(1+r^W),$$

$$\text{(11b)} \quad L = [(1-\tau^{NR})w/\eta_L C^{-1/\varsigma}]^{\psi},$$

$$\text{(11c)} \quad E_t\{[\kappa((K^P_{+1}/K^P) - 1) + 1)]^{-1}[(1-\tau^{NR})r^K_{+1} + 1 - \delta^P + 0.5\kappa(\Delta(K^P_{+2})^2/(K^P_{+1})^2)\} = 1 + r^W,$$

together with the appropriate transversality conditions on K^P and D^P. In (11c), r^K is the rate of return on private capital, and $\Delta(K^P_{+2})^2 = (K^P_{+2})^2 - (K^P_{+1})^2$. Equation (11a) is the standard Euler equation, (11b) defines labour supply, and (11c) is the arbitrage condition that determines the demand for private capital.

Let C^i denote consumption of goods produced by sector i = N,T. In the second stage of the optimization problem, the representative household maximizes the sub-utility function

[9]See Agénor (2014) for details. In solving this optimization problem, it is assumed that the household does not internalize the complementarity effect; this is equivalent to setting $\varphi K = 1$ in (8).

(12) $C = (C^N)^\theta (C^T)^{1-\theta}$,

where $\theta \in (0,1)$, subject to the budget constraint

(13) $C = C^T + z^{-1}C^N$.

The solution is given by

(14) $C^N = \theta z C, \qquad C^T = (1-\theta)C$.

3.4 Government Budget and Sovereign Fund

The government receives revenues from resource production, T^R, taxes on nonresource income, T^{NR}, as well as lump-sum taxes on households, T^L. It also receives interest income on the stock of foreign-currency assets, F, held in a sovereign fund, at the interest rate r^F. Total revenue, measured in foreign-currency terms, is thus given by

$$T = T^R + T^{NR} + T^L + r^F F,$$

or equivalently,

(15) $T = (1-\chi)\tau^R p^R Y^R + \tau^{NR}(Y^T + z^{-1}Y^N) + T^L + r^F F$,

where $\chi \in (0,1)$ is the fraction of resource revenues saved in the sovereign fund.

In the initial steady state, government spending is set as fixed fraction $\psi^G \in (0,1)$ of aggregate output. In response to a resource price or quantity shock, however, we assume that (log) deviations in government spending from its steady-state value is given as a fraction $1-\chi$ of (log) deviations in resource revenues, and (log) deviations in interest income:

$$(16) \quad G^{SS}\ln(G/G^{SS}) = (1-\chi)T^{R,SS}\ln(T^R/T^{R,SS}) + r^F F^{SS}\ln(F/F^{SS}),$$

where the superscript SS is used to indicate a steady-state value.[10]

Government spending is allocated to infrastructure investment, I^G, and consumption of nontraded goods, $z^{-1}C^G$:

$$(17) \quad G = I^G + z^{-1}C^G.$$

Both components of spending are set as fixed fractions of total expenditure:

$$(18) \quad I^G = \upsilon^G G, \qquad z^{-1}C^G = (1-\upsilon^G)G,$$

[10]Note that equation (16) applies only when solving for the optimal value of χ.

where $\upsilon^G \in (0,1)$. In turn, public investment is allocated in fixed proportions between spending on nontraded goods, I^{GN}, and spending on nonresource traded goods, I^{GT}:

(19) $I^{GN} = \upsilon^{GN} z I^G, \qquad I^{GT} = (1-\upsilon^{GN})I^G,$

where $\upsilon^{GN} \in (0,1)$.

The stock of public capital evolves according to

(20) $K^I = (1-\delta^G)K^I_{-1} + \varphi_{-1}I^G_{-1},$

where $\varphi \in (0,1)$ is an indicator of efficiency of spending on infrastructure and $\delta^G \in (0,1)$ is the depreciation rate. To capture absorption capacity constraints, the efficiency parameter is assumed to be negatively related with the ratio of public investment to public capital:

(21) $\varphi = \varphi_0(I^G/K^I)^{-\varphi 1},$

where φ_0, $\varphi 1 > 0$.

Public debt, D^G, is constant at $D^G{}_0$; the government's budget is balanced through changes in (lump-sum) taxes, so that

(22) $T = r^W D^G{}_0 + G.$

Accumulation in the sovereign fund is driven by

(23) $F_{+1} = (1 - \phi^F)F + \chi\tau^R p^R Y^R,$

where $\phi^F \in (0,1)$ is a coefficient that measures a management fee paid to nonresidents, levied on the stock of assets held in the fund.

3.5 Market-Clearing Conditions and World Interest Rate

The market-clearing condition of the market for nontradable goods is given by

(24) $Y^N = C^N + C^G + I^{GN},$

whereas the equilibrium condition of the labor market is given by

(25) $L = L^N + L^T.$

As noted earlier, private capital is imperfectly mobile across sectors. The stock of capital is given as a CES function of K^N and K^T:

(26) $K^P{}_{-1} = [\zeta K(K^{PT})^{(\eta K-1)/\eta K} + (1-\zeta K)(K^{PN})^{(\eta K-1)/\eta K}]^{\eta K/(\eta K-1)},$

where $\zeta K \in (0,1)$ is the share of capital in the traded goods sector in the steady state, and $\eta K > 0$ is the elasticity of substitution between K^T and K^T. The aggregate rental rate of capital is thus given by

$$(27) \quad r^K = [(\zeta K)^{\eta K}(r^{KT})^{1-\eta K} + (1-\zeta K)^{\eta K}(r^{KN})^{1-\eta K}]^{1/(1-\eta K)},$$

which implies that, with perfect capital mobility in the long run, $r^{KN} = r^{KT} = r^K$.

The savings-investment balance (obtained by consolidating the budget constraints of the private and public sectors) is given by[11]

$$(28) \quad D_{+1} - F_{+1} = (1+r^W)D - Y^T + C^T + I^P + I^{GT} - (1+r^F-\phi^F)F - [\psi^R + (1-\psi^R)\tau^R]p^R Y^R,$$

where $D = D^P + D^G$ is the economy's total stock of external debt.

Finally, the interest rate earned by the country's sovereign fund, r^F, is equal to the constant risk-free world interest rate, r^{WR}, whereas the market cost of foreign borrowing is set equal to the world risk-free rate and a risk premium, PR:

$$(29) \quad r^{WR} = (1+r^W)(1+PR) - 1.$$

[11]Equation (28) is obtained by combining equations (10), (13), (15), (17), (22), (23), and (24), and noting that $I^G = I^{GT} + z^{-1}I^{GN}$.

In turn, the risk premium is positively related to the country's government debt-total output ratio:

(30) $PR = PR_0(D^G{}_0/Y)^{pr1}$,

where PR_0, $pr1 > 0$ and Y is aggregate output, defined as

(31) $Y = p^R Y^R + Y^T + z^{-1}Y^N$.

Finally, the overall and the nonresource primary balances are defined as

(32) $opb = (1-\chi)\tau^R p^R Y^R + \tau^{NR}(Y^T + z^{-1}Y^N) + T^L - G$,

(33) $nrpb = \tau^{NR}(Y^T + z^{-1}Y^N) + T^L - G$.

3.6 Steady State

The steady-state equilibrium of the model is described in detail in Agénor (2016). Most of the equilibrium conditions are standard; in particular, from the Euler equation (11a), the steady-state world interest rate is given by the standard expression $r^W = \Lambda^{-1} - 1$. And from (11c) the economy-wide rental rate of capital is equal to $(1-\tau^{NR})r^K = r^W + \delta^P$, whereas from (8) and (9) private investment is equal to $I^P = [\delta^P K^P/(K^I/K^P)^{1-\varphi K}]^{1/\varphi K}$, with the standard case (no direct complementarity, or $\varphi K = 1$) corresponding to $I^P = \delta^P K^P$.

4. Calibration

The model is now calibrated using various data sources, including DRC's National Institute of Statistics and the Central Bank of Congo, the World Bank's African Development Indicators (ADI), the IMF's World Economic Outlook (WEO), as well as parameter estimates from Agénor (2016) and various other papers.

For households, the intertemporal discount factor is set at 0.898, based on the estimates of the real interest rate and the depreciation rate of private capital provided below. The intertemporal elasticity of substitution, ς, is set at 0.2, in line with the evidence for low-income countries reported in Agénor and Montiel (2015). The Frisch elasticity of labor supply is set at 0.125 (implying that $\psi = 8$) to capture a fairly inelastic supply of labor. This is a fairly reasonable assumption for a low-income country like DRC. The preference parameter η_L is set at 0.14, to account for a weak effect of leisure on household utility. The share of nontradables in total consumption, θ, is set at 0.56, as in Rabanal and Tuesta (2013) for instance. The fraction ψ^R of the share of resource revenues not going to the government but instead to domestic households is assumed to be 0.1; thus, 90 percent of the resource income that is not going to the government budget accrues to non-residents.

The share of capital in the nonresource tradable sector, ζK, is calibrated at 0.6, to capture that the nonresource tradable sector is more capital intensive than the nontradable sector. The elasticity of substitution between nonresource traded and nontraded goods, ηK, is set to 0.4, to capture a relatively low degree of substitution across production sectors. The rate of depreciation of private capital, δ^P, is set at 0.045, a fairly standard value. To capture initially high adjustment costs to private capital, the parameter κ is set at 25. The direct complementarity effect of public capital on private investment, φK, is assumed to be absent initially, which implies that φK = 1. The sensitivity analysis with a positive value (that is, a lower value of φK) will be discussed later.

The relative sizes of the different production sectors are calculated, based on the data published in the annual report of the Central Bank of Congo (2013, Table I.2). The size of the resource sector, which corresponds to $p^R Y^R/Y$ in the model, is calculated as the share of extraction industries in total GDP at factor cost—the relevant concept in the model—in 2012, that is, 31.3/95.4 = 32.8 percent. The size of the nonresource tradable sector in 2012, which corresponds to Y^T/Y in the model, is estimated by adding the nonresource primary sector (namely, agriculture, forests, etc.) to manufacturing industries, that is (9.0 + 7.8)/95.4 = 17.6 percent. Thus, the size of the nontradable sector in 2012, which corresponds to $z^{-1}Y^N/Y$, in the model, is determined residually and is given by 1 - 0.328 - 0.176 = 49.6 percent.

For the resource sector, and given the previous discussion about the magnitude of DRC's natural resources, the degree of persistence in production, ρyR, is taken to be very high at 0.96, and the standard deviation of the nonsystematic shock ε^{yR} is set at 0.1. For resource prices, the degree of persistence, ρpR, is set at 0.93 and the standard deviation of the nonsystematic shock ε^{pR} is set at 0.25, as in Maliszewski (2009).[12]

For the nonresource sector, elasticities of production with respect to labor, βN and βT, are set equal to 0.7 and 0.6, respectively, to capture the fact that production in the nontradable sector is relatively more labor intensive than production in the nonresource tradable sector ($\beta N > \beta T$). The elasticity of output with respect to public capital, ω is set at 0.17, which corresponds to the long-run value estimated through meta-regression analysis by Bom and Ligthart (2014, Table 4) for core public capital. Thus, public infrastructure is equally productive in the production of tradables and nontradables.

Regarding the government, the fraction of resource revenues saved in the sovereign fund, χ, is set initially equal to 0. The initial stock of assets in the sovereign fund, F, is set at 1 percent of GDP (assumed to correspond to an initial lump-sum transfer from the government), whereas the coefficient ϕ^F, which measures the management fee paid to non-residents, is set as in Agénor (2016) at 0.25 percent of the stock of assets held in the fund.[13] The interest rate on assets held in the sovereign wealth fund, r^F, is set at 4 percent initially, and sensitivity analysis is conducted later on.

According to IMF data, total revenue and grants amounted to 20.1 percent of GDP in 2012 (corresponding to T/Y in the model), whereas total expenditure amounted to 19.6 of GDP in the same year. To abstract from debt accumulation, it is assumed that the overall balance, 0.5 percent of GDP, corresponds to the share of transfers to households in GDP. The

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[12]Maliszewski's study focuses on oil prices; we use the same numbers for resource prices in general, given that these prices tend to exhibit strong co-movements.

[13]Because the model is log-linearized near an initial steady state, an initially positive value of F is needed. The results are not much affected in a value smaller than 1 percent of output is used.

share of resource revenues in total revenues, corresponding to T^R/T in the model, is estimated at 26.5 percent, based on the calculations of Lundgren et al. (2013, Table 1) for 2010. To calculate τ^R the formula $T^R/T = \tau^R p^R Y^R/T = \tau^R(p^R Y^R/Y)(Y/T)$; given the above numbers, this formula gives $0.265 = \tau^R(0.331)(1/0.201)$, or $\tau^R = 16.1$ percent. In the same vein, to calculate τ^{NR} the formula $T^{NR}/T = \tau^{NR}(Y^T + z^{-1}Y^N)/T = \tau^{NR}[(Y^T + z^{-1}Y^N)/Y](Y/T)$, which gives, given the data provided earlier, $1 - 0.265 = \tau^{NR}(1-0.331)(1/0.201)$, or $\tau^{NR} = 22.1$ percent.[14]

The initial ratio of noninterest current spending in GDP, G/Y, is set equal to the share of total (interest-inclusive) expenditure in GDP for 2012, 19.6 percent, minus debt service after debt relief, 1.9 percent of GDP in 2012, and minus infrastructure investment, which is estimated by the World Bank at 2 percent of GDP in 2012 (of which 1.5 of GDP on road infrastructure). This gives G/Y = 15.7 percent. Thus, components of capital expenditure other than infrastructure investment in the budget data are treated as current expenditure.[15] Given this result, the share of infrastructure investment in total government spending, υ^G, can be estimated as $(I^G/Y)(G/Y)^{-1} = 0.02/0.157$ or equivalently $\upsilon^G = 12.7$ percent. As noted earlier the steady-state solution of the government overall fiscal balance (22), which gives $T = r^W D^G + G$, is thus used to calibrate the initial value of lump-sum taxes, T^L, as a proportion of GDP.

The parameter that captures the allocation of investment in infrastructure to nontraded goods, υ^{GN}, is set at 0.62, within the range of estimates of the share of nontradables in total investment for Côte d'Ivoire, Gabon, Ghana, and Uganda reported by Bems (2008, Table 8).

[14]These calculations assume implicitly that the share of grants is also fixed as a share of GDP.

[15]This is a reasonable assumption given that the model does not capture the stock effects of other productive components of public investment, on education and health for instance.

There are no direct data available for the efficiency of public investment in infrastructure in DRC; using the average value for the 30 Sub-Saharan African countries (excluding South Africa) in the sample compiled by Dabla-Norris et al. (2012, Table 1), the efficiency parameter for public investment, φ, is set at 0.37.[16] The parameter $\varphi 1$ is set at the low value of 0.05 initially, which implies that φ_0, which is solved for residually, is equal to 0.33. The rate of depreciation of public capital, δ^P, is set at 0.035, a fairly standard choice.

External public debt as a share of GDP, D^G/Y, is set equal to 27.1 percent, which is equal to the ratio of general government gross debt to GDP in 2010, as estimated in the IMF's WEO database. Thus, all public debt is assumed to result from foreign borrowing. From the estimates compiled by Boyce and Ndikumana (2012, Table 1), the stock of private capital flight for DRC in the same year represented a staggering 258.4 percent of GDP.[17] Thus, the economy's net stock of external debt, as a share of GDP, can be calibrated at 27.1 - 258.4 = 231.3 percent. By this metric, in the initial equilibrium the country is a net creditor to the rest of the world. However, as noted earlier, due to market imperfections only the public debt matters in the determination of the risk premium.

The world risk-free interest rate (in foreign-currency terms), r^{WR}, is set initially at 0.017, which corresponds to the difference between recent averages on nominal yields on U.S. treasury 30-year bonds and an average rate of U.S. inflation of 2.0 percent. To estimate the country risk premium, and given that there are no data available for DRC, the spread on sovereign bonds issued by Kenya on international financial markets is used. Recent averages

[16]Dabla-Norris et al. (2012) define their metric on a range of 1 to 4 with an average value of 1.47 for the 30 countries; this value was simply divided by 4 to obtain an indicator between zero and unity.

[17]The average for Sub-Saharan Africa in the same year was 78.7 percent.

on nominal yields on 30-year sovereign bonds issued by that country is 13.3 percent; the risk premium (in foreign-currency terms) can thus be calculated as [(1+0.113)/(1+0.017)] - 1 = 0.094.This also implies that the household discount factor is equal to 1/(1+0.113) = 0.898, as noted earlier.[18] Finally, the elasticity of the risk premium with respect to the debt-output ratio, pr1, is set at 0.8 initially, and sensitivity analysis is reported later on.

5. Macroeconomic Effects and Optimal Allocation of Resource Windfalls

We now turn to estimate the macroeconomic effects of resource windfalls, together with an analysis of optimal allocation rules. First, the model is log-linearized in the vicinity of the initial steady state to obtain its solution.[19] We then consider an unanticipated and temporary positive shock to the real price of natural resources by 10 percent. The resource windfall corresponds therefore to the log-difference between actual resource revenues and their steady-state value (as defined in the log-linearized version of the model), weighted by their initial steady-state value.

5.1 Macroeconomic Effects

The properties of the model is illustrated using two extreme cases: a *full spending* case, where the windfall is spent entirely by the government (in proportions given by the

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[18]This expression is derived from the steady-state relationship between the world interest rate and the discount factor, $r^W = \Lambda^{-1} - 1$.

[19]The model is solved using DYNARE. An appendix summarizing the log-linearized equations is available upon request.

initial composition of public expenditure), and a *full saving* case, where the windfall is entirely accumulated in the sovereign fund, and only the interest income is transferred to the budget and used to finance government spending. This second scenario is thus consistent with the PIH approach discussed earlier.

Consider first the *full spending* case. The direct effect of the windfall is an increase in revenues for the government and a positive wealth effect for domestic households. In turn, the increase in spending raises the demand for nontraded goods, and this leads to a real appreciation. The real appreciation in turn generates standard expenditure-switching effects on the demand side, and a shift toward production of nontradables, which raises the demand for labor in that sector. To maintain equilibrium in the labor market, the product wage (measured in terms of the price of nonresource tradable goods) must increase. This increase, however, is less than proportional compared to the movement in the real exchange rate, implying that the product wage in the nontradable sector falls. There is therefore a shift on the supply side toward the production of nontradables.

Simultaneously, the increase in private consumption raises the demand for leisure and lowers overall labor supply; hence, total employment falls, as workers reallocate from the nonresource tradables to nontradables. The expansion of the nontradable sector exceeds the drop in the production of nonresource tradables, implying total output growth. This tends to increase nonoil tax revenues. And because public debt is fixed, the debt-to-output ratio falls, lowering the risk premium. The reduction in the world interest rate also tends to reduce today's consumption through the intertemporal effect, thereby magnifying the initial increase associated with the wealth effect. However, the rate of return to private capital also falls, implying a drop in private investment and the rate of accumulation of private capital as well. At the same time, capital shifts gradually toward the nontradable sector and sustains expansion there.

Because the increase in government revenues is distributed across all components of expenditure, both public consumption and investment expand in the same proportion. The impact of higher public investment on the stock of public capital is partly mitigated by a drop in investment efficiency, due to a relaxation of absorption constraints. However, because the private capital stock falls over time, the public-private capital ratio increases gradually, thereby increasing productivity of private inputs and promoting activity in the nonresource tradable and nontradable production sectors. Indeed, the increase in the public-private capital ratio raises the marginal product of labor, thereby contributing to the employment recovery. Activities in both sectors increase over time. The increase in government spending is large enough to translate into a weakening of the nonresource primary balance, despite the increase in nonresource tax revenues.

Overall, under full spending, a resource windfall generates the typical Dutch disease effects. However, the expansion in public investment and public capital stock (despite being mitigated by a drop in the efficiency of investment spending) attenuates these effects over time, as the increase in public capital benefits the supply side. These results are consistent with other studies that have emphasized the productivity effects of infrastructure.

Consider next the *full saving* case. Assets held in the sovereign fund increase rapidly as a share of output—the speed itself being a function of the size of the shock and its degree of persistence—and stabilize at about 250 percent of GDP. As described earlier, the interest income from the fund is used to finance both government consumption and investment, in line with initial spending allocations. The key difference with the previous case is that spending does not increase proportionally; will rise only gradually over time. Because domestic households benefit to the same extent, private consumption rises just as before. The direct, *partial equilibrium* effect is an appreciation of real exchange rate, which induces the supply-side effects described earlier. However, because government spending is constant, and private investment falls, the increase in the supply of nontradables dominates the change in demand; the *general equilibrium* effect now is a *depreciation* of the real exchange rate (in contrast to the full spending case), together with a shift in production toward nontradables. Over time, because public investment increases, the public capital stock also rises, despite a drop in efficiency. As before, the public-private capital ratio increases over time. However, the deterioration in the nonresource primary balance is now more persistent.

To further illustrate how the transmission process of commodity price shocks is affected by our choice of parameters, two sensitivity tests were conducted in the full spending case: *a*) the case where the sensitivity of the efficiency of spending on infrastructure parameter with respect to the ratio of public investment to public capital, $\varphi 1$, goes from -0.05 to -0.5 (see equation (21)), which captures stronger absorption constraints related to the government's capacity to select, implement, and manage investment projects; and *b*) the case where the sensitivity of the risk premium to the public debt-to-output ratio, pr1, increases from 0.05 to 0.4 (see equation (30)), which captures higher sensitivity of world capital markets with respect to the domestic country's external debt position. In both figures, the continuous (blue) line corresponds to the benchmark case, whereas the dotted (red) line corresponds to the alternative scenario. Broadly speaking, the results are qualitatively similar to those discussed earlier. In the first case, for instance, stronger absorption constraints means a much larger drop in the efficiency of public capital on impact; consequently, the accumulation rate of public capital is weaker. Over time, this exerts negative effects on output in *both* nonresource sectors. In the second case, the initial drop in the risk premium documented earlier is also stronger; implying the drop in private investment while private consumption increases (through the intertemporal effect). Therefore, the appreciation of the real exchange is also more significant, which translates into a larger output expansion of nontradables and a stronger contraction of nonresource tradables, compared to the benchmark case described earlier.

Several other sensitivity tests could be conducted, regarding other parameters of the model—for instance, the elasticity of output with respect to public capital in production, or the share of labor in each sector. However, while these exercises can be of interest in their own right, we opt to focus on the main issues of this paper—the optimal allocation of resource windfalls between spending today and spending tomorrow, through accumulation in a resource fund.

5.2 Optimal Allocation Rule

Here, we follow closely the approach proposed by Agénor (2016). Conceptually, the issue is to find the fraction $\chi \in (0,1)$ of the oil windfall that needs to be allocated to a sovereign fund, as defined in (15), and the fraction $1-\chi$ allocated to spending today. With $\chi <$

1, the government raises not only spending today but also all future spending by using some of the current windfall to increase its assets held in the sovereign fund. Formally, the optimal value of χ is determined so as to minimize a social loss function, $L(\chi)$, defined as a weighted geometric average of the volatility of private consumption (a measure of household welfare), V_C and the volatility of the nonresource primary balance as a share of nonresource output, $V_{NRPB\text{-}NRY}$:

(34) $$L(\chi) = (V_C)^{\mu}(V_{NRPB\text{-}NRY})^{1-\mu},$$

where $\mu \in (0,1)$ is the relative weight attached to household welfare.[20] Thus, if the government sets policy solely on the basis of household welfare (respectively, fiscal stability) considerations, the $\mu = 1$ (respectively, $\mu = 0$); in the general case, the higher μ is, the smaller the concern with fiscal stability. An alternative stability criterion is to determine χ so as to minimize a generalized social loss function that involves a weighted average of the volatility of private consumption (as before) and a measure of macroeconomic volatility, defined in terms of a weighted average of the volatility of the nonresource primary balance as a share of nonresource output and the volatility of the real exchange rate (see Agénor (2016)).

Numerical experiments, using (unconditional) asymptotic variances, to calculate V_C and $V_{NRPB\text{-}NRY}$, show that the loss function (34) is convex (or U-shaped) in χ. The intuition behind this result, as discussed in Agénor (2016), is as follows. Spending all the revenues

[20]See Baunsgaard et al. (2012) for a more general discussion of the nonresource primary balance as an indicator of fiscal sustainability. Here we follow Lundgren et al. (2013, p. 34), in using nonresource output as a scaling variable.

associated with a windfall creates a lot of volatility in the economy. As χ increases, more of the windfall is saved; the reduction in today's spending tends at first to reduce that volatility. However, as χ continues to rise, the interest income from the assets held in the sovereign fund becomes larger, and this tends to raise spending over time—thereby increasing volatility once again. Put differently, there is a *dynamic volatility trade-off* between spending now and spending later. The exact nature of this trade-off depends on a number of factors—the persistence of the price shock, the interest rate (net of management fees) on assets held in the sovereign fund, the efficiency of public investment, and so on.

Table 20.2 shows the minimum value of the loss function (34) and the associated optimal value of χ, for μ varying between 0 and 1 with a grid of 0.1, for a range of experiments. As noted earlier, for each value of μ, there is a U-shaped relationship between the loss function and χ; for lack of space, only the optimal values are reported. The first block in Table 20.2 shows these optimal values when the nonresource primary balance-to-nonresource output ratio is used to calculate fiscal volatility, as defined earlier (that is, $V_{NRPB\text{-}NRY}$). The results indicate that if policymakers in DRC are only concerned with fiscal volatility ($\mu = 0$), then 50 percent of the windfall should be saved. By contrast, if they are only concerned with consumption volatility ($\mu = 1$), then the windfall should be entirely spent. In practice, one would expect policymakers to be concerned about both types of volatility. Thus, if we assume as a benchmark case, that policymakers are *equally* concerned with consumption and fiscal volatility, then it is optimal to save about 30 percent of the windfall.[21] This estimate

[21]It is worth noting that this value of χ is significantly lower than the value of 0.5 estimated in Agénor (2016) for a "representative" low-income country, in the benchmark case where the government attaches equal weights to consumption volatility and fiscal volatility. This is consistent with the evidence, which suggests that following years of conflict, infrastructure needs in DRC are very high—even compared to other countries at the same level of per capita income.

can be refined by doing a finer grid search at intervals of 0.01 for instance instead of 0.1. We have done so in a few cases, where the one-decimal grid search did not generate a clear difference when performing sensitivity analysis. Although these results are not reported here, it can be shown for instance that, in the interval 0.4-0.5 of the benchmark case, the optimal value of χ for μ = 0.2 is 0.44 rather than 0.4.

Table 2
DRC: Minimized Loss Function and Optimal Share of Saving in the Sovereign Wealth Fund

	μ										
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Benchmark parameters											
Nonresource primary balance to nonresource output											
Minimized Loss function	61.94	56.87	52.18	47.67	43.56	39.63	35.99	32.48	29.20	26.17	23.30
Optimal value of χ	0.50	0.50	0.40	0.40	0.40	0.30	0.30	0.20	0.10	0.10	0.00
Nonresource primary balance to total output											
Minimized Loss function	121.48	104.48	89.67	76.66	65.36	55.49	46.91	39.56	33.23	27.86	23.30
Optimal value of χ	0.60	0.50	0.50	0.40	0.30	0.30	0.20	0.10	0.10	0.00	0.00
Overall primary balance to total output											
Minimized Loss function	21.25	21.64	22.02	22.41	22.81	23.16	23.42	23.63	23.70	23.59	23.30
Optimal value of χ	0.50	0.40	0.40	0.40	0.40	0.30	0.30	0.20	0.20	0.10	0.00
General index of macroeconomic volatility 2/											
Minimized Loss function	12.95	13.90	14.93	16.01	17.09	18.19	19.28	20.33	21.35	22.36	23.30
Optimal value of χ	0.50	0.50	0.50	0.40	0.40	0.30	0.20	0.20	0.10	0.00	0.00

Source: Pinto-Moreira (2016).

The second and third blocks in Table 2 show the values of the minimum loss function and the optimal value of χ when, alternatively the fiscal volatility measure is based on *a*) the nonresource primary balance over total output, and *b*) the overall primary balance over total output. In practice, these two measures are often used in fiscal policy analysis, so it is worth considering their performance in the context of these experiments. In addition, the fourth block of the table shows the results for the minimum loss function and the optimal χ when a more general index of *macroeconomic* volatility, involving not only the volatility of the nonresource primary balance as a share of nonresource output but also the volatility of the real exchange rate (with equal weights), is used, as in Agénor (2016). Although the results differ slightly from the benchmark case, they are remarkably consistent; the lower the concern with fiscal/macro volatility (the higher μ is), the smaller the proportion of the windfall that should be saved. Put differently, fiscal volatility is a key consideration when deciding whether and how much of a resource windfall should be set aside in a sovereign fund.

6. Sensitivity Analysis

To assess the robustness of the results established in the previous section, we considered changes in some key parameters and variables. The focus here is on the implications of these changes for the optimal allocation of resource windfalls between spending today and spending tomorrow, that is, the optimal value of χ, rather than their implications on the transmission mechanism of resource shocks to the economy—even though these implications are of interest in their own right.

Specifically, the following changes are considered: higher elasticity of output with respect to public capital, as measured by a value of ω of 0.22 instead of 0.17, consistent with the results in Agénor and Neanidis (2015); lower rate of return on assets held in the sovereign wealth fund, as measured by a value of r^F of 3 percent instead of 4 percent; stronger direct complementarity effect between public capital and private investment as measured by a value of φK of 0.4 instead of 1.0; higher elasticity of the risk premium with respect to the debt-to-output ratio as measured by a value of pr1 of 0.4 instead of 0.25; and full spending of interest income (following a resource windfall) on infrastructure investment, which is equivalent to setting υ^G to unity, from the initial steady-state value of 0.127.

The results of these experiments are reported in Table 20.2, using the original and preferred measure of fiscal volatility. In all cases, and as before, the weaker the concern with fiscal volatility is (the higher μ is), the larger the proportion of the windfall that should be spent today. However, in the benchmark case where policymakers are equally concerned with consumption and fiscal volatility (that is, $\mu = 0.5$), the optimal value of χ varies across some of these experiments. In particular, in the case of a lower rate of return on the assets held in the sovereign funds, the optimal value is substantially higher at 0.6; by contrast, with full spending on investment, the optimal value is about 0.1. These results are fairly intuitive; with a lower return, more resources must be saved to achieve the same level of spending; otherwise, lump-sum transfers must fall and this would increase volatility in consumption. When all resources are spent on investment, output and nonresource revenues are higher, implying that the lower interest income associated with reduced accumulation of assets in the fund is mitigated. For all other experiments, the results are quite close to those obtained in the benchmark case—with equal concern for consumption volatility (household welfare) and fiscal volatility, it is optimal to save about one third of a resource windfall into a sovereign fund.[22]

Finally, it is worth noting that in the case of a negative shock, the intuition is symmetric, with χ representing now the proportion of the resources that are *taken out* of the

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[22]Of course, a finer grid search of 0.01 would show more differences across the simulation results, given that a grid of 0.1 is not always sufficient to pass judgment. This would be the case, for instance, when comparing the results of the benchmark experiment with the case of a higher elasticity of output with respect to public capital, ω; for a benchmark value of $\mu = 0.5$ for instance, the optimal value of χ is 0.3 for $\omega = 0.22$, instead of 0.31 for $\omega = 0.17$.

sovereign fund. With small withdrawals (χ low) the adverse shock creates volatile environment, in particular through a concomitant contraction in government spending. As χ increases (more and more resources previously saved are withdrawn from the fund), the adverse effect of the initial shock on spending is mitigated and volatility decreases at first. But as χ continues to rise and public outlays increase, volatility starts increasing again—albeit at a slower rate now, given that the interest income (which is also spent) generated by the lower level of assets held in the sovereign fund becomes smaller. Thus, the relationship between the loss function (34) and the parameter χ takes again a convex shape.

7. Summary and Policy Implications

Managing natural resources effectively, in an environment of volatile commodity prices, continues to be a challenge in many developing countries. This paper contributes to the ongoing debate on fiscal management rules that aim, in response to resources windfalls, to allocate sufficient resources to meet a country's needs in infrastructure investment—a critical step not only to promote economic activity but also to achieve education and health outcomes—while at the same time maintaining fiscal and macroeconomic stability.

The main policy implication of the paper is that given that political economy considerations and weak institutional framework in DRC may translate into a *time preference for spending the windfall today*, setting up *institutionalized savings rules* to secure resource revenues needed for future investments seem to us a critical policy move for DRC.[23] Setting-

[23] Paul Collier (2012) indicates that in the absence of such institutionalized savings rules, there is a possibility that their savings may merely transfer spending power to a bad successor.

up a SWF (in the form of a savings account) would help further improve DRC's fiscal policy, protect the economy against the volatility of resource price, strengthen fiscal buffers, and smooth consumption and maintain price stability. Lessons could be learned from the experience of Chile's successful management of resource windfalls.[24]

[24] Chile has made fiscal policy a cornerstone for managing resource revenues. The Fiscal Responsibility Law enacted in 2006 (Law 20128) provided an institutional framework that strengthened the link between the fiscal rule and use of government savings. It also established two sovereign funds (SWFs).

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Bibliography

Agénor, Pierre-Richard, *Public Capital, Growth and Welfare*, Princeton University Press (Princeton, New Jersey: 2012).

------, "Optimal Fiscal Management of Commodity Price Shocks," *Journal of Development Economics*, 122 (September 2016), 183-96.

Agénor, Pierre-Richard, and Peter J. Montiel, *Development Macroeconomics*, 4th ed., forthcoming, Princeton University Press (Princeton, New Jersey: 2015).

Agénor, Pierre-Richard, and Kyriakos Neanidis, "Innovation, Public Capital, and Growth," *Journal of Macroeconomics*, 44 (June 2015), 252-75.

Alhashel, Bader, "Sovereign Wealth Funds: A Literature Review," *Journal of Economics and Business*, forthcoming (March 2015).

Bems, Rudolfs, "Aggregate Investment Expenditures on Tradable and Nontradable Goods," *Review of Economic Dynamics*, 11 (October 2008), 852-83.

Berg, Andrew, Rafael Portillo, Shu-Chun S. Yang, and Luis-Felope Zanna, "Public Investment in Resource-Abundant Developing Countries," *IMF Economic Review*, 61 (March 2013), 92-129.

Bom, Pedro R., and Jenny E. Ligthart, "What Have we Learned from Three Decades of Research on the Productivity of Public Capital?," *Journal of Economic Surveys*, 28 (December 2014), 889-916.

Boyce, James K., and Léonce Ndikumana, "Capital Flight from Sub-Saharan African Countries: Updated Estimates, 1970-2010," Research Report, University of Massachusetts Amherst (October 2012).

Central Bank of Congo, *Annual Report 2013*, CBC Publications (Kinshasa: 2013).

Collier, Paul, Frederick van der Ploeg, Michael Spence, and Anthony J. Venables, "Managing Resource Revenues in Developing Economies," *IMF Staff Papers*, 51 (April 2010), 84-118.

Dabla-Norris, Era, Jim Brumby, Annette Kyobe, Zac Mills, and Chris Papageorgiou, "Investing in Public Investment: An Index of Public Investment Efficiency," *Journal of Economic Growth*, 17 (September 2012), 235-66.

Frankel, Jeffrey A., "The Natural Resource Curse: A Survey," Working Paper No. 15836, National Bureau of Economic Research (March 2010).

Gelb, Alan, Silvana Tordo, and Havard Halland, "Sovereign Wealth Funds and Long-Term Development Finance: Risks and Opportunities," Policy Research Working Paper No. 6776, World Bank (February 2014).

Gupta, Sanjeev, Alex Segura-Ubiergo, and Enrique Flores, "Direct Distribution of Resource Revenues: Worth Considering?," Staff Discussion Note No. 14/05, International Monetary Fund (June 2014).

International Monetary Fund, *Macroeconomic Policy Frameworks for Resource-Rich Developing Countries*, IMF publications (Washington DC: 2012).

Lundgren, Charlotte J., Alun H. Thomas, and Robert C. York, *Boom, Bust, or Prosperity? Managing Sub-Saharan Africa's Natural Resource Wealth*, International Monetary Fund (Washington DC: 2013).

Melina, Giovanni, Shu-Chun S. Yang, and Luis-Felipe Zanna, "Debt Sustainability, Public Investment, and Natural Resources in Developing Countries: The DIGNAR Model," Working Paper No. 14/50, International Monetary Fund (March 2014).

Rabanal, Pau, and Vicente Tuesta, "Nontradable Goods and the Real Exchange Rate," *Open Economies Review*, 24 (July 2013), 495-535.

van der Ploeg, Frederick, and Anthony J. Venables, "Absorbing a Windfall of Foreign Exchange: Dutch Disease Dynamics," *Journal of Development Economics*, 103 (July 2013), 229-43.