INTERNATIONAL MONETARY FUND

ALGERIA

Selected Issues

Prepared by Holger Floerkemeier, Nkunde Mwase
and Taline Koranchelian (all MCD)

Approved by Middle East and Central Asia Department

December 21, 2004

Contents Page

Figures

Tables

Figures

Appendices

Tables

Figures

Appendix

OVERVIEW

The main challenge facing the Algerian economy is to engage the private sector in sustainable growth that aims to reduce unemployment while maintaining macroeconomic stability. Over the last few years, the authorities have relied on an expansionary fiscal stance to stimulate growth and employment, but structural reforms virtually stalled. However, while the economy has recorded increasing growth, the nonhydrocarbon sector remains small and unemployment pervasive. The current political stability and a strong financial position provide a favorable framework for taking decisive steps to strengthen private sector activities, and to complete the transition to a market economy. To maintain macroeconomic stability, Algeria should manage its large external inflows from hydrocarbon exports. This will require fiscal and monetary policies that aim to contain inflation at a moderate level.

Against this background, the following chapters address three issues with important implications for macroeconomic stability in Algeria: (a) the fiscal management of hydrocarbon revenues; (b) the impact of government spending on growth; and (c) the assessment of the equilibrium exchange rate in Algeria.

Chapter I examines some guidelines for the efficient fiscal management of hydrocarbon wealth in Algeria. It presents strategies and policy instruments to tackle the macroeconomic policy challenges discussed above which would enable the country to reap the potential benefits of its natural resource wealth. The chapter recommends setting the fiscal policy in a long-term framework that aims at preserving the permanent per capita income from hydrocarbon wealth.

Chapter II examines whether government expenditure has induced growth during the period 1967-03. It finds that real government capital expenditure had a positive effect on real nonhydrocarbon GDP and that real government current expenditure followed real hydrocarbon GDP. This suggests that government capital expenditure can be used as a policy instrument to stimulate growth. However, given that capital expenditure is already high, continued increases in capital expenditure may not necessarily translate into higher growth.

Chapter III analyzes the evolution of the Algerian dinar's real exchange rate. It finds that Algeria's equilibrium real exchange rate varies over time. The Balassa-Samuelson effect together with real oil prices explain the long-run evolution of the equilibrium real exchange rate. It also suggests that the current level of the real exchange rate is consistent with equilibrium, confirming that Algeria presently does not have a Dutch Disease problem. The chapter recommends that Algeria's exchange rate policy continues to aim at flexibly aligning the real exchange rate with its fundamental determinants

I. Fiscal Management of Hydrocarbon Revenues[1]

Algeria faces important macroeconomic policy challenges with respect to the management of its natural resource wealth. The paper provides an overview of the issues relevant to prudent fiscal management of hydrocarbon revenues. It discusses alternative fiscal guidelines both for short-term and long-term policy formulation, and presents simulations for the sustainable long-run use of hydrocarbon revenues in Algeria under alternative scenarios, using a permanent income framework. Equally important is the question of how to make best use of the country's hydrocarbon wealth to tackle the pressing tasks of attaining higher growth and reducing unemployment.

A. Introduction

1. After a decade of civil strife and economic difficulties, Algeria has recently been experiencing a renewed growth performance, in large part aided by the strong development of the hydrocarbon sector since 1999. The hydrocarbon sector dominates the Algerian economy, accounting for 36 percent of GDP, almost 70 percent of fiscal revenue, and 98 percent of export receipts in 2003. Past efforts to diversify the economy by building up an import-substituting heavy industrial base during the period of centralized economic planning largely have failed.

2. The dominance of the hydrocarbon sector has been an important element in shaping the structure and management of the Algerian economy (Nashashibi et al. 1998). It weakened the incentives to develop the production of tradable goods outside the hydrocarbon sector. It distorted the tax structure through neglecting alternative revenue sources. Finally, it lead to an unstable fiscal policy stance that transmitted the volatility of international oil prices into the domestic nonhydrocarbon sector, thereby distorting factor allocation and hurting private sector investment and growth. The budget's dependence on volatile hydrocarbon revenues also created a significant deficit bias by ratcheting up fiscal expenditures. Favorable oil prices were regularly seen as permanent increases in revenue and were followed by expenditure increases, which were difficult to reverse when the oil revenue increases proved to be only temporary.

3. Natural resource-based economies like Algeria face several macroeconomic policy challenges both in the short and long term. In a short- to medium term perspective, fiscal policy has to deal with high volatility of hydrocarbon revenues due to frequent and unpredictable price fluctuations, as well as with the impact of substantial foreign exchange inflows in the context of limited absorptive capacity of the domestic economy. In the long term, policymakers have to consider the exhaustibility of hydrocarbon resources and uncertainty of hydrocarbon wealth in connection with intergenerational equity and fiscal sustainability considerations.

---

[1] Prepared by Holger Floerkemeier (ext. 38322).

4. In the case of Algeria, these fiscal policy challenges have to be evaluated in the context of the need to reduce the very high unemployment, to diversify the economic base, and to achieve a high rate of economic growth. In a situation of high unemployment, and with the society still recovering from a period of political instability and civil strive, policy makers have to weigh the medium- to long-term benefits of a prudent fiscal stance against the immediate needs of a fragile economy and social demands. However, Algeria's history has shown that neglecting the fiscal policy challenges has not served the economy well. Unproductive and volatile spending has created allocative inefficiencies, economic disincentives, uncertainty in the private sector, and unviable state-run industries. Policy makers should take into consideration the specific characteristics of Algeria's natural resource-based economy. A well thought-out and far-sighted fiscal policy could contribute to economic stability and growth, including the development of the nonhydrocarbon economy and the creation of employment opportunities.

