Dutch Disease and Spending Strategies in a Resource-Rich Low-Income Country

The Case of Niger

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Abstract

This paper examines spending plans suggested by the recent literature regarding Dutch disease and examines their implications to Niger relative to its expanding mineral sector. The key to the benefits of significant mineral revenue lies with the productivity and supply responses of spending. If significant output gain is ensured, then there is little difference across the spending plans in their effects on real consumption. The overshooting of relative prices of the non-tradable sector or the shrinking share of traded sectors in gross domestic product is also ameliorated with greater supply flexibility. Growth paths of alternative spending strategies differ markedly in timing and pattern when spending does not raise productivity. As a caution against expectations

that exaggerate the benefits of mineral revenue under all circumstances, the more aggressive spending plan may result in a boom-bust cycle if fiscal adjustments and debt repayments are necessary for any significant borrowing against future revenue and productivity gains are not realized. Using extractive industries revenue for transfers to households would have a greater effect on poverty reduction in the short and medium term but the long-run gains from investment in human and physical capital are likely to offset the initial lack of pro-poor bias. Different strategies differ significantly with regard to risks and required technical implementation capacity and political capacity to sustain a chosen course of action.

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Dutch Disease and Spending Strategies in a Resource-Rich Low-income Country – The Case of Niger

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Introduction

Natural resources can contribute to economic growth and poverty reduction in Niger. Over the next two decades, Niger will see a dramatic increase in natural resource revenues which will greatly improve its external and fiscal position. In a brief period of time, exports of oil and uranium are expected to account for close to 20 percent of GDP by 2015 (from less than 8 percent in 2009). Likewise, total public revenue will reach 20 percent of GDP by 2015 (from less than 15 percent in 2009).²

The infusion of resource money will have to be used very wisely in order to address several challenges unique to Niger. After decades of political instability and turmoil, there is much ground to catch up. Niger's historical growth record has been very weak. Its per capita income growth was negative in the 1990s and close to stagnant in the 2000s, albeit more positive in recent years. The country currently ranks at the bottom of the UNDP's human development index. Its poverty rate is high—about 44 percent of the population lives below \$1.25 a day and 75 percent below \$2 a day. Its adult literacy rate, at 29 percent, is among the lowest. Health indicators, such as maternal and child mortality, are very poor. In addition, Niger's terrain is harsh and dry – more than 80 percent of Niger is desert; only 12 percent, mainly in the south, is cultivated; and only about 1 percent is forested. Subsistence agriculture, livestock and fishing constitute the backbone of the economy, employing 86 percent of the active population. The road and infrastructure network in this landlocked economy is still very limited. Lack of water is a major problem.

An important policy question will be how to harness the increased income from natural resources to bring about sustained growth and poverty reduction in Niger over a long period of time. Options include improving the productivity of agriculture with infrastructure investment, diversifying the economy away from mining and traditional agriculture, improving human capital, and maintaining a reserve fund as a safety net against world price shocks. The current government anticipates using revenue from natural resources to finance public investment in infrastructure, agriculture, health care, and education (IMF, March 2012).

Even so, there are several issues and risks. In low-income countries, not only are spending needs relatively large and the growth of the tradable sector important for future income, capacity is usually low to optimize consumption over time or to hedge and stabilize revenue against fluctuating export prices. We briefly survey findings from the recent economic literature and its implications for Niger in a series of simulations. In particular, the effects of resource revenue on the real exchange rate and their economic repercussions have continued to receive wide attention in the literature. If the supply response or absorptive capacity is limited in the rest of the economy, the resource windfalls may induce a rapid

² IMF country report for Niger, May 2012.

appreciation of the real exchange rate, a loss of competitiveness in the non-resource export sector, deindustrialization of the traditional sectors, and poorer growth prospects overall for the economy. These potential harmful effects were labeled as “Dutch disease” when they were noticed in Netherlands after the discovery of North Sea gas.³ In this paper, we examine Dutch disease in the context of Niger and its discovery of oil and uranium deposits. We quantify the likely impact of the expansion of the extractive industries on Niger’s real exchange rate and economy and suggest policy options to mitigate the negative impact of an appreciating exchange rate on Niger’s international competitiveness. Obtaining quantitative estimates of the impact of the expansion of Niger’s extractive industries sector on the country’s competitiveness is of particular interest as it directly affects Niger’s efforts to diversify the economy.

We analyze the macroeconomic implications of an increase in revenue from export sales in a recursive dynamic computable general equilibrium (CGE) model for Niger, 2009. The underlying data for the model are from a 2009 social accounting matrix (SAM), which is estimated and updated from the 2004 matrix using information from Niger’s national accounts. The model includes private and public investment. Public capital increases infrastructure which is assumed to increase productivity growth. Note the SAM for 2009 includes uranium production (at the 2009 level as part of the broader mining sector); there is no petroleum production in 2009. The discovery and extraction of petroleum and expanded uranium output will have an impact on the economy mainly through the increase in foreign revenue to government and the economy-wide repercussions of its use. The nascent oil sector is assumed to be a highly extractive and the revenue to Niger is only the government’s share in its export revenues, assuming that petroleum production is financed mainly by foreign capital and foreign labor. Likewise, we assume that new expanded uranium production is financed mainly by foreign capital and foreign labor.

The baseline replicates the historical GDP growth for Niger. Policy shocks include an increase in revenue from export sales of oil and uranium – using estimates of the share of export revenue that accrues to the government. The revenue that goes to the government may directly increase public expenditures to provide public infrastructure, deliver education and health services, and pay for public administration. Alternatively and through government transfers, the income can go to households which spend most of their incomes on subsistence agriculture. For each simulation, we report the annual growth rate of GDP, investment, consumption, imports, exports, the real exchange rate, private capital, and public capital.

Although Niger’s mineral revenue can bring about greater development, its use can clearly affect its external balance of payments (BOP) and debt situation. Without undertaking a new debt sustainability analysis (which is beyond the scope of this paper), a simple approach undertaken is to assume that no new debt burden is incurred at the margin over the

³ Corden and Neary (1982) and Wijnbergen (1984).

horizon of the analysis – that is, whatever may be borrowed against future revenue in the initial periods is fully paid back at the end periods of the analysis. The model will be used to evaluate different timing options to spend the mineral revenue. Assuming the government can borrow against the expected oil revenue, one can evaluate the growth effects of different spending patterns of the extra revenue – for example, Niger can borrow and spend the expected oil revenue early in the dynamic simulation. However, against potential benefits of more public spending in the early periods are likely fiscal adjustments in the late periods in the form of fiscal consolidation or adjustment needed to meet the debt obligations incurred. The magnitude and timing of the fiscal policy needed will in turn depend on many factors – the absorptive capacity of the Nigérien economy, the productivity of government spending, the growth of the economy and its tax base etc. We examine the economic implications of alternative assumptions or scenarios in this paper.

The remainder of the paper is organized as follows. Section 2 discusses the data and the structure of Niger’s economy. Section 3 briefly describes the methodology or the recursive dynamic CGE model used for the analysis. Section 4 sets up the spending strategies regarding the mineral revenue. Section 5 presents the simulations and results. Our conclusions appear in section 6.

Niger’s Economic Performance and Structure

Niger’s economy is dominated by activities in the rural sector, which contributed 44 percent of GDP in 2012. These consist of agriculture which contributed 28 percent, livestock with 11 percent, and forestry and fishing, with 5 percent. Trade, which contributes 15 percent of GDP, and government with 12 percent are the other main sectors of the Nigérien economy. In the mining sector, the contribution of uranium to GDP, at 3 percent, is recently overshadowed by oil, which contributed already 5 percent of GDP in 2012. Other sectors such as industry, energy and handicrafts (6 percent of GDP), construction and public works (3 percent of GDP), transport (including the new pipeline) (7 percent of GDP) and other services (6 percent of GDP) are relatively small and underdeveloped.

Most of Niger’s economic activity takes place in the traditional sector and only 31 percent in the modern sector. Activities in the traditional sectors are primarily agriculture, livestock, forestry and fishing, but also mostly informal trade and production activities. From the employment side this is even more striking, as about 80 percent of Niger’s population is employed in the rural sector and only a small share of the population in formal employment. Given that much of the traditional sector does not contribute to government revenue, Niger’s tax base is very narrow.

Niger's economic growth has accelerated from an annual average of 4.4 percent during the period 2002-2007 to 5.5 percent during the period 2007-2012. This was achieved despite profound political disturbances, two severe droughts in 2009 and 2011, and an increasingly adverse external environment. Inflation has been below 4 percent in most years since 2000. Until 2008, inflation tended to increase on account of food shortages whenever a food crisis occurred. More recently in 2010 and 2012, inflation remained low despite severe food crises. This reflects on the one hand the impact of the food safety net -- during years of crisis food is distributed free or at subsidized prices to vulnerable households with funding from government and donors. On the other hand, this also reflects the lack of purchasing power of vulnerable households who contribute little to effective demand even during years following harvest failures.

Figure 1: Economic growth and inflation, 2000-2012

Source: Authors' calculations from government data, IMF database and WDI.

Table 1: GDP growth 1992-2012 and contributions to growth [expenditure side]

	2007	2008	2009	2010	2011	2012	Average 2002-2007	Average 2007-2012
Growth rates								
Gross domestic product (100%)	0.6%	9.6%	-1.0%	10.7%	2.2%	11.2%	4.4%	5.5%
Public consumption (15%)	6.0%	6.6%	7.1%	-2.6%	-4.4%	25.7%	7.7%	6.4%
Private consumption (73%)	-0.5%	2.8%	11.2%	-4.7%	5.4%	5.7%	2.6%	3.3%
Gross fixed capital formation (33%)	2.2%	48.5%	4.6%	52.8%	3.0%	-4.5%	15.6%	17.8%
Exports of goods and services (22%)	7.9%	21.0%	4.8%	19.5%	2.2%	27.2%	4.0%	13.8%
Imports of goods and services (44%)	3.1%	31.8%	29.2%	14.6%	5.4%	0.5%	6.9%	14.1%
Contribution to growth								
Public consumption	0.9%	1.0%	1.1%	-0.4%	-0.7%	3.5%	1.2%	1.0%
Private consumption	-0.4%	2.1%	7.8%	-3.6%	3.6%	4.0%	2.0%	2.3%
Gross fixed capital formation	0.5%	11.1%	1.4%	17.3%	1.3%	-2.0%	3.0%	6.5%
Net exports of goods and services	0.4%	-5.9%	-9.7%	-2.9%	-2.2%	5.8%	-1.7%	-3.7%
Exports of goods and services	1.3%	3.7%	0.9%	4.0%	0.5%	6.0%	0.7%	3.0%
Imports of goods and services	-0.9%	-9.6%	-10.6%	-6.9%	-2.7%	-0.3%	-2.0%	-6.2%

Note: numbers in brackets are shares of total.

Source: Government of Niger, IMF Niger data base, and World Bank WDI.

On the expenditure side, faster growth of private consumption, investment, and exports contributed to the improved growth performance (Table 1). Increased aggregated demand also resulted in an acceleration of import growth.

Table 2: GDP growth 2002-2012 and contributions to growth [output side]

	2007	2008	2009	2010	2011	2012p	Average 2002-2007	Average 2007-2012
Growth rates								
GDP at factor cost (100%)	2.1%	9.5%	-1.5%	11.1%	1.5%	12.4%	3.6%	5.8%
Rural sector (44%)	4.6%	16.2%	-9.5%	16.7%	-3.7%	6.7%	5.5%	5.2%
Agriculture (28%)	5.0%	23.9%	-17.6%	28.7%	-7.9%	9.2%	7.7%	6.9%
Livestock (11%)	4.3%	4.4%	4.4%	-4.6%	4.5%	2.8%	4.0%	2.6%
Forestry and fishing (5%)	3.3%	3.6%	9.2%	9.9%	3.0%	1.7%	0.5%	5.1%
Mining+ Upstream oil (8%)	-5.8%	-2.1%	39.5%	19.5%	7.5%	196.8%	0.5%	42.6%
Industry, energy, and handicrafts (6%)	-2.4%	4.7%	5.1%	8.9%	3.9%	-2.1%	1.1%	3.0%
Manufacturing industries and handicrafts + Refinery (5%)	0.3%	3.9%	4.4%	3.3%	8.5%	-4.0%	2.3%	2.7%
Electricity and water (1%)	-13.5%	8.8%	8.4%	33.7%	-12.1%	5.7%	-3.3%	5.2%
Construction & Public Works (3%)	3.6%	5.0%	7.9%	20.3%	-3.2%	7.3%	6.1%	6.8%
Commerce, transport, and services (28%)	-1.5%	4.0%	4.6%	5.4%	5.0%	6.6%	2.7%	4.0%
Commerce (15%)	1.2%	4.8%	5.7%	5.3%	3.4%	3.9%	3.1%	4.0%
Transport + Pipeline (7%)	2.3%	4.8%	5.0%	7.9%	10.2%	8.4%	2.6%	6.4%
Services (6%)	-10.2%	1.7%	1.6%	2.8%	3.0%	11.1%	2.2%	1.7%
Government (12%)	5.8%	2.0%	6.9%	0.3%	14.2%	11.5%	1.4%	6.8%
Oil GDP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Oil and uranium GDP (8%)	-5.8%	-2.1%	39.5%	19.5%	7.5%	184.5%	0.5%	40.5%
Modern sector (31%)	-1.9%	6.0%	9.3%	10.2%	9.1%	21.5%	2.8%	9.0%
Traditional sector (69%)	1.7%	11.0%	-4.6%	10.8%	-0.5%	5.9%	4.0%	4.0%
Contribution to growth								
Rural sector	2.1%	7.7%	-4.8%	7.7%	-1.8%	3.1%	2.4%	2.3%
Agriculture	1.4%	6.9%	-5.8%	7.9%	-2.5%	2.7%	1.8%	1.8%
Livestock	0.6%	0.6%	0.6%	-0.6%	0.5%	0.3%	0.5%	0.3%
Forestry and fishing	0.2%	0.2%	0.4%	0.5%	0.1%	0.1%	0.0%	0.2%
Mining+ Upstream oil	-0.1%	0.0%	0.7%	0.5%	0.2%	5.9%	0.0%	1.2%
Industry, energy, and handicrafts	-0.2%	0.3%	0.3%	0.6%	0.3%	-0.1%	0.1%	0.2%
Manufacturing industries and handicrafts + Refinery	0.0%	0.2%	0.2%	0.2%	0.5%	-0.2%	0.1%	0.1%
Electricity and water	-0.2%	0.1%	0.1%	0.4%	-0.2%	0.1%	0.0%	0.1%
Construction & Public Works	0.1%	0.1%	0.2%	0.6%	-0.1%	0.2%	0.2%	0.2%
Commerce, transport, and services	-0.5%	1.2%	1.3%	1.6%	1.4%	1.9%	0.9%	1.2%
Commerce	0.2%	0.7%	0.8%	0.8%	0.5%	0.6%	0.5%	0.6%
Transport + Pipeline	0.2%	0.3%	0.3%	0.6%	0.7%	0.6%	0.2%	0.5%
Services	-0.8%	0.1%	0.1%	0.2%	0.2%	0.7%	0.2%	0.1%
Government	0.6%	0.2%	0.8%	0.0%	1.5%	1.4%	0.1%	0.8%
Of which Oil GDP	0.0%	0.0%	0.0%	0.0%	0.0%	4.7%	0.0%	0.8%
Oil and uranium GDP	-0.1%	0.0%	0.7%	0.5%	0.2%	5.6%	0.0%	1.1%
Modern sector	-0.6%	1.8%	2.7%	3.3%	2.9%	7.3%	0.9%	2.9%
Traditional sector	1.4%	8.5%	-3.6%	8.2%	-0.4%	4.4%	3.1%	3.1%

Note: Numbers in brackets are shares of total, p – preliminary estimate.

Source: Government of Niger, IMF Niger data base, and World Bank WDI.

On the output side, the acceleration in economic growth is primarily explained by the start of oil production and the expansion of government. The mining and oil sector grew during the period 2007 to 2012 by 43 percent, contributing 1.1 percentage points to economic growth. Government expanded by 7 percent and contributed 0.8 percentage points to

economic growth. However, the rural sector remains the main contributor to economic growth with 2.3 percentage points, a performance similar to that of the preceding five year period.

The modern sector, which includes the oil industry, grew annually by 9 percent during the period 2007 to 2012 and contributed half of Niger's overall economic growth, despite the fact that it only accounts for 31 percent of the economy. The growth of the extractive industries and modern sectors bodes well for Niger's capacity to generate government revenue.

Trade and Balance of Payments

During the period 2007 – 2012, the nominal value of both exports and imports grew at an annual average rate of 20 percent. Uranium has been Niger's main export, accounting for 43 percent of total exports in 2012. Exports of refined oil products started in 2012 and contributed already 13 percent of total exports, despite start-up problems which resulted in production and exports being significantly below capacity. The remaining exports are mainly agricultural products. Livestock contributes 8 percent to total exports. Exports of cowpeas contribute another 8 percent to total exports and onions account for 5 percent.

Table 3: Exports and Imports, Million CFAF, 2007-2012

	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012	Share in total 2012
Exports								
Uranium	143	198	196	242	301	339	19%	43%
Oil	0	0	0	0	0	102	0%	13%
Livestock	38	50	61	58	51	63	11%	8%
Cowpeas	19	42	58	53	54	60	26%	8%
Onions	42	42	40	40	39	43	1%	5%
Other	50	50	87	131	111	134	22%	17%
Re-exports	26	26	29	46	44	46	13%	6%
Total	318	409	471	570	601	788	20%	100%
Imports								
Food	88	120	206	182	228	237	22%	22%
Oil products	66	91	126	133	140	16	-25%	1%
Capital goods	112	227	302	290	344	424	30%	39%
Intermediate goods	59	31	132	251	99	170	23%	15%
Other goods	113	136	81	116	242	251	17%	23%
Total	438	604	847	973	1052	1097	20%	100%

Source: Government of Niger, IMF Niger data base, and World Bank WDI.

Capital goods accounted for 39 percent of total imports in 2012, reflecting large scale investment in the extractive industries and energy sectors. Food imports have grown rapidly during the period 2007 – 2012 – partly as a result of repeated harvest failures that made donor funded food imports necessary in order to meet the basic needs of the population - and account now for 22 percent of total imports. Other goods, which include a wide range of

consumption goods, accounted for 23 percent of imports and intermediate goods for 15 percent.

Table 4: Balance of payments, percent of GDP, 2007-2012

	2007	2008	2009	2010	2011	2012
Current account balance (including official transfers)	-8.3%	-13.0%	-24.7%	-19.9%	-24.7%	-17.7%
Current account balance (excluding official transfers)	-10.5%	-15.2%	-25.4%	-25.4%	-28.0%	-20.9%
Goods and services	-12.6%	-16.9%	-26.9%	-26.9%	-28.5%	-20.4%
Goods	-5.9%	-8.2%	-15.0%	-14.2%	-15.1%	-9.2%
Exports	15.6%	17.0%	18.7%	20.2%	20.1%	23.5%
Imports	-21.5%	-25.2%	-33.7%	-34.4%	-35.2%	-32.7%
Services	-6.7%	-8.8%	-11.9%	-12.7%	-13.4%	-11.2%
Income	0.0%	-0.4%	-0.6%	-0.8%	-0.8%	-1.8%
Current transfers	4.4%	4.3%	2.8%	7.9%	4.6%	4.6%
Capital and Financial Account	12.1%	16.2%	21.4%	23.5%	23.7%	20.5%
Capital account	6.3%	4.8%	4.8%	3.4%	2.5%	4.9%
Capital transfers	5.0%	4.8%	4.8%	3.4%	2.5%	5.8%
Acquisition/disposal of non-produced, nonfinancial assets	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Financial Account	5.7%	11.5%	16.7%	20.1%	21.2%	15.6%
Direct investment	2.8%	11.0%	13.8%	17.5%	16.7%	8.4%
Portfolio Investment	-0.1%	-0.2%	0.3%	0.3%	0.3%	0.1%
Other investment (excl. except. financing)	3.0%	0.7%	2.6%	2.2%	4.3%	7.1%
Errors and Omissions	-0.4%	-0.2%	-0.3%	0.0%	0.0%	0.0%
Overall balance	3.4%	3.0%	-3.6%	3.6%	-0.9%	2.9%
Financing	-3.4%	-3.0%	3.6%	-3.6%	0.9%	-2.9%
Change in net foreign assets (-increase)	-3.5%	-3.2%	3.4%	-3.8%	0.9%	-2.9%
Rescheduling obtained	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%

Source: Government of Niger, IMF Niger data base, and World Bank WDI.

Niger suffers from a structural trade deficit, which, due to investment related large scale imports of capital and intermediate goods, increased from 12.6 percent of GDP in 2007 to 28.5 percent of GDP in 2011. With the completion of the refinery in 2011 and the switch from an importer to an exporter of oil, the trade deficit dropped to 20.4 percent of GDP in 2012. Developments in the trade account are mirrored in the current account deficit (excluding official transfers), which increased from 10.5 percent of GDP in 2007 to 28 percent of GDP in 2011 before dropping to 20.9 percent of GDP in 2012.

The current account is financed through foreign direct investment and donor assistance. As a result of large scale foreign investments in the uranium and oil sectors, foreign direct investment increased from 2.8 percent in 2007 to 17.5 percent in 2010 and 16.7 percent in 2011. With the completion of the oil refinery in 2011, foreign direct investment dropped to 8.4 percent in 2012. Donor funding in the form of grants and loans was affected by the political crisis during the period 2009 to 2011, which resulted in a temporary decline in donor support. This also led to fluctuations in the overall balance of payments which registered surpluses of about 3 percent of GDP in most years with the exception of 2009 and 2011 when the overall balance registered deficits.

Fiscal Policy

Despite the economic and political turbulence experienced between 2009 and 2012, fiscal policies remained consistent with macroeconomic stability. The government's fiscal policy was broadly consistent with macro-economic programs agreed with the IMF. The fiscal deficit (including grants) increased only slightly from 2.4 percent of GDP in 2010 to 3.0 percent of GDP in 2011. For 2012, the deficit is projected to increase to 3.5 percent of GDP.

Table 5: Central Government Operations (% of GDP), 2009-2015

	2009	2010	2011pr	2012p
Domestic Revenue	14.7	13.6	14.3	16.0
Current Expenditure	12.1	13.0	12.7	12.4
Capital Expenditure)	12.5	7.7	8.4	13.3
Net lending	0.0	0.0	1.5	0.0
Fiscal deficit (commitment basis, excl. grants)	-9.9	-7.0	-6.8	-9.7
Grants	4.5	4.6	3.8	6.2
Net. Loans	1.4	0.9	2.8	4.5
Domestic financing	4.5	1.9	0.3	-0.7

Source: IMF Niger data base.

Note: pr – preliminary; p – projected.

Monetary and Exchange Rate Policy

Niger's monetary and exchange rate policy is determined within the West African Monetary and Economic Union (WAEMU) mechanisms. In particular, Niger's exchange rate – the CFA Franc – is tied to the Euro. Niger does not have an independent monetary policy. In the analysis, exchange rate appreciation is mainly about the relative price of tradable and non-tradable goods.

Table 6: Money and credit, 2007-2012, CFAF billion

	2007	2008	2009	2010	2011	2012	Average annual change 2007-2012
Net foreign assets	231.8	285.0	193.8	292.9	263.5	388.7	11%
Central Bank of West African States	240.7	297.3	224.2	292.6	265.2	363.8	9%
Commercial banks	-9.0	-12.3	-30.4	0.3	-1.7	24.9	0%
Net domestic assets	123.9	114.2	278.5	283.1	348.1	394.8	26%
Domestic credit	141.4	147.8	311.4	351.2	418.8	472.5	27%
Net bank claims on government	-50.5	-114.8	0.5	4.1	16.2	-16.2	-20%
Credit to the economy	191.9	262.6	310.9	347.2	402.6	488.7	21%
Money and quasi money	355.7	399.2	472.3	576.0	611.6	783.5	17%
Currency outside banks	132.8	147.7	187.0	234.9	269.9	344.6	21%
Deposits with banks	221.5	250.0	285.3	341.2	341.6	438.9	14.7%
Private sector	208.4	230.7	263.5	312.0	323.0	416.6	14.9%
Public institutions	13.2	19.3	20.0	27.8	18.7	18.7	7.2%
Velocity of circulation of money (GDP/broad money)	5.7	6.0	5.3	4.9	4.9	4.3	

Source: IMF Niger data base.

Over the period 2007 – 2012, Niger has experienced some monetary deepening, with the ratio of broad money to GDP increasing from 17 percent in 2007 to 26 percent in 2012. Nonetheless, the degree of monetization of Niger's economy remains among the lowest worldwide and also well below the 41 percent average for Sub-Saharan Africa. The overall level of financial intermediation has continued to increase but remains low and the range of financial products available is still limited. Credit to the private sector increased fairly rapidly at an annual average rate of 23 percent. The main beneficiaries of credit are enterprises in the mining, telecoms and trade sector in urban areas. Small and Medium Enterprises (SMEs) and rural areas continue to have little access to credit.

Debt

Following a significant reduction of Niger's external debt through the Enhanced Highly Indebted Poor Country (HIPC) initiative and the Multilateral Debt Reduction Initiative (MDRI), public and publicly guaranteed (PPG) external debt has been rising quickly from 14.9 percent in 2007 to a projected 24 percent in 2012. Most of Niger's external borrowing is on concessional terms to support its large development needs. A government guarantee for the government share of US\$352 million in the loan for the construction of the petrol refinery has significantly added to Niger's external debt. The planned refinancing through a concessional loan from the Exim Bank of China in 2013 will further increase Niger's stock of public external debt as the entire loan amount would be on the government's books, even though it is expected that 60 percent of the loan amount would be guaranteed by the foreign investor. Domestic public sector debt has declined from 9.2 percent of GDP in 2007 to 5.7 percent of GDP in 2012.

Table 7: Public sector debt, percent of GDP, 2007 - 2012

	2007	2008	2009	2010	2011	2012
Public sector debt (% of GDP) 1/	24.2	22.0	27.2	24.0	29.9	29.7
o/w external (% of GDP)	14.9	15.1	18.9	17.0	22.4	24.0
o/w domestic (% of GDP)	9.2	7.0	8.3	7.0	7.5	5.7
Debt service-to-revenue and grants ratio (in percent) 2/	13.1	8.1	-1.2	7.2	4.0	8.0
Debt service-to-revenue ratio (in percent) 2/	18.2	10.7	-1.5	9.6	5.1	11.0

Source: IDA and IMF. Niger: Debt Sustainability Analysis. March 2013.

The Extractive Industries Sector

Uranium and, more recently, oil are Niger's main exports. In addition, the country also produces gold and is home to rich coal deposits whose use is at present limited to fueling a thermal power plant that provides energy for the uranium mines.

Uranium was discovered in Niger in 1957 and production started in 1971 from the Arlit deposit and in 1974 from the Akouta deposit through a joint venture with a French nuclear power company. Total uranium production from these two mines was 4,351 tons in

2011 generating exports of about F CFA 300 bn in 2011. Since 2009, development of the Imouraren deposit is underway, which is expected to more than double uranium production in Niger by adding 5,000 tons per year. Production is expected to start in 2015. In 2010, mining of the Azelik deposit started in a joint venture between the Nigerien government and Chinese partners. Production is expected to reach 2,500 tons per year by 2015 and potentially double that by 2020.

Niger started to produce oil in November 2011 in a joint venture with a foreign investor. The foreign investor holds 60 percent and the Government of Niger the remaining 40 percent in the joint venture, which is governed by a production sharing agreement. The project includes the development of the Agadem oil field, the construction of a refinery which is connected to the oil fields by a pipeline. The oil reserves of the Agadem oil field were initially estimated at around 300 million barrels. However, in 2011, the government announced that the reserves may be significantly higher at around 900 million barrels. The refinery has a capacity of 20,000 barrels per day, producing gasoline, diesel, and liquefied petroleum gas (LPG). Currently, domestic demand is estimated at around 7,000 barrels per day with the remaining production of the refinery to be exported. Due to startup problems, production during 2012 was only about half of available refining capacity. For 2013, it is projected that production will be increased to at least 16,000 barrels per day. In June 2012, Niger signed an agreement with neighboring Chad to construct a 600 km (373 miles) pipeline linking it to the Chad-Cameroon pipeline which will enable it to export its crude. Niger is expected to begin operating reserves on four fields at its Agadem bloc by early 2014, and increase its production to 80,000 barrels per day of which 60,000 will be exported through the pipeline. In 2011, Niger reached the compliant status under the Extractive Industries Transparency Initiative (EITI), the international standard for revenue transparency in the extractive industry (EITI 2013).

A 2009 SAM for Niger

The structure of the Nigérien economy has remained largely unchanged over the last decade and the backbone is still subsistence agriculture, reflecting the obstacles of industrializing or adding more value added with agro industries. To help understand the economic relationships in the Niger economy, we look at the data in Niger's Social Accounting Matrix (SAM). We begin by updating the 2004 SAM to 2009 using data from Niger's National Accounts by economic activity as compiled by the United Nations (UN 2009).⁴ Very briefly, the steps entail the following – i) the 2004 SAM is first aggregated into 11 sectors (two sectors, petroleum and utilities, are not produced in Niger in 2009) – see Table 8; ii) the value added for each sector and final demand component are scaled to the 2009 numbers; iii)

⁴ The 2004 Social Accounting Matrix for Niger is provided by the International Food Policy Research Institute (IFPRI). In the update to 2009, we retain the technology coefficients of the input-output table underlying the 2004 SAM, given that the economic structure of Niger has not changed very much.

new data about the distribution of factor income for labor and capital, indirect and commodity taxes, and external accounts are incorporated; and iv) using the maximum-entropy method for estimating and balancing a SAM developed by Arndt, Robinson, and Tarp (2002), the 2009 SAM is derived by targeting key aggregates such as GDP and its final demand components, aggregate labor and capital income, tax revenue, exports and imports figures etc. In addition to having more recent data, the new SAM (albeit an estimated one) offers another advantage – it corrects the low level and share of capital income in the value added by sector in the 2004 SAM. The capital income reported in the 2004 Niger SAM is quite low – 5.5 percent of value added. Such a low figure is contrary to most empirical results from growth accounting, which tend to give relatively higher factor income shares to capital in low-income countries (as much as 50 percent or higher) and relatively lower share for wage income. The primary reasons for this pattern relate to the fact that capital is scarce and expensive in developing countries while labor, especially the unskilled in agriculture and services, are abundant and inexpensive. Partly for this reason, we update the 2004 matrix to 2009 in order to obtain better estimates of the factor income shares.

Table 8: Sector aggregation for Niger 2009 SAM

Aggregate Sector	Components from the 2004 SAM
Food agriculture (subsistence agriculture)	Agriculture vivrière irriguée Agriculture vivrière non irriguée Elevage et pêche Forêt
Other Agriculture	Agriculture de rente irriguée Agriculture de rente non irriguée
Mines	Industrie d'extraction
Petroleum	Produits pétroliers
Food manufacturing	Fabrication aliments et boissons
Other manufacturing	Textiles et habillement Industrie chimique Autres manufactures Production des métaux
Construction	Construction
Utilities	Electricité, gaz, eau
Services	Transport et communication Services financiers Services immobiliers et aux entreprises Hôtels et restaurants Autres services Services communautaires et personnels
Public Services	Administration publique
Education & Health	Education Santé et services sociaux

Note: The original 2004 SAM was provided courtesy of the International Food Policy Research Institute (IFPRI).

There are seven factors in the 2004 SAM, which we aggregate to five factors - agricultural labor, land, unskilled labor, skilled labor, and capital. Table 9 presents the mapping:

Table 9: Factor aggregation in the 2009 SAM

Aggregate factors	Factors from the 2004 SAM
Agricultural labor	Travail agricole Travail des autres activités rurales
Unskilled labor	Travail du secteur informel Travail non qualifié du secteur privé formel Travail non qualifié du secteur public formel
Skilled labor	Travail qualifié du secteur privé formel Travail qualifié du secteur public formel
Capital	Rentiers
Land	Land is assumed to be 50% of the income reported to capital in the two agricultural sectors

In Niger, 86 percent of employment is in subsistence agriculture. The informal sector does not employ many skilled workers. Therefore we assign workers in the informal sector to the unskilled labor category.

Structure of the Nigérien Economy

Using data from the 2009 SAM, we consider the structure of consumption, production and trade (see table 10) in Niger. We find that agriculture (reported as food agriculture and other agriculture) and services have the highest shares in total consumption (25.7 and 20.7 percent respectively). Likewise, these two sectors have the highest share of total production. Niger depends heavily on imported goods – 26.9 percent of total consumption is imported. Important import sectors include manufacturing goods (93.5 percent of total consumption is imported) and petroleum (100 percent of total consumption in 2009 is imported); manufacturing is the largest import sector, accounting for 65.1 percent of total imports. The next largest import good is petroleum, which accounts for 15.3 percent of total imports.

Mining is the most important export good – it accounts for 46.7 percent of total exports. The majority of mining is exported – 80.9 percent of production. Agriculture (reported as food production and other agriculture) is the next largest export, accounting for 38.4 percent of total exports.

Construction, public services, and education/health are purely non-traded goods.

As seen in Table 11, the service sector employs the majority of unskilled non-agricultural labor – 81.3 percent.⁵ The sectors public service and education/health employ

⁵ Note, the category services is an aggregate of the following sectors represented in the 2004 SAM: transport and communication services (19.2 percent), financial services (2.7 percent), real estate and business services (30.3 percent), hotel and restaurant services (8.3 percent) other services (36.7 percent), and personal and

53.6 and 26.3 percent of skilled labor respectively. The majority of capital is employed in the two agricultural sectors, which employ 52.1 percent of the capital stock. The sectors mines and processed food employ 16.2 and 10.8 percent of the capital stock.

The mining, manufacturing, and processed food sectors have high value added shares for capital which accounts for over 80 percent of total value added in each of the sectors (see Table 12). Likewise, there is a high share of capital in value added in the construction sector (61.5 percent).

Table 10: Structure of consumption, production, and trade (percent) in Niger, 2009

	Consumption	Production	Imports	Exports	Import share of consumption	Export share of production
Food agriculture	19.9	23.9	10.2	26.2	13.7	16.3
Other agriculture	5.8	7.0	4.7	12.2	22.1	25.6
Mines	1.4	8.6	0.0	46.7	0.0	80.9
Processed food	8.2	9.0	2.0	0.6	6.6	1.0
Petroleum	4.1	0.0	15.3	0.0	100.0	0.0
Other manufacturing	18.7	3.3	65.1	12.8	93.5	57.3
Construction	5.4	6.3	0.0	0.0	0.0	0.0
Utilities	2.4	2.2	1.8	0.0	20.1	0.0
Services	20.7	24.0	1.0	1.5	1.3	0.9
Public services	8.0	9.4	0.0	0.0	0.0	0.0
Education/Health	5.4	6.3	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	26.9	14.8

Source: Authors' calculations using the microeconomic SAM for Niger, 2009.

Table 11: Allocation of factors and value added by sector (percent) in Niger, 2009

	Agricultural Labor	Unskilled labor (non-agriculture)	Skilled labor	Capital	Land	Value added
Food agriculture	78.0	0.0	0.0	40.9	78.5	35.0
Other agriculture	22.0	0.0	0.0	11.2	21.5	9.6
Mines	0.0	2.9	1.2	16.2	0.0	6.1
Processed food	0.0	1.8	0.2	10.8	0.0	4.0
Other manufacturing	0.0	0.7	0.1	3.4	0.0	1.3
Construction	0.0	3.3	0.2	4.9	0.0	2.6
Utilities	0.0	0.5	3.9	2.4	0.0	1.3
Services	0.0	81.3	11.8	6.0	0.0	27.1
Public services	0.0	6.9	56.3	4.1	0.0	9.3
Education/Health	0.0	2.6	26.3	0.1	0.0	3.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations using the microeconomic SAM for Niger, 2009.

As seen in Table 13, consumption patterns vary by agent. Households, particularly rural households, have the highest expenditure shares for food agriculture, followed by services and processed food. Government purchases public services and education/health.

community service (2.8 percent). Given this composition of services, particularly the small financial services component, one does not expect a large share of skilled labor in the services sector.

Both public and private investment spending is highest in construction and other manufacturing. Public investment also emphasizes spending on education/health. These different expenditure patterns suggest that income given to different agents will have very different impacts on the structure of the economy. For example, income to the government that is spent on current consumption will increase demand for non-traded goods.

Table 12: Share of value added to factors by sector (percent) in Niger, 2009

	Agricultural Labor	Unskilled labor (non- agriculture)	Skilled labor	Capital	Land	Value added
Food agriculture	25.6	0.0	0.0	37.2	37.2	100.0
Other agriculture	26.2	0.0	0.0	36.9	36.9	100.0
Mines	0.0	14.1	2.1	83.8	0.0	100.0
Processed food	0.0	13.2	0.6	86.2	0.0	100.0
Other manufacturing	0.0	15.9	0.9	83.2	0.0	100.0
Construction	0.0	37.6	0.9	61.5	0.0	100.0
Utilities	0.0	11.2	31.0	57.8	0.0	100.0
Services	0.0	88.3	4.6	7.1	0.0	100.0
Public services	0.0	21.7	64.3	14.0	0.0	100.0
Education/Health	0.0	21.3	78.3	0.5	0.0	100.0
Total	11.5	29.4	10.7	31.8	16.6	100.0

Source: Authors' calculations using the microeconomic SAM for Niger, 2009.

Table 13: Expenditure shares by agent (percent) in Niger, 2009

	Rural HH	Urban HH	Capital owners	Government purchases for current consumption	Public Investment	Private Investment
Food agriculture	46.44	29.68	36.43	0.0	6.95	8.50
Other agriculture	4.38	7.45	2.47	0.0	0.09	0.39
Mines	0.00	0.00	0.00	0.0	2.80	3.26
Processed food	13.17	12.83	16.18	0.0	0.08	0.08
Petroleum	3.05	4.45	3.65	0.0	0.00	0.00
Other manufacturing	12.53	12.57	12.76	0.0	22.54	34.37
Construction	0.61	0.52	0.30	0.0	30.47	47.47
Utilities	2.74	2.48	4.78	0.0	4.98	0.00
Services	16.90	29.18	21.22	0.0	3.75	4.07
Public services	0.00	0.00	0.00	53.1	0.00	0.00
Education/Health	0.19	0.85	2.21	46.9	28.33	1.87
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Authors' calculations using the microeconomic SAM for Niger, 2009.

Methodology

We use a multi-sector computable general equilibrium (CGE) model of Niger to analyze how oil and uranium export revenue affects the economy. Like other resource-rich low-income countries, the significant capital investment required for resource extraction is financed by international companies and the returns accruing to Niger are captured primarily through government's share of mineral revenue in the form of taxation, royalties, and the government share in returns from the joint venture. The sophisticated skills needed to operate the mines are likewise assumed to be provided by foreigners and the production is taken as an enclave activity.⁶ Public revenue from the mineral resource is therefore modeled as an exogenous inflow to Niger, much like foreign aid and transfers.

The CGE Model for Niger

In the CGE framework, the economy is disaggregated into eleven sectors: food agriculture, other agriculture, mines, food manufacturing, petroleum, other manufacturing, construction, utilities, services, public services, and education/health.⁷ The sectors public services and education/health are consumed primarily by the government. Note that both sectors do not use other sectors as intermediate inputs – there are no backward linkages. There are five factors of production: agricultural labor, unskilled non-agricultural labor, skilled labor, land, and capital. The structure of the economy in 2009 is the base for the dynamic analysis.⁸ There is both private and public investment. Private investment increases the stock of capital available to production the next time period. The amount of private capital available in the current year depends upon the stock of capital from the previous year, net of depreciation plus investment which depends upon savings.⁹

The model uses the standard specification of trade typical of CGE models. Imports and domestic goods are imperfect substitutes in consumption (Armington assumption). Output can be sold on the domestic market or exported and there is a constant elasticity of transformation (CET) function between the domestic and the exported variety. We assume there is flexibility between imports and domestic goods (elasticity of substitutions range from 1.5 to 2 for each commodity) as well as flexibility between exports and the domestic variety (transformation elasticity of 1.5). However, we assume that it is difficult to switch mining products out of the domestic market and into the export market, and in that sector the

⁶ We this specification, we do not consider the case in which labor from Niger would enter the petroleum sector, leaving other sectors. We do not capture the resource-movement effect in which labor leaves traditional sectors such as agriculture and moves into the petroleum sector. Trevino (2011) finds a steady decline in the annual growth rate of the number employed in agriculture in oil-exporting countries in the CFA Franc zone, (i.e. Cameroon, Chad, Congo, Equatorial Guinea, Gabon, and Cote d'Ivoire) from 1990- 2009.

⁷ In 2009, petroleum and utilities are imported and not produced in Niger. We use the structure of the economy in 2009 as the base for our analysis. We use projections for labor and land growth to update beyond 2009.

⁸ In 2009, there is no petroleum production and petroleum accounts for 13.3 percent of total imports.

⁹ We assume the average capital output ratio is 5, which is reasonable for a poor country.

elasticity of transformation is 0.3. A low transformation elasticity limits the export supply response to a price change.

Since the data include information about public capital and the structure of the economy, we can examine how government spending on public capital improves the economy's infrastructure and how better infrastructure improves total factor productivity by sector. Given that the economy consists mainly of subsistence agriculture and that the terrain is rough and varied, infrastructure will be a key factor to integrating supply and inputs, linking and mobilizing demand. For this reason, we introduce and model the productivity story in a particular way. Total factor productivity growth by activity is a function of the growth rate of public capital. In the base, there is no productivity and in selected simulations, the effects of total factor productivity (TFP) are purposefully linked to public infrastructure. TFP by sector is thereby a function of the growth in public investment.¹⁰ As part of the macroeconomic closure, the existing structure of government expenditure is retained as a realistic option (and which could be changed by policy). In that structure, government investment as a share of government income is 30 percent according to the 2009 SAM.

The model is recursive dynamic with updates to labor and capital each time period.¹¹ Labor grows at an exogenous rate set at 3.5 percent per year.¹² Land grows at an exogenous rate set at 1.5 percent per year. The private capital stock grows as savings and the amount available for investment grows, net of depreciation which is assumed to be 5 percent. There is also the option of allowing total factor productivity to grow each time period and/or factor embodied technological change each time period.¹³

The model includes both private and public capital.¹⁴ In the base period, 32 percent of total investment is public investment, 68 percent is private investment. Investment in private capital increases the supply of capital to be used in production the next period. Capital accumulation is further explained below.

¹⁰ The productivity gains depend on the sector's use of infrastructure. In the simulations reported in this study, we assume no productivity links when export income goes to household consumption. When export income goes to the government, infrastructure expands and we assume an elasticity of 0.35.

¹¹ Model development to include recursive dynamics in a CGE model are similar to work done in Robinson and Thurlow (2004) and applied to Zambia in Lofgren, Robinson, and Thurlow (2004). In the model code for this analysis, there is also the option for agents to optimize over a set time period or epoch.

¹² We assume there is full employment.

¹³ When government spends more on education and health, one expects an increase in labor productivity in future time periods. We consider this option in simulations in which exogenous export revenue goes to the government which spends a large share of its income on education/health. There is a factor specific growth rate (applied to agricultural labor and unskilled labor, the growth rate is felt in years 13 and beyond. In the simulations with borrowing, it is assumed that the growth rate is higher than in the other simulations.

¹⁴ See Turnovsky (1997) and Lofgren, Cicowiez, and Diaz-Bonilla (2013) for a discussion of public capital in general equilibrium models.

Foreign aid and foreign borrowing are exogenous and can be set over time. The interest on foreign borrowing is a function of the ratio of foreign debt to export earnings in the previous year. In this analysis we do not consider changes in foreign borrowing or foreign debt.

In this analysis we do not optimize the allocation of exogenous oil export revenue across agents (households, government, or private savings); nor do we optimize foreign borrowing. Instead, we explore the implications of an increase in exogenous export earnings and the different spending options arising from the exogenous earnings.¹⁵

The framework is a recursive dynamic model in which the capital stock is updated each period based on investment and depreciation in the previous period. Two options affect the allocation of capital across sectors each period. Capital can be fixed once installed and only new capital is allocated to sectors based on the differences in the return to capital by sector.¹⁶ Alternatively, the entire capital stock can move across sectors each period.

Model closure assumptions include the following:

- The current account balance is defined exogenously for counterfactual analysis of the effects of the new mineral revenue on the economy and on the real exchange rate (i.e. the Dutch disease issue). As a reference to the policy experiments, the base run refers to the case without oil or its revenue and the economy growing modestly along the historical path. In this base run, the initial current account balance is set intentionally at the level where the real exchange rate is constant every year, not appreciating nor depreciating before further shocks or inflows are introduced to the external sector. A modest growth of approximately 4 percent per year in the current account balance (slightly more than GDP growth) is sufficient to maintain a real exchange rate at a value equal to one in the base case. By calibrating the external balance in the base run this way, the experiments will reflect the economic effects of alternative what-if policy scenarios – that is, how much of the oil revenue is introduced and spent in the economy (as additional exogenous external inflows) and how it is utilized (consumed, or invested plus the assumptions about its productivity) The real exchange rate varies to clear the current account with different levels of exogenous inflows in the experiments. The nominal CFA exchange rate is however constant, domestic prices adjust, and the real exchange rate is the nominal exchange rate divided by the domestic price index).
- Neoclassical macroeconomic closure – private investment is savings driven.

¹⁵ We will explore inter-temporal optimization of oil export revenues in future work.

¹⁶ Capital responds to the relative rates of returns across sectors through new investments, following the formulations of Dervis, de Melo, and Robinson (1982) for a developing country.

- Flexible real government expenditure - government savings is exogenous and set to grow at a modest 2 percent a year.¹⁷ Thirty percent of government income is allocated to public investment; the remainder is spent on current expenditures.
- The mobility of factors depends on the specification of the experiment. Labor by type is generally mobile across sectors (with agricultural labor used only in the two agricultural sectors and unskilled labor used only in the non-agricultural sectors); the labor supply growth rate is set exogenously at 3.5 percent a year. Land is only used in the two agricultural sectors and grows at 1.5% per year.¹⁸ Capital may be mobile or fixed depending on the simulation and is explained further below.

Reference Scenario

A baseline scenario is defined as the historical growth case of Niger. In this base case, GDP is the non-oil GDP from the base year 2009, growing by the historical growth rate of the 2000s, at 3.5 percent a year - that is, before the mineral oil revenue is expected to flow. It is therefore a low growth case without the benefit of the new revenue.

Table 14: Projections of uranium and oil production and government revenue, 2013-2030

	2013 Proj.	2014 Proj.	2015 Proj.	2016 Proj.	2017 Proj.	2018 Proj.	2019 Proj.	2020 Proj.	Annual average 2021- 2025 Proj.	Annual average 2026- 2030 Proj.
Uranium										
Value CFAF billion	290	292	308	320	441	589	634	653	803	942
Volume (tons)	4,790	5,050	5,374	5,551	7,733	10,417	11,106	11,298	11,298	11,298
Average price (US\$/kg)	130	123	121	120	119	118	119	121	148	174
Government Revenue CFAF billion	73	73	77	80	110	147	159	163	201	235
Oil										
Value CFAF billion (refined and crude)	298	379	1,336	1,337	1,363	1,390	1,418	1,446	1,535	1,694
Production (barrel/day)	16,000	20,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000
Average price (US\$/barrel)	109	110	96	96	98	99	101	103	110	121
Government Revenue CFAF billion	55	79	294	293	474	634	648	705	771	863
US\$:FCFA exchange rate	467.28	471.40	475.12	478.80	478.80	478.80	478.80	478.80	478.80	478.80

Source: World Bank and IMF staff calculations.

Against this baseline scenario, we introduce the effects of an exogenous increase in mineral revenue and various key assumptions as alternative policy scenarios. In particular, as shown in Table 14, we assume that in 2015 Niger starts to export 60,000 barrels/day of crude oil and that this level of exports is sustained throughout the projection period. Uranium production which generates export revenue is also projected to increase significantly under the assumption that the Imouraren mine starts production as planned. In the analysis, the additional mineral revenue that accrues to Niger is the share of mineral export revenue that is

¹⁷ We tried several “rules based” macroeconomic assumptions regarding the internal and external balance. We report results using an annual growth rate of the internal balance at 2 percent per year and the external balance set to maintain its share of GDP.

¹⁸ Land expansion is equivalent to land improving investment (i.e. land embodied technological change).

received by the government. Price and exchange rate projections from the IMF's World Economic Outlook show only limited changes in prices and exchange rates over the projection period.

Figure 2 shows that the government share of mineral revenue is expected to be large relative to the size of the Nigérien economy, reaching as high as 20 percent of GDP.¹⁹ Hence, issues about absorptive capacity will be important. Furthermore, it has the typical hump shape reflecting an acceleration of production in the early stages and a rapid decline at the end as resources are expected to be depleted. Although the revenue is sizable, it is still finite. Its optimal or sustainable use is therefore another crucial issue.

Figure 2: Projections of mineral revenue going to the government
(in FCFA billions and as percent share of GDP)

Source: World Bank and IMF staff calculations.

¹⁹ Estimates for revenue from the petrol sector were prepared using a generic Petroleum Fiscal Analysis model that has been prepared by the IMF's Fiscal Affairs Department for Niger and kindly shared with the Word Bank for illustration purposes. Estimates of revenue from the uranium sector assume that 25 percent of the value of production accrues to the government as revenue, in line with historical estimates.

Options for Managing the Mineral Revenue

Suggestions from Recent Literature

Economic literature has traditionally associated resource windfalls with problems related to the paradox of plenty – for examples, Dutch Disease (Corden and Neary, 1982), resource curse (Gelb, 1988, Auty 1993) – and more recently, conflicts (Collier and Hoeffler, 2004). Even so, Sachs and Warner (1997) and van der Ploeg (2011) suggest both positive and negative outcomes are possible. Botswana, Chile and Norway are often cited as successful cases; however, history is also beset with many failed cases, such as Bolivia, Congo, and Sudan. Analysis of oil-rich exporting countries in central Africa (i.e. Cameroon, Chad, Congo, Equatorial Guinea, Gabon) finds evidence of real exchange rate appreciation. (Trevino, 2011). Several studies in recent years point to pathways by which resources can have a positive effects on growth: (i) good governance (Mehlum, Moene, and Torvik, 2006); (ii) openness to international trade (Arezki and van der Ploeg, 2012); (iii) countercyclical fiscal rules in the face of volatile mineral revenue (Frankel 2012 and Schmidt-Hebbel, 2012); and (iv) micro instruments or conditional cash transfers such as Progresa and Bolsa Familia in Mexico and Brazil to help poor people cope with income shocks from commodity price fluctuations and improve poverty reduction (Bourguignon 2012) etc.

Several new studies also highlight the practical policy problems of managing resource revenue in developing countries - Collier, van der Ploeg, Spence, and Venables, 2010; Baunsgaard, Villafuerte, Poplawski-Ribeiro, and Richmond, 2012; van der Ploeg and Venables, 2011; van der Ploeg, 2010; Arezki, Dupuy, and Gelb, 2010; Arezki, Pattillo, Quintyn, and Zhu, 2012; and Dixon, Kauzi, and Rimmer, 2010. Alternative prescriptions include policy rules relating to the permanent income hypothesis (PIH), sovereign wealth funds (SWF), Bird-in-hand (BIH), scaling investment and consumption in a capital scarce developing country, fiscal sustainability for resource rich developing countries, and coping with revenue volatility. Whatever mechanism chosen, defining that sustainable expenditure path will not be easy in a developing country facing several needs – when the marginal social value of consumption is high in the near term because the country is poor, when the social returns to investment are high because capital is scarce, and when the underlying market price for the resource is volatile.²⁰

²⁰ One option is that the savings rate from depleting resources varies inversely with the rate of change in the world price of natural resources. The Hotelling rule (1931) in resource economics postulates that the price of natural resources can be expected to increase at the world rate of interest. However, there is usually uncertainty about size of the global mineral reserves, demand conditions, and about future price paths. In addition to uncertain prices of natural resources, resource-rich countries in practice tend to follow different policies that are tailored to their distinctive circumstances. In particular, the saving and investment challenges in a resource-rich low-income developing country are many and the solutions are less clear cut. See Annex 1 for further discussion about the optimal growth of consumption under alternative social discount rate.

In view of the wide-ranging spending strategies suggested by the recent literature, we will focus mainly on three options in our simulations, which cover possible conservative to aggressive expenditure policies for Niger: 1) bird-in-hand (BIH) strategy; 2) permanent income hypothesis (PIH); and 3) borrow now to raise consumption and investment significantly in the short-term. Figure 3 illustrates the incremental spending for each option given the expected time path of mineral revenue. Although expenditure pattern and timing are different in the short to medium term, all three strategies will maintain sustainability of mineral wealth in the long term when mineral reserve is depleted in period 20 (by current estimate).²¹ That is, the income from mineral sales that is not spent and put aside over the years is expected to last beyond 20 years in all scenarios, albeit the level will differ for each strategy. By year 20 and beyond, the standing wealth in each case is expected to earn a constant interest income that lasts continuously. The world interest rate assumed is 2.4 percent, the same rate used in the debt sustainability analysis for Niger (IDA and IMF 2013). As seen in Figure 3 and the discussion below, the BIH strategy, being the most conservative will have the most mineral revenue accumulated when the mineral reserves are depleted at the end of the 22 year period. We explain each option further below.

Figure 3: Possible incremental spending in Niger under alternative strategies
(in FCFA billions)

Source: Authors' calculations.

²¹ We do not consider the case where government spends every year all mineral revenue it gets. This is because the revenue reaches close to 20 percent of GDP at its peak, a very significant amount, and spending it all would result in excessive appreciation of the real exchange rate and a severe reduction of tradable sectors. Also, there is no sustainability in the long-term when revenue drops to zero at the terminal period, requiring substantial economic adjustment.

Bird-in-Hand (BIH) Strategy

All revenue is put in a foreign reserves or sovereign wealth fund (SWF) and incremental consumption or investment is restricted to the interest earned on the fund. This is a very conservative and cautious strategy for smoothing, with the windfall not valued until it has been banked. As the wealth accumulates, the income space for additional consumption or investment will be at the highest when the mineral reserve is depleted and interest income reaches the maximum. At that point, the interest income is close to 6 percent of the reference-run GDP, which confirms that the mineral revenue flows, especially when banked and accumulated, are significant in the case of Niger.

Although this option builds spending slowly, it has two advantages: it is the most feasible in terms of its minimal demand for institutional capacity to manage the resource fund; and it guards against any unexpected future drops in mineral export prices. Its disadvantage is obvious – it benefits the present generations the least when spending needs are the highest.

Strategy under Permanent Income Hypothesis (PIH)

All new revenues are also transferred a sovereign wealth fund (SWF). Unlike the BIH option, it is assumed that Niger has good access to the financial markets and can execute the necessary financial contracts to optimize and smooth incremental spending, i.e., by achieving a steady interest income flow from the expected mineral wealth. Computationally, this simply means discounting all revenue flows to a present value, which then earns a constant interest income for spending, continually at the world interest rate. It is analogous to buying an annuity derived from the expected flow of future incomes from minerals, a continuing stream of fixed payments from a willing external party.

If mineral production and revenue start immediately at the peak levels, both BIH and PIH options have the effect of transferring much of the consumption increases to future generations (the usual depiction in recent studies). However, because of the size and the hump shape of revenue in Figure 2 (when production starts slowly, before peaking and declining), this is not necessarily the case for the PIH strategy in Niger. The early periods already achieve significant increases in spending. Whether this strategy is feasible or not depends largely on Niger's capacity to manage a sovereign wealth fund in this manner.

Borrow Now for Higher Spending in the Short-Term (BOR)

If managing a sovereign wealth fund is difficult initially, an alternative is to build near-term spending by simple borrowing and debt accumulation. As the receiver of the mineral rents and taxes, the government is the central player to make the strategic spending and savings decisions to benefit present and future generations. One option is to borrow against future revenues in order to raise the low levels of consumption and capital stock.

As an illustrative scenario, we assume that spending level is raised for 5 years by an incremental amount equivalent to 8 percent of the reference-run GDP in the first year, gradually reaching 10 percent by the fifth year. In the sixth year, we further assume that the government is able to put in place a sovereign wealth fund to affect a PIH strategy as described above. Accordingly, the government is able to receive a continuous stream of fixed payments like an annuity in the PIH case, but it is delayed or only from that point onward. However, it also has to pay back the new external debt. It does this by amortizing the accumulated debt and its interests through equal payments for 5 years. This explains the shape of the “Borrow Now” curve in Figure 3. Relative to the BIH and PIH options, this strategy benefits the present generations more while still protecting the future generations with significant amount of future spending. Compared to the PIH, spending in the middle periods, when debt is being repaid, is lower.

A Boom-Bust Cycle Possibility (BB)

This is essentially the aggressive borrow-now strategy with a very poor outcome. The borrowing strategy as described above depends very much on two assumptions. First, the government is able to put in place an SWF and smooth spending in time, starting in year 6. Second, the government is able to undertake the necessary fiscal adjustment to pay back the external public debt, also year 6 by construction. We assume the fiscal adjustment is realized by means of lump-sum taxes on households (but we do not preclude other taxes or spending cuts). If these actions are not available, the strategy will require dipping into the future mineral revenue and wealth to pay for the external debt, causing a significant delay of what is the only option left possible, a BIH route. The “Boom-bust” curve in Figure 3 depicts the risky pattern and trade-offs in this lower case – an initial period of significant increments in spending (“feast”), followed by a rapid fall in spending in the medium-term period when debt reduction and fiscal consolidation has to take place (“famine”), and a BIH period that kicks in later than the straight BIH strategy (“slow recovery”). If, in addition, the spending is wasted in the sense that no productivity is gained, this could become a “Boom-Bust” scenario associated with the resource curse in the literature. This is true of any spending plan that has little productivity effect and that dips into the “capital” (the revenue flow and accumulated wealth) in the short term, but paying for it fiscally while necessitating a more conservative spending path in the future.

Simulations and Results

We explore different smoothing strategies in a recursive dynamic model of Niger, with the incremental changes to income described in Figure 3. As the recipient of royalties or taxes from mining, the government spends all revenue essentially. Among many policy scenarios, we consider two avenues for spending the revenue: lump-sum transfers to households and

direct public expenditures. The reason is this – it provides a simple mechanism to contrast two types of spending effects. Transfers to households primarily support and increase consumption because their savings rates are low. For simplicity, the transfers go in equal shares to three types of households in the model: rural, urban, and capital-owners. Even so, households do save a smaller share of their after tax income and this goes to investment spending in private capital.²² Scaling public spending while keeping the composition of government expenditures is a means to raise the productive capacity of the economy. About 30 percent of public expenditures goes to infrastructure, which will raise sector productivity; close to 20 percent goes to education and health, which we assume will raise labor productivity.²³ This does not mean that all spending, public or private, including their investment component, is productive and we include a sensitivity test.

Productivity, Supply Response, and Dutch Disease

Two sides of the Dutch disease problem reflect the quantity versus the price response of the economy to a significant exogenous inflow of revenue. When ‘quantity’ or supply in the economy is unable to respond quickly to the exogenous inflow of mineral revenue, relative prices will tend to overshoot in the short-term in favor of non-tradable goods. The key relative price is the real exchange rate, which is the relative price of tradable and non-tradable goods. The overshooting of the exchange rate is an appreciation that goes against tradable goods because prices for tradable goods are constrained by world prices in an open economy, so that most of the price increases arising from the extra income and demand will come from non-tradable goods like construction and services. This temporary overshooting of relative prices could create permanent problems if it causes the non-mineral tradable sectors to shrink over time or retards its development, becoming incapable of providing new sources of growth when the mineral revenue is exhausted.²⁴

Hence, supply productivity, flexibility and growth will likely affect the degree of the Dutch disease. Figure 4 illustrates the real exchange effects under the PIH spending strategy and two conditions – rising productivity and output over time and the mobility (responsiveness) of capital:

²² Each household has a different savings rate of after tax income: rural households, 6.8 percent; urban households 15.7 percent; and capital households 0.3 percent.

²³ We assume 2 percent factor embodied technological change for agricultural labor and unskilled labor, beginning thirteen years after the initial increase in government spending on education and health. In the scenarios with more borrowing early in the time period, we assume 4 percent factor embodied technological change in those inputs. This approach is to illustrate potential gains between increased government spending on education and health and labor productivity. A more detailed analysis can be done using a MAMS (Maquette for MDG Simulations) approach.

²⁴ Similar issues may be encountered in developing countries when foreign aid is scaled up significantly (see Adam 2006).

- As may be recalled, the PIH strategy already entails significant resource income and spending in the near future. Much of the spending is on non-traded goods. Hence, the real exchange rate will appreciate (fall below 1.00) immediately. As output rises over time, the real exchange rate recovers and will eventually depreciate in the long-run. This is a case where productivity increases as government spends more on education, health and infrastructure to raise human and public capital. About 30 percent of the government income is spent on public capital or infrastructure, the remainder is spent on current consumption for either education/health (47 percent of spending on current consumption) or public infrastructure (53 percent of spending on current consumption). The crucial assumption is that public spending on education, health, and infrastructure is productive and will raise productivity especially in the tradable sectors.
- Moreover, when capital is mobile across sectors (responsive supply within each period), the real exchange rate appreciates slightly less than when capital is fixed once installed (rigid supply in the short-term). In the latter case, capital responds to the relative rates of returns across sectors through new investments, following the formulations of Dervis, de Melo, and Robinson (1982) for a developing country. In the long run, real exchange rate also depreciates less in the case where capital is mobile, underlining further the importance of supply flexibility.

Figure 4: Real exchange rate under alternative supply and productive behavior

Source: Model simulations.

Table 15 shows the other side of the Dutch disease problem, the quantity response in terms of the GDP shares of the traded sectors, semi-traded sectors, and non-traded sectors. When the exogenous mineral revenue is first received, the non-traded goods expand and their value-added share increases the most among the three types of sectors. This contrasts with the decreased share for traded goods immediately. Moreover, when capital is fixed there is slightly less of a supply response than when capital is mobile. Over time, the pattern is

reversed and the share of traded goods will eventually increase when there are significant productivity and output growth in those sectors.

Table 15: Shares of real GDP value added by type of sectors

	Initial Year of Exogenous Income			Terminal Year of Exogenous Income	
	Base	PIH with Public Investment - Fixed Capital	PIH with Public Investment - Mobile Capital	PIH with Public Investment - Fixed Capital	PIH with Public Investment - Mobile Capital
Traded Good	8.16	7.17	6.64	10.94	11.07
Semi-Traded Good	46.60	46.41	45.72	45.48	45.56
Non-traded Good	45.23	46.43	47.64	43.58	43.37

Source: Model simulations.

Note: To distribute the sectors into the three broad goods in the table, we assume the following classifications: traded goods = mining which is exported only, there are no imports; semi-traded goods = food agriculture, other agriculture, food manufacturing, other manufacturing, there are both imports and exports; and non-traded goods = construction, services, public services, and education/health, there are no imports or exports (with the exception of services which has a very small share of consumption imported and a very small share of production exported).

Real Exchange Effects of Alternative Spending Strategy

In what follows, we assume that capital is fixed once installed as this is more realistic for a developing country like Niger. New investment is allocated each period based on the relative rate of returns of each sector.

Figure 5 (Panels A, B, C, and D) shows the real exchange effects of each spending strategy. For each strategy, we compare the case in which exogenous mineral export income is used mainly for consumption and the case in which exogenous mineral export income is used to raise human and public capital. In the consumption case, households receive the mineral revenue through lump-sum transfers from government and spend it primarily for consumption, saving a small portion for investment. We further assume that consumption and investment by households in a subsistence economy are diffused and do not raise productivity very much. To be sure, the assumption is made mainly for simplicity and to distinguish the effects of consumption and investment.

Figure 5: Real exchange rate effects under alternative strategy – consumption versus investment

Source: Model simulations under the assumption that capital is fixed once installed.

The following summary observations may be made:

- In the short-term, the real exchange rate will appreciate straightaway under all spending strategies except under the most conservative spending plan, the BIH. In other words, the Dutch disease will be less evident initially in the BIH case, but will still register over time if there are no significant investment and productivity gains.
- The appreciation relative to the base run appears permanent in the long-run under all spending cases when spending is primarily for consumption. When there is significant investment to raise productivity and output growth, the appreciation will ameliorate and reverse itself (depreciate) over time.

- In the worst case, the boom-bust case, the repayment of debts through fiscal adjustment will reduce spending and the real exchange rate will depreciate during the middle-periods.

Macroeconomic and Other Effects of Alternative Spending Strategy

Table 16 shows the effects on Niger's economy under alternative spending plan. We make the following observations:

- When there is significant investment and productivity, GDP (non-oil) may grow by 6.8 to 7.5 percent a year and consumption may rise by 7 to 7.7 percent a year. Although there are differences across spending plans, the differences are quantitatively minor. This is true also in the two borrowing cases.
- Even so, the "Borrow-Now" strategy has the potential of raising average output growth slightly more if spending raises investment and productivity, despite some adjustment in the middle periods. We discuss this further in the next subsection.
- When resources are consumed rather than invested primarily, GDP growth will not improve relative to the base case in all spending plans. Aggregate consumption will grow slightly more than the base case, but nowhere near the cases where investment raises output growth.
- Even so, when resources go to the households through lump-sum transfers from the government, there is still a slight increase in real private investment compared to the base case – for example in the PIH scenario, real investment grows annually by 4.63 percent, while in the base scenario it grows annually by 4.47 percent. This is because households will save a small portion of these transfers; the increase in total savings results in a modest increase in the annual growth rate of real private investment. This pattern holds for all simulations in which resources are given to the households, compared to the base case.
- Although equity impact, which is not the focus of this study, is best investigated with more household data and approaches that merge macro and micro modeling (such as Go et al. 2010), some broad distribution effects among the three basic types of households (rural, urban, and capital-owners) are discernible from these two and contrasting avenues of spending. When additional resources are used by the government to increase public infrastructure, there will be higher GDP and household income growth if there is productivity growth arising from the investments. Owners of capital receive 95 percent of their income from capital returns, so they generally benefit from infrastructure spending that improves the returns to capital. The relative distribution of factor income in the infrastructure spending case is similar to the base

case – average annual income grows faster for capital owners than for other types of households.

- However, when all income goes to households, the average annual growth rate for rural households exceeds the average annual growth rate for capital owners. Rural households receive slightly over 50 percent of their income from agricultural labor. Subsistent agriculture is also largely a non-traded good and its prices will rise as household spend more on food from the additional income, raising the prices of agriculture and non-traded goods, therefore the return to agricultural labor. This implies that transfers to households, especially when targeted well, will likely benefit the poor and have more immediate impact on poverty reduction.

Table 16: Macroeconomic effects under alternative spending plan
(Real average annual growth rate over the simulation period)

	Base Case	Bird in Hand (BIH)	BIH with Public Investment	Permanent Income Hypothesis (PIH)	PIH with Public Investment	Borrow (BOR)	BOR with Public Investment	Boom & Bust (BB)	BB with Public Investment
Consumption	3.69	4.07	7.04	3.99	7.21	3.99	7.66	4.04	7.54
Private Investment	4.47	4.69	5.63	4.63	5.67	4.63	5.89	4.67	5.86
Public Investment	5.88	6.33	9.73	6.20	9.71	6.19	10.12	6.30	10.13
Total Investment	4.97	5.28	7.32	5.19	7.33	5.19	7.65	5.26	7.64
Government	1.98	2.03	5.33	2.03	5.41	2.03	5.88	2.03	5.81
Exports	4.50	3.75	8.35	3.78	8.63	3.81	9.27	3.81	9.09
Imports	4.14	4.45	7.21	4.35	7.34	4.35	7.80	4.42	7.71
GDP (at mkt prices)	3.52	3.55	6.81	3.53	7.00	3.53	7.49	3.54	7.35
Household income:									
Rural household	3.47	4.63	6.68	4.41	6.81	4.39	7.44	4.55	7.35
Urban household	3.41	4.05	6.53	3.87	6.61	3.87	7.08	4.00	7.02
Capital-owners	3.91	4.46	7.06	4.32	7.23	4.31	7.53	4.42	7.42

Source: Model simulations.

Behavior of Consumption over Time

Figure 6 shows the effects on consumption over time. When there are productivity gains from investment and spending, consumption will grow steadily over time relative to the base case, appearing to benefit similarly across alternative spending plans. The dip in consumption during the middle periods for the “Borrow Now” or “Boom-bust cycle” seems small. At the end of the simulations, consumption is close to twice the reference level in the conservative BIH case and more than twice the reference case in the other spending plan.

When there are no productivity gains, the timing and changes in consumption become distinct across the spending plans. Consumption in the PIH and “Borrow-Now” cases start at a high level relative to the BIH case, but all three will converge to about 5 to 10 percent

higher than the reference case at the end of the simulations, much lower than the cases with productivity gains in the first graph. There is the expected dip in consumption during the middle periods for the “Borrow now” case. However, when smoothing is not possible even in the future, the fiscal adjustment and debt repayments in the low case scenario will lead to a big drop in consumption from their initial high levels, leading to negative deviations from the reference values during the middle periods (as high as -5 percent), before rising and converging eventually to the levels of the other spending plans. Herein lies an illustration of the risks and cautionary tale of the resource curse – a case of overspending and borrowing with little or no productivity, followed by fiscal adjustment and contraction, before attaining a slow recovery. As discussed in Van der Ploeg (2011), we find that uncertainty and volatility in resource markets can lead to sharp cuts in future spending, as seen in consumption in the boom-bust scenario when there are no productivity gains (see Figure 6). The volatility in consumption can reflect a combination of factors: absorptive capacity constraints in the boom periods; unfinished projects in the bust period; and capital investments not able to be used.²⁵

Figure 6: Real consumption over time across spending plans
(as a ratio to the base case)

Source: Model simulations.

Output by Aggregate Sectors

Table 17 shows the growth rates of sectoral outputs grouped according to traded goods, non-traded goods, and semi-traded goods. All sectors tend to grow at higher rates when there are productivity gains from public spending on infrastructure, education and health. This is

²⁵ There is also volatility in natural resource prices, affecting the income stream expected from exports. Analysis of volatility in export income is beyond the scope of this study and is an important area for future research.

particularly true for traded goods – their growth will start high in the initial periods (year 1 to 5) and accelerate the most in subsequent periods.

Table 17: Annual growth rates of real output by aggregate sectors

	Initial Period (Y1-Y5)	Middle Period (Y6-Y10)	All Periods (Y1-Y22)
Traded Goods			
Base Case	5.30	5.14	5.08
Bird in Hand (BIH)	4.95	4.12	4.27
Permanent Income Hypothesis (PIH)	3.21	5.36	4.91
Borrow (BOR)	2.01	6.25	4.90
Boom & Bust (BB)	2.01	6.42	4.96
BIH with Public Investment	7.76	7.81	9.04
PIH with Public Investment	8.16	10.02	10.22
BOR with Public Investment	6.90	10.70	11.03
BB with Public Investment	6.90	8.86	10.84
Non-traded Goods			
Base Case	3.71	3.67	3.65
Bird in Hand (BIH)	3.75	3.77	3.71
Permanent Income Hypothesis (PIH)	3.69	3.56	3.59
Borrow (BOR)	3.81	3.59	3.59
Boom & Bust (BB)	3.81	3.93	3.62
BIH with Public Investment	5.84	6.55	7.20
PIH with Public Investment	6.96	6.32	7.10
BOR with Public Investment	7.41	6.19	7.76
BB with Public Investment	7.41	6.04	7.65
Semi-traded Goods			
Base Case	3.71	3.72	3.70
Bird in Hand (BIH)	3.72	3.74	3.71
Permanent Income Hypothesis (PIH)	3.85	3.64	3.69
Borrow (BOR)	3.85	3.58	3.70
Boom & Bust (BB)	3.85	3.47	3.71
BIH with Public Investment	6.13	6.81	7.44
PIH with Public Investment	6.99	7.34	7.78
BOR with Public Investment	6.89	7.21	8.24
BB with Public Investment	6.89	6.42	8.09

Source: Model simulations.

Note: traded goods = mining which is exported only, there are no imports; Semi-traded goods = food agriculture, other agriculture, food manufacturing, other manufacturing, there are both imports and exports; and non-traded goods = construction, services, public services, and education/health, there are no imports or exports (with the exception of services which has a very small share of consumption imported and a very small share of production exported).

When there are no productivity gains, the effects of Dutch disease are reflected by slower growth rates in traded goods, particularly in the two cases associated with borrowing in the initial periods – Borrow (BOR) and Boom & Bust (BB).

Conclusions

We examine three spending plans suggested by the recent literature regarding Dutch disease and examine their implications to Niger relative to its expanding mineral sector. The spending strategies include – 1) Bird in hand (BIH), 2) Permanent income hypothesis (PIH) and 3) Borrow-Now (BOR) options. For each of these strategies, we consider the cases where additional government spending falls primarily (a) on investments in infrastructure and human capital that increase future productivity, or (b) on transfers to households that primarily increase consumption. The reference case is a historical growth run where GDP and real consumption grow slowly by 3.5 and 3.7 percent, respectively, before the impact of significant inflow of mineral revenue.

The work illustrates that the medium-to-long-term impact of the expanding extractive industries sector on the real exchange rate, consumption and GDP growth, and income distribution depends primarily on whether revenue is used to enhance productive capacity or consumption. Spending strategies with regard to the timing of revenue use impacts significantly the path for the evolution of macro-economic variables. Although not captured in the macro-economic modeling, it is also important to note that the various spending strategies differ significantly with required capacities and implied risks.

In the short-term, the real exchange rate will appreciate straightaway by about 20 percent under all spending strategies except under the most conservative spending plan, the BIH. The appreciation relative to the base run appears permanent in the long-run under all spending cases when spending is primarily for consumption. When there is significant investment to raise productivity and output growth, the appreciation will ameliorate and reverse itself (depreciate) over time. This implies that diversifying the economy by expanding the tradable sectors of the economy will require greater efforts. In addition to ensuring that revenue is used for investment in physical and human capital, policy reforms to remove obstacles to private sector activities are essential to overcome the negative real-exchange rate impact.

Under each of the spending scenarios, real consumption will grow by over 7 percent a year over the 20-year period when there are productivity gains in the investment in infrastructure and when there are positive effects on human capital from government spending on education and health. When spending is mainly for consumption with no

productivity advances, real consumption growth is about 4 percent a year across spending plans, only slightly higher than the reference case of slow growth.

Although the average growth rate of consumption appears stable, growth paths differ markedly in timing and pattern, especially when spending does not raise productivity. Here, there is an early increase in real consumption in the more aggressive spending plans, but it will result in negative deviations from the low levels of consumption of the reference case if fiscal adjustment and debt repayments result in contraction and the government is unable to smooth consumption even in the future. This is a caution against expectations that exaggerate the benefits of mineral revenue under all circumstances. It is important to note that the different strategies differ significantly with regard to risks and required technical implementation capacity and political capacity to sustain a chosen course of action.

Many countries have increased investment following resource finds, with little impact on growth. Absorptive capacity and a poor investment climate have emerged as serious constraints where public spending has been ratcheted up quickly. In addition, the quality of public investment management tends to be far worse in resource-rich countries than in resource-poor countries.

The key to the benefits of significant mineral revenue lies with the productivity and supply responses of spending. If significant output gain is assured, then there is very little difference across the spending plans in their effects on real consumption. We further conduct sensitivity tests regarding the mobility of capital and show that the Dutch disease in terms of the overshooting of relative prices or the shrinking share of traded sectors in GDP can be ameliorated with greater supply flexibility. This also points to the importance of improvements in Niger's investment climate to be able to transform revenue from the extractive industries sector into sustainable economic growth. Doing Business indicators suggest that Niger is among the countries where it is most difficult to do business and reforms are thus essential to ensure the productivity of investment funded from the revenue of the extractive industries.

An important constraint of the more aggressive spending plans like the PIH and Borrow-Now options will be the institutional capacity to manage a sovereign wealth fund to effect consumption smoothing in the early or middle periods.

The BIH has the least demand on managing the mineral wealth. It will raise real consumption over time and if coupled with productivity gains in spending, the Dutch disease will be less or not be evident.

Borrowing against future resource rents is the most risky strategy. In particular, macroeconomic and fiscal adjustment is asymmetric to large resource swings, so that the net

effect of a boom-bust cycle is typically adverse. The asymmetry does not show up in the simulations which allows for smooth adjustment, both up and down the cycle.

Using extractive industries revenue for transfers to household would have a greater impact on poverty reduction in the short and medium term, as investments in physical capital would primarily benefit the owners of capital and investment in human capital have a longer gestation period. However, in the long run, the trickle down effects from accelerated economic growth as a result of investment in human and physical capital are likely to offset the initial lack of pro-poor bias. Nonetheless, this may imply that considering distributional aspects in the use of government revenue from the extractive industries sector also need to be taken into account. A mixed strategy where revenue is used to enhance public infrastructure, investment in human capital, and transfers through social protection programs may thus be preferable to a strategy that focusses only on one of these elements.

Future Work

In this analysis, we use a recursive dynamic model to analyze the effects of an exogenous increase in oil revenue. For future work, we will optimize over timing and spending source of exogenous oil revenues.

To further analyze development strategies for Niger, we can investigate the links between spending on sectors such as health and education and their impact on labor productivity. An analysis using a MAMS (Maquette for MDG Simulations) approach would provide a better explanation of total factor productivity growth.²⁶

Finally, in this analysis, we treat export revenue from the sale of a natural resource (oil) as an exogenous increase in income – we are interested in how that income is spent in the economy. This is a reasonable description of the oil sector in Niger. China is providing the labor and capital to extract crude oil in Niger; the impact on Niger is via the revenue from oil sales. For other natural resources, a change in output to increase exports can impact the economy as resources are used in that natural resource sector. Mining is labor intensive, using unskilled labor in Niger that could also be used in other sectors. When uranium production expands, other sectors will see increased input costs as the uranium production competes with other sectors for factor inputs. We will expand our analysis to include the structural changes that occur as the expanding natural resource sector competes for domestic inputs to production.

²⁶ See Lofgren et al. (2013).

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Annex 1:

The Optional Growth of Consumption and the Social Discount Rate

The parameter most relevant to the allocation of mineral revenue (or any project) over time is generally the social discount rate, which measure the revenue's opportunity costs or its value to the future whenever costs and benefits differ in their distribution over time. More than a few authors have therefore focused on and debated its value and implications in developing countries. A frequent approach to estimating the social discount rate is the Ramsey formula from the optimal long-run growth model with a representative consumer. In the context of intergenerational choice, it is often used to recommend a relatively low rate in order to protect future generations. Stern (2007), for example, uses it to explore the cost of climate change in the long-term. However, no discount rate could meet all the financing concerns and risk characteristics of every economic issue or project; tax distortions and competing use between private and public sectors also add to the calculation problems; issues are also raised about developing countries with scarce capital and low levels of income and consumption (see further below). Harrison (2010) reviews several practical difficulties and options.

Table A1: Social discount rates from the Ramsey formula in selected studies

Source	Social discount rate, <i>SDR</i>	Pure rate of social time preference, ρ	Elasticity of marginal utility of consumption, σ	Growth rate in consumption, $\dot{C}/C$
Stern (2007)	1.4	0.1	1	1.3
Nordhaus (2007)	5.5	1.5	2	5.5
Weitzman (2007)	6.0	2.0	2	2.0
Arrow (2007)	2-6	0	2-3	1-2
Gollier (2006)	2.6-5.2	0	2-4	1-3
HM Treasury (2003)	3.5	1.5	1	2.0
Harrison (2010)	0.24-11	0	2-4	1.3
Dasgupta (2006)	2-8	0	2-4	1-2
Collier et al. (2010)				
Fast growing economy	10	If 1	1	9
Slow growing economy	2-3	If 1	1	1-2

Note: Zhuang et al. (2007) and Harrison (2010) compile many of these rates and others.

In practice, different views and social discount rates are employed by countries. Environmental applications tend to use low discount rates. The United States Environmental Protection Agency recommends two to three percent; the World Bank has employed 10-12 percent; and the rates can range from 1 to 15 percent in various countries (see Harrison 2010 and Zhuang et al. 2007). Collier et al. (2010) argue that generational equity in a poor country requires that the discount rate should be high to attach more importance to the present when consumption level is still very low and capital is still scarce, raising the point that as the

economy grows, future generations will be richer than the present. Table 15 lists some of the discount rates, the associated parameters, and the implied growth in consumption.²⁷ As the numbers in the last column suggest, consumption growth can vary from a low 1 percent to a high 9 percent, which basically corresponds to how conservative or aggressive is the spending strategy being adopted.

²⁷ The Ramsey formula behind the numbers is:

$$SDR = \rho + \varepsilon n + \sigma \dot{C}/C$$

where ρ is the rate of time preference; $\dot{C}/C$ is the expected rate of growth of consumption; ε depends on how changes in populations are valued and determines the effect of population growth, n ; and the parameter σ is the elasticity of marginal utility of consumption that measures the value of marginal consumption to poor people relative to the richer. Most studies ignore population growth ($n = 0$) or a Benthamite social welfare function ($\varepsilon = 0$) where only total utility of all current and future household members matter.