5. The paper provides an overview of some of the issues relevant to prudent fiscal management of hydrocarbon revenues, such as the main macroeconomic policy challenges, the role of fiscal rules, and the alternative uses of hydrocarbon revenues. It discusses alternative fiscal guidelines both for short-term and long-term policy formulation, and presents simulations for the sustainable long-run use of hydrocarbon revenues in Algeria under alternative scenarios, using a permanent income framework.

6. The remainder of the paper is organized as follows: Section B portrays the most relevant aspects of the Algerian hydrocarbon sector and its relation to the government budget. Section C discusses the main macroeconomic policy challenges policymakers face in a hydrocarbon-based economy. Section D deals with the issue of long-term wealth preservation and introduces the permanent income framework. Alternative uses of saved hydrocarbon revenues are discussed in Section E. Section F presents some short- and medium term stabilization considerations, together with the most relevant indicators of the fiscal stance and respective fiscal guidelines. Simulations of the sustainable long-run path of the primary nonhydrocarbon balance in Algeria are carried out in Section G, while illustrative scenarios to bridge the gap between the current fiscal stance and a long-term sustainable one are presented in Section H. The concluding Section I summarizes the main results and policy recommendations.

B. The Algerian Hydrocarbon Sector

Background

7. Algeria has a sizable hydrocarbon industry with a well-diversified product portfolio. The development of the Algerian hydrocarbon sector commenced in 1958 after the discovery of two giant oil and gas fields at Hassi-Messaoud and Hassi R'Mel in the Northern Sahara region. Crude oil production was at the centre of the expansion of the hydrocarbon sector during the 1960s and 1970s, even though natural gas extraction started already in 1961. Algeria became the world's first Liquefied Natural Gas (LNG) producer in 1964, and refinery capacity expanded during the 1970s. The production and export shares of crude oil declined rapidly at the beginning of the 1980s, as oil production became increasingly

constrained by OPEC quotas,[2] some oil fields were gradually depleted, and secondary recoveries remained inadequate. Between 1980 and 1982, the export share of crude oil dropped from almost 80 percent to under 30 percent, while the export share of refined petroleum products, condensates, and LNG tripled. The diversification of the hydrocarbon product mix evolved further, when dry gas and LPG exports gained importance in the mid-1980s. Total gas production and exports more than doubled during this time as a result of the further development of gas liquefaction and pipeline capacity.

8. From independence in 1962 to the mid-1980s, Algeria followed a policy of economic nationalism and central economic planning. The government strategy was to transform the hydrocarbon sector into a highly integrated, state-owned complex under centralized management (Nashashibi et al. 1998). The national oil company, Sonatrach, which had been established in 1963, was initially only responsible for the transportation and marketing of hydrocarbon products. However, it soon also got involved in exploration, extraction, and processing. Sonatrach became a quasi-monopoly after Algeria began to nationalize assets of foreign oil companies in 1971. The scale and scope of operations soon caused managerial inefficiencies, and in 1982 Sonatrach was restructured, and its mission restricted to upstream oil and gas activities and hydrocarbon exports. However, the Algerian hydrocarbon sector remained sheltered from external competition and unable to engage in cooperative ventures with foreign partners. The resulting isolation inhibited technical progress and an effective adaptation to developments in the world energy market. Lack of investment in exploration and production capacity began to severely constrain the further development of the hydrocarbon sector.

9. Implicit subsidization of energy products due to administered prices as well as the promotion of energy-intensive heavy industries resulted in surging domestic energy demand, reducing the amount of hydrocarbon products available for exports. Algeria's per capita energy consumption increased rapidly to levels several times higher than in countries with similar per capita incomes.[3] During the 1970s, domestic consumption of refined products absorbed most of the production. Since the late 1980s, the authorities have gradually reduced the implicit subsidization of domestically consumed energy products and encouraged a switch from oil to natural gas consumption, thereby improving allocative efficiency, encouraging energy conservation, and freeing up oil production for exports.

10. Following the 1986 reverse oil price shock, the Algerian hydrocarbon sector was gradually opened to foreign participation. The 1986 hydrocarbon law opened the country for foreign investors engaged in oil exploration, under the terms of concession agreements, service contracts, or production-sharing contracts (Nashashibi et al. 1998). Amendments of the law introduced in 1991 further expanded the possibilities for foreign participation. In the

[2] Algeria became an OPEC member in 1969.

[3] Energy consumption per capita tripled between 1972 and 1983 and has stabilized since then. In 2001, annual per capita energy consumption was at about 955 kg oil equivalents, compared to 377 kg in Morocco and 850 kg in Tunisia.

early 1990s, a major investment plan was launched with the objectives to (1) boost exploration activity and develop new fields; (2) adopt enhanced recovery techniques at existing production sites; (3) expand the existing transportation infrastructure; and (4) increase and upgrade liquefaction capacity for LNG exports. In recent years, Algeria has been increasingly successful in attracting foreign capital and technology, in spite of the civil strife during most of the period. Intensified exploration, especially in the remote southern part of the country, also lead to numerous discoveries of additional hydrocarbon reserves, lifting the replacement ratio above unity.

11. Sonatrach still dominates the Algerian hydrocarbon sector, with foreign companies participating in only about 12 percent of production (EIU 2004). An initiative to further open up and restructure the sector failed with the blocking of the 2001 draft hydrocarbon law. The new legislation aimed to address Sonatrach's double role as both a producing company and a regulator of the hydrocarbon sector by introducing a new regulatory structure which would have improved transparency, facilitated bidding and licensing, and increased foreign direct investment in the sector.

Oil

12. Algeria's proven crude oil reserves are estimated at 11.3 billion barrels, which is about one percent of global proven crude oil reserves.[4] At current extraction rates, reserves will be depleted within the next 26 years. However, increased exploration activity has led to numerous new hydrocarbon discoveries in recent years. While most of the discoveries have been made by foreign companies, the most recent find—a large oil field in the south of the country with estimated reserves of 360m barrels—was announced by Sonatrach in mid-February 2004. Algeria is still considered to be relatively under-explored, and recoverable crude oil reserves may range as high as 27.7 billion barrels according to the U.S. Geological Survey (USGS 2000). Moreover, the country has significant resources of lease condensate and natural gas plant liquids of between 3 and 8 billion barrels. Algeria's Sahara blend is extremely light and sweet, which makes it one of the highest quality crudes worldwide.

13. Average crude oil production in Algeria was almost 1.2mn barrels per day (b/d) in 2003. Including 0.45mn b/d of lease condensate and 0.25mn b/d of natural gas plant liquids, total oil production reached more than 1.8mn b/d (about 2.4 percent of world oil production). While production of condensate and LPG has remained stable, average crude oil production surged more than 30 percent in 2003. Algeria has persistently exceeded its OPEC quotas in recent years (Figure 1).[5] With the significant production increase in 2003, it has on average been producing almost 55 percent above its quota during the first half of 2004.[6] Pointing to

[4] For a discussion of problems in definition and estimation of reserves, see Haider 2000.

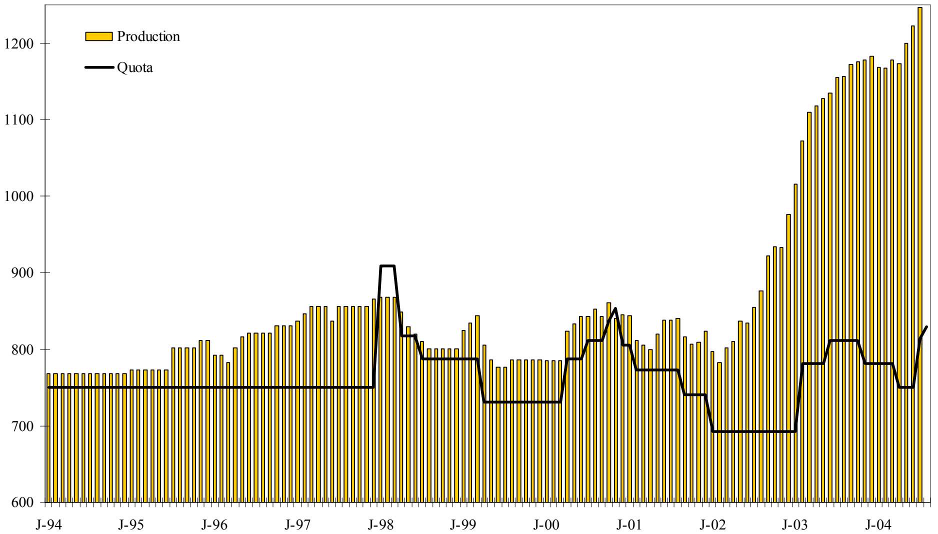
[5] Only crude oil production falls under the OPEC quota.

[6] All OPEC member countries produced above their respective quotas in the recent past, with the exception of Indonesia (on average 21.5 percent below quota in the first six months of 2004) and Venezuela (9 percent below quota). However, Algeria has been the single largest quota-buster in relative terms. Qatar, Nigeria, Kuwait, and

(continued…)

the country's significantly increased production potential, the Algerian authorities are lobbying for an increase in the country's OPEC quota share. Algeria's quota fell from more than 4 percent (including Iraq) in the late 1980s to the present 3.2 percent (excluding Iraq).

Figure 1. Algeria's OPEC Quota and Crude Oil Production, 1994–2004
(In 1000 b/d)



Sources: OPEC and U.S. Energy Information Administration

14. More than 80 percent of Algeria's total oil production is exported.[7] The continuing substitution of natural gas for oil in domestic consumption will help free up additional oil for exports. With around 90 percent of exports, Algeria's main market is Western Europe (Italy, Germany, France). In 2003, 45 percent of total oil exports were crude oil, 22 percent condensate, 20 percent refined products, and 13 percent LPG.

15. The Algerian authorities are implementing an ambitious plan to increase Algeria's oil production capacity in the coming years. Crude oil production capacity already increased from 0.9mn b/d in 2001 to currently 1.2mn b/d. The target is to expand capacity to 1.5mn b/d by 2005 and up to 2.0 b/d by 2010. Increased exploration, the development of new fields, and the introduction of enhanced oil recovery systems in existing fields will necessitate the inflow of significant levels of foreign investment into the upstream oil sector. In 2004, Algeria opened its fifth licensing round for oil and gas, involving ten onshore blocks with an expected total foreign investment of at least $130 million.

Libya follow with 23 percent, 18.5 percent,17.5 percent, and 15 percent production, respectively, above quota. Iran, Saudi Arabia, and the United Arab Emirates exceeded quotas by about 10.5 percent, 9 percent, and 7.5 percent.

[7] Algeria ranks as the 10th largest oil exporter in the world.

Natural Gas

16. Algeria has proven natural gas reserves of about 4.5 trillion cubic meters (tcm), ranking seventh in the world (just under three percent of world proven natural gas reserves).[8] Known reserves will last for approximately 57 years at current extraction rates. As in the case of oil, significant reserve growth is expected in the coming years, and recoverable reserves could potentially be as high as 7.4 tcm. The most recent major natural gas discovery was announced in October 2003. Around 60 percent of Algeria's reserves are associated gas.[9]

17. Total dry gas production reached 79bcm in 2003. 21bcm dry gas were consumed domestically, most of it for power generation. To a lesser extent, natural gas is used as a feedstock for the petrochemical industry. Algeria still subsidizes domestic gas consumption, which leads to inefficient energy use and could potentially limit the growth of exports. Natural gas is exported via pipeline[10] and LNG tanker.[11] Most of Algerian gas exports go to Western Europe, only about 2 percent are shipped to the United States. Algeria is extremely well situated to supply the fast growing European gas market, having large reserves in close proximity and a well-developed transportation infrastructure. It accounted for 20 percent of European gas imports in 2000. The Algerian Ministry of Energy and Mines expects gas exports to reach 85bcm/y by 2010, which would imply an annual growth rate of about 5.5 percent. While Algeria will benefit from robust growth of European gas demand, the liberalization of the EU natural gas market could threaten Algeria's long-term sales arrangements, complicate contract negotiations, and lead to lower gas prices delinked from oil prices.

18. Several major natural gas projects are currently under development, In total, they are expected to increase natural gas production to up to 140bcm by 2020. The largest undertaking is the In Salah natural gas project, developed in a joint venture between Sonatrach and a foreign company. Other natural gas and condensate projects are Ohanet, In Amenas, and Gassi Touil. Additionally, feasibility studies are under way for new pipeline projects: The 8bcm/y Medgaz pipeline would link Algeria directly to Spain. Another 8-10bcm/y pipeline is planned to go to Italy via Sicily and would possibly extend further to

---

[8] Estimates vary between different sources, including the Algerian Ministry of Energy and Mines, the Oil and Gas Journal, Petroleum Economics, the World Energy Council, and the U.S. Geological Survey.

[9] For an introduction to the terminology and economics of natural gas, see Okogu (2002).

[10] Currently, there are two pipelines, the 25.5bcm/y Transmed/Enrico Mattei pipeline via Tunisia and Sicily to mainland Italy, and the 8bcm/y Maghreb-Europe Gas (MEG)/Pedro Duran Farell pipeline via Morocco to Cordoba, Spain.

[11] Algeria is the second largest exporter of LNG worldwide (after Indonesia). It has LNG production capacity of around 28.3bcm/y. In early 2004, an explosion heavily damaged LNG production facilities in Skikda. While the large Arzew liquefaction complex had enough spare capacity to make up for the production shortfall, the accident might well limit Algeria's potential to expand LNG exports to Europe in the short- to medium term.

southern France. A third potential project is a Trans-Sahara gas pipeline from Nigeria to the Mediterranean coast.

Hydrocarbon Revenues

19. The Algerian treasury receives hydrocarbon revenues through royalties, taxes, and dividends from Sonatrach and its affiliates. An oil rent (*redevance*) of 20 percent is extracted from total value added (exports and domestic consumption). A direct tax of 85 percent is then levied on gross hydrocarbon profits (value added minus royalties and operation costs). Finally, as a state-owned enterprise, Sonatrach pays annual dividends to the treasury.

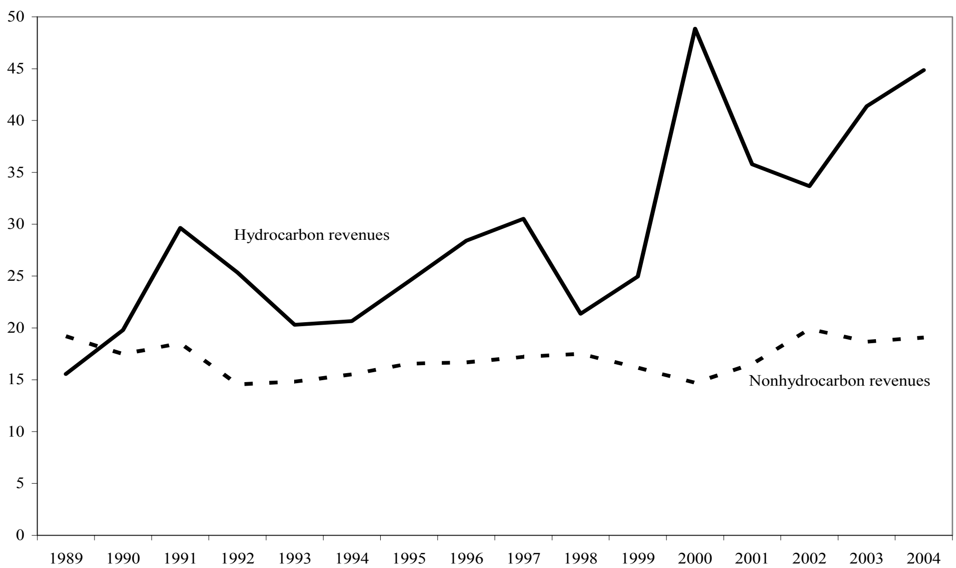
20. On average during 1989–2003, budgetary hydrocarbon revenues in Algeria accounted for almost two thirds of total budget revenues. In line with rising hydrocarbon export prices, their importance has increased significantly in relation to nonhydrocarbon revenues over the past few years. In 2003, total hydrocarbon exports amounted to $24 billion (98 percent of total exports of $24.5 billion) and budgetary hydrocarbon revenues to $17.5 billion. The average annual growth rate of budgetary hydrocarbon revenues (in US$) during 1989–2003 exceeded 7 percent. Growth was strongest during the price hikes in 1990 and 2000 (Figure 2). Apart from price developments, the strong increase of natural gas production and exports was the main factor driving hydrocarbon revenues.

Figure 2. Algeria: Hydrocarbon Revenues (In billions US$)
And Oil Price (In US$)

Sources: Algerian authorities and IMF staff estimates.

21. Hydrocarbon revenues have been far more volatile than nonhydrocarbon revenues, mainly due to the large fluctuations in world oil prices (Figure 3). Measured as a share of nonhydrocarbon GDP, the coefficient of variation of hydrocarbon revenues is three times higher compared to the respective coefficient for nonhydrocarbon revenues. Measured in terms of total GDP, hydrocarbon revenue volatility still exceeds nonhydrocarbon revenue volatility by a factor of two.

Figure 3. Algeria: Government Revenues
(In percent of NHGDP)



Sources: Algerian authorities and IMF staff estimates.

Stabilization Fund

22. In 2000, the Algerian government established an (off-budget) hydrocarbon stabilization fund (*Fonds de régulation des recettes*) in order to (i) reconstitute the cushion of external reserves that had been used in 1998-99 during a period of low hydrocarbon revenues; (ii) to service the stock of public debt in the context of strictly limited domestic bank and nonbank financing capacities (by law, monetary financing of the treasury is subject to strict limits and nonbank financing is constrained by the still underdeveloped treasury bill market); and (iii) to smooth the longer-term profile of expenditures. The hydrocarbon stabilization fund does not have intergenerational transfer purposes.

23. Any hydrocarbon revenues in excess of those budgeted are deposited into the stabilization fund, which is currently not separated from the treasury account at the central bank. In the preceding years, the budget laws were built on conservative oil price assumptions of US$19 per barrel in 2000, $22 in 2001, and $19 in 2002 and 2003, while actual oil export prices averaged $28.5 in 2000, $24.8 in 2001, $25.2 in 2002, and $29 in

2003. This arrangement resulted in substantial gross inflows to the stabilization fund, amounting to a total of DA1,052.5 billion at end-2003 ($14.5 billion, or 20.5 percent of 2003 GDP).

24. The 2004 budget law introduced exceptional advances by the central bank to the Treasury as an additional source of inflows to the stabilization fund. This change is related to the new law on money and credit. It authorizes the central bank to make such advances to the Treasury if they are intended exclusively for the active management of the external debt.

25. By law, the amounts accumulated in the fund can be used to (i) finance the budget deficit in case of lower-than-budgeted hydrocarbon revenues, and (ii) reduce the outstanding national debt. Regarding the former, the 2004 draft budget law clarified that the amount of money that can be drawn from the fund is limited to the shortfall in hydrocarbon revenues resulting when realized hydrocarbon prices are lower than those projected in the budget law. The latter use opens a serious loophole in the budgetary process: the use of financial resources of the stabilization fund for amortization payments has led to an actual use of oil revenues for additional spending (often in the context of supplementary budgets) which has resulted in budget deficits much larger than envisaged in the budget law.

26. So far, actual hydrocarbon prices stayed consistently above those budgeted, and consequently the authorities' policy has been to restrict the use of the fund's resources to financing debt amortization payments. At end-2003, total credits to the fund were DA1,052.5 billion ($14.5 billion, or 20.5 percent of 2003 GDP), while drawings for debt amortizations from 2000 to 2003 added up to DA484.1 billion ($6.7 billion, or 9.4 percent of 2003 GDP). Therefore, the net amount accumulated at end-2003 was DA568.4 billion ($7.8 billion, or 11.1 percent of 2003 GDP). This amount represents a mere 7.3 percent of the total government hydrocarbon revenues of DA7,739 billion in the period 2000–03.

Table 1. Algeria: Stabilization Fund

	2000	2001	2002	2003	Proj. 2004
Actual average oil export price (in $)	28.5	24.8	25.2	29.0	37.4
Budgeted oil export price (in $)	19.0	22.0	19.0	19.0	19.0
Stabilization Fund (in DA bn)	232.1	249.0	275.5	568.4	...
Accumulation (in DA bn)	453.2	123.9	26.5	448.9	616.3
Utilization (in DA bn)	221.1	107.0	0.0	156.0	...
Stabilization Fund (in percent of GDP)	5.7	5.9	6.2	11.1	...
Accumulation (in percent of GDP)	11.1	2.9	0.6	8.8	10.5
Utilization (in percent of GDP)	5.4	2.5	0.0	3.0	...

Source: Algerian authorities and IMF staff estimates

C. Economic Policy Challenges

27. Economies with large hydrocarbon industries have certain unique economic characteristics: (i) hydrocarbon reserves are exhaustible; (ii) reserves and future price paths are uncertain; (iii) hydrocarbon prices are extremely volatile; (iv) the hydrocarbon sector typically is an enclave more or less separated from the rest of the domestic economy; (v) hydrocarbon revenues originate largely from abroad; and (vi) hydrocarbon revenues are often an important source of total government revenue. From these special characteristics result the following challenges for economic policy:

- **Efficient use** of hydrocarbon revenues.
- **Fiscal sustainability** with a view to the finite and uncertain hydrocarbon revenue stream;
- **Intergenerational equity** considerations with regard to the intertemporal distribution of the natural resource wealth;
- Transmission of hydrocarbon sector volatility into the nonhydrocarbon economy through **fiscal policy**, thus hurting private sector development and growth, reducing public spending quality, and creating a deficit bias;
- **Dutch disease** phenomena through real exchange rate appreciation, induced by large foreign exchange inflows resulting from hydrocarbon export revenues;
- **Governance problems** and rent-seeking behavior due to the concentration of revenues from the hydrocarbon sector and their significance for the government budget.

28. Given that most hydrocarbon revenues accrue to the government, these policy challenges relate to primarily fiscal policy decisions, although there are important implications for monetary policy as well. Prudent macroeconomic policy would strive to insulate the nonhydrocarbon economy from the volatility of the hydrocarbon sector, sterilizing excess foreign exchange inflows, and diversifying the fiscal revenue base, while at the same time ensuring long-run fiscal sustainability and taking into account intergenerational economic equity concerns.

Efficient Use of Hydrocarbon Revenues

29. Algeria’s large hydrocarbon resource endowments can be very beneficial for the economy. Used wisely and efficiently, the country’s hydrocarbon wealth opens up opportunities to achieve broad economic objectives, including increasing growth and employment. Government hydrocarbon revenues can be spent to satisfy current economic needs and to invest in the country’s future economic potential. Naturally, the use of hydrocarbon revenues for capital and social spending is high on the government’s political

and economic agenda. However, Algeria has not at all times been successful in efficiently using its hydrocarbon wealth. On the contrary, volatile public spending has often had damaging effects, harming the private nonhydrocarbon sector, as well as creating uncertainty and adjustment costs. At the same time, the public sector has not always been able to use hydrocarbon wealth productively in the form of growth-enhancing investments. Like other natural resource based economies, Algeria has so far not been able to utilize its hydrocarbon wealth to create the necessary conditions for sustained faster growth and economic development.[12]

Fiscal Sustainability

30. Oil and natural gas are non-renewable resources, and the size of recoverable reserves is subject to considerable uncertainty. Even though natural resource endowments can generate significant government revenues over several generations, fiscal policy finally will have to manage the transition to a situation where the natural resources will be depleted (Bjerkholt 2002). In order to meet its inter-temporal budget constraint, the government should save a part of current hydrocarbon revenue to be able to maintain spending levels in future periods. One possible way of achieving long-run sustainability of fiscal policy with hydrocarbon revenues is for the government not to spend out of its current hydrocarbon income, but out of its permanent income (see section IV). Alternatively, fiscal policy could follow rules imposing limits on expenditures or a certain budget deficit measure, and might additionally restrict government's ability to borrow (Davoodi and Fasano 2004).

31. In addition to the exhaustibility of natural resource reserves, government has to take into account the uncertain nature of future hydrocarbon revenue streams. Hydrocarbon revenues are notoriously difficult to forecast. The long-term path of hydrocarbon prices is highly uncertain, and prices exhibit strong volatility in the short term.[13] Past efforts of long-term price projections have been regularly far off the mark.[14] The predictability of hydrocarbon prices depends on their statistical properties. Empirical studies have been inconclusive so far as to whether oil prices are mean reverting or follow a random walk.[15]

---

[12] On examples for the interrelation of public expenditure and nonhydrocarbon growth, see Fasano and Wang (2001) and Al-Faris (2002). On the relatively unfavorable growth record of natural resource-based economies see Sachs and Warner (1995).

[13] According to Engel and Valdez (2000), oil prices are more volatile than prices of other export commodities because of international market conditions (e.g. OPEC cartel).

[14] See Bjerkholt (2002) who cites forecasts of reputed international forecasters at the time of the second oil crisis in 1981, which on average predicted oil prices to be $160/b in 1995 and $200/b in 2000.

[15] See for example the discussion of recent literature in Engel and Valdez (2000). The existence of a unit root would imply markedly higher uncertainty about hydrocarbon wealth compared to the case of mean-reverting prices. Some studies indicate that oil prices revert to a long-term mean, albeit at a very slow pace. Generally, there seems to be some support for the assumption that oil price changes have fairly strong transient elements (Engel and Valdez 2000), although hydrocarbon prices are occasionally also subject to permanent shocks (such

(continued…)

The impossibility to calculate accurately the flow of revenue even in the short term necessitates the early accumulation of precautionary savings in the form of liquid financial assets in order to provide a cushion for fiscal expenditures in years with unexpectedly low hydrocarbon revenues.

32. Other ways to reduce the impact of future revenue shortfalls are targeting persistent surpluses (Alier and Kaufman 1999), diversifying government revenue sources, or the use of contingent financial instruments (Daniel 2001). Raising the royalty rate and lowering the hydrocarbon tax rate would also reduce the impact of oil price volatility on government hydrocarbon revenues (Bjerkholt 2002). Finally, government economic policy could aim at enhancing growth of the non-hydrocarbon sector which could be potentially taxed.

Intergenerational Equity

33. Natural resource endowments constitute a part of national wealth, and the revenues that are generated by extracting them represent a depletion of this wealth. Hydrocarbon proceeds therefore should not be treated as current income but as financing (Tersman 1991, Barnett and Ossowski 2002). The size of hydrocarbon wealth in the ground can be estimated by the present value of the rent earned when it is extracted. Ensuring intergenerational equity would call for a preservation of wealth over time by saving and investing at least part of the rent.

34. The term "intergenerational equity", however, needs further specification, depending on how the welfare of future generations is valued relative to that of the present generation. In the recent economic discussion, the two most popular targets chosen are keeping the government's net wealth constant either (i) in real terms, or (ii) in real terms per capita. Following the first target would imply that the government could fully spend the real return on its net wealth, favoring the current generation at the expense of future generations, as a constant stock of wealth will in the future be shared among a larger population. Pursuing the second target would be more restrictive on current spending, allowing the provision of a time-invariant level of public goods to all citizens over time (Davoodi and Fasano 2004).[16] Defining what constitutes economic equity between generations is ultimately a political decision, depending on the government's social welfare function.

35. As indicated above, the uncertainty regarding ultimately recoverable reserves, the future hydrocarbon revenue stream, or society's discount rate create a precautionary savings motive in addition to the intergenerational equity motive (Katz et al. 2004).

---

as the oil crises). By using a fractionally integrated model with a mean shift component during the oil crises, Gil-Alana (2001) suggests that oil prices show mean-reverting behavior.

[16] An alternative, even more restrictive target would aim at keeping real net government wealth constant as a percentage of nonhydrocarbon GDP. Following this target would imply a patient society that saves enough to ensure growing real per capita consumption out of hydrocarbon wealth (Bailén and Kramarenko 2004).

Volatile Fiscal Expenditure

36. Hydrocarbon price volatility is often transmitted to the nonhydrocarbon economy through fiscal expenditure policy. Volatile government expenditures have a negative impact on the economy by increasing uncertainty about aggregate demand as well as through adjustment costs for frequent factor reallocation. Fiscal policy induced "boom-bust-cycles" therefore hurt private sector development, in particular long-lived investment, and are in part responsible for the growth underperformance and low diversification of hydrocarbon-based economies.

37. Government expenditure volatility entails significant fiscal costs in the form of reduced spending quality and efficiency, as large expenditure swings are difficult to manage. In times of rising revenues, it proves regularly hard to resist political pressures to increase expenditures in line with revenues (Talvi and Végh 2000). With planning, implementation, and management capacity being limited, the risk increases that additional fiscal resources are used for financing unviable capital projects and costly current expenditure programs. The adverse effects are intensified by corruption and governance problems connected with large spending programs. When government expenditure has to be reduced, capital and maintenance expenditure mostly bear the bulk of the adjustment burden, which may also be a source for low capital productivity and economic growth in hydrocarbon-producing economies.

38. Additionally, volatile fiscal expenditures often lead to a deficit bias of fiscal policy, as spending programs become entrenched. The implementation of expenditure cuts regularly turns out to be more difficult politically than the initial expenditure increases. As a result, fiscal imbalances build up, and the government is forced to either increase borrowing in an environment of increasing borrowing costs (Hausmann and Rigobon 2002) or to abandon capital projects and social spending programs. While domestic borrowing would be inflationary or crowd out credit to the private sector, external borrowing would increase fiscal vulnerability; introducing forced expenditure cuts in a disorderly, disruptive fashion could lead to social instability and reduced future growth (Barnett and Ossowski 2002).

Dutch Disease

39. Since oil and natural gas production is for the most part exported, hydrocarbon revenues bring about sizable foreign exchange inflows into the economy. Increased domestic use of external hydrocarbon revenues generally leads to an appreciation of the real exchange rate, which is unrelated to productivity improvements in the nonhydrocarbon sector of the economy. The appreciation of the domestic currency makes domestically manufactured goods less competitive, increasing imports, and decreasing exports. This phenomenon is commonly referred to as Dutch disease (Corden, W. M. 1984).

40. The Dutch disease phenomenon can be described best in a simple model of an economy with three sectors (Wakeman-Linn et al. 2004): a traditional tradable goods sector, a nontraded-goods sector, and the hydrocarbon sector. Rising world hydrocarbon prices lead

to higher foreign exchange inflows via hydrocarbon export receipts. Higher real incomes from the hydrocarbon sector lead to increased expenditures on both tradable and nontraded goods. As a result, the real exchange rate appreciates, as nontraded goods prices increase, while tradable goods prices—which are determined in the international market—remain constant. Faced with higher factor prices which cannot be passed through to goods prices, the tradable goods sector becomes less profitable and looses international competitiveness. The sector contracts, and resources move from the tradable goods sector to the nontraded goods sector. Depending on the flexibility of the domestic economy and the ability of the nontraded goods sector to absorb labor freed up in the tradable goods sector, unemployment increases during a—possibly prolonged—transition period.

41. Close coordination of fiscal, monetary, and exchange rate policies is required to avoid excessive real exchange rate appreciation connected with the Dutch disease phenomenon. In addition, productivity-enhancing structural reforms can further help preserving the competitiveness of the nonhydrocarbon private sector.

42. In the case of Algeria, adverse Dutch disease effects can be controlled and minimized by an appropriate fiscal management of hydrocarbon revenues. Being a mainly export-oriented industry situated in remote areas, and with high capital and low labor intensity, the hydrocarbon sector has strong enclave characteristics. An increase in world hydrocarbon prices does by and large not directly affect domestic demand. Most of the increase in hydrocarbon export revenues accrues directly to the government. Therefore, the main channel of transmission to the nonhydrocarbon economy is government expenditure.

Governance

43. The hydrocarbon sector generally has a much higher significance for fiscal revenues than its share of GDP would suggest. Effectively managed, large hydrocarbon rents should provide a country with the resources to finance economic development and necessary structural reforms, including measures to reduce the political and social costs of those reforms (social safety net). However, the experiences of natural-resource-rich countries show that natural resource revenues often tend to be spent on current consumption, rather than to finance infrastructure projects conducive to private sector growth, investment in human capital, or structural reforms (Wakeman-Linn et al. 2004).

44. The easy availability of hydrocarbon revenues in periods with high world market prices reduce pressures for economic reforms, encourages overoptimistic expenditure plans, and reduces incentives for appropriate planning and monitoring of spending projects. At the same time, political pressures for increased government spending intensify.

45. The high concentration of hydrocarbon revenues and their large share in total budget revenues also make their use prone to lead to widespread corruption and rent-seeking behavior by special interest groups. Improving transparency and accountability in the fiscal management of hydrocarbon revenues and a proper regulation of hydrocarbon sector operations is therefore of utmost importance for ensuring good governance.

D. Long-Term Wealth Preservation

46. In an oil and gas producing economy, hydrocarbon reserves will eventually be depleted, and hydrocarbon earnings as a government revenue source will consequently vanish. On the grounds of fiscal sustainability and intergenerational equity considerations, the main challenge for fiscal policy in the long run is deciding how to allocate the economy's wealth (including hydrocarbon wealth) across time (Barnett and Ossowski 2002).

47. In the following, the permanent income framework will be employed as one possible way of ensuring intergenerational economic equity and long-term sustainability of fiscal policy. The section focuses on issues of wealth preservation and fiscal sustainability. The discussion does not cover broader concerns such as social returns of alternative uses of hydrocarbon revenues, or how to use oil revenues efficiently for the purpose of employment creation.

48. Intertemporal optimization would imply a prudent fiscal policy preserving government net worth, which would guarantee a constant consumption out of wealth for all generations (Solow 1974, 1986). The permanent income hypothesis assumes that the government does not spend out of its current income, but out of its permanent income, which is the notional income stream from its net wealth (Davoodi and Fasano 2004). Fiscal policy is sustainable over the long run, if the government's primary nonhydrocarbon deficit is smaller or equal to the country's permanent income out of the government's net wealth. The primary rather than the overall deficit is the relevant concept because net interest income is considered to change net wealth.

49. Two alternative long-run frameworks for fiscal policy will be considered: The first keeps government's net wealth constant in real terms, which implies constant real spending in each period. The second aims at preserving the same wealth in per capita terms, entailing rising government spending in line with population growth.

50. In general, government net wealth encompasses the sum of hydrocarbon wealth, financial assets net of government debt, and nonfinancial wealth (Davoodi and Fasano 2004). However, valuation of government nonfinancial wealth (such as physical capital and ownership of commercial or quasi-commercial entities) is generally difficult to determine and data usually not available.[17] Furthermore, most government nonfinancial assets, such as infrastructure capital, do not provide a regular income stream to the government if at all. For these reasons, nonfinancial wealth is excluded from the following analysis. The results could be qualified and adjusted, if more information about the valuation of government nonfinancial wealth were available. However, it is not certain in which direction the valuation of total government net wealth would change if government nonfinancial wealth would be considered, since both nonfinancial assets and liabilities would have to be included.

[17] This valuation is the calculation of the net present value of future income from nonfinancial wealth.

It might well be that quasi-fiscal deficits from loss-making public enterprises[18] and contingent liabilities likely existing in the social security system and local municipalities outweigh the future income from nonfinancial assets.[19]

Abstracting from nonfinancial wealth, the relevant policy variable is total government net wealth W_t as the sum of hydrocarbon wealth H_t and net financial wealth F_t:

$$W_t = H_t + F_t \tag{1}$$

Hydrocarbon wealth is defined as the present discounted value of projected future government hydrocarbon revenue up to period T, in which hydrocarbon reserves are finally depleted:

$$H_t = \sum_{n=1}^{T} \frac{r_{t+n}}{(1+i_t)^n} \tag{2}$$

In equation (2), real hydrocarbon revenue in period t is given by r_t, while i represents the real interest rate.

Preservation of government net worth requires that government spending in each period is limited to the implicit return on government wealth. If total wealth is to be kept constant, hydrocarbon production can be thought of as a portfolio transaction in which natural resource assets extracted from the ground are converted into financial assets. Hence, financial wealth must increase to the extent that hydrocarbon wealth is drawn down. This requires that part of oil revenue is saved.

$$(W_t - W_{t-1}) = (F_t - F_{t-1}) - (H_{t-1} - H_t) = 0 \tag{3}$$

The permanent income framework can be applied to operationalize the decision problem of the natural resource based economy.[20] The permanent income is the maximum amount of current hydrocarbon revenues that can be used for actual spending each year without

---

[18] According to IMF staff estimates, the non-recording in the budget of the quasi-fiscal operations of public banks to cover losses of public enterprises overestimates (underestimates) the size of the overall surplus (deficit) by at least one percentage point of GDP. See IMF Country Report 04/33, February10, 2004.

[19] Earlier World Bank and IMF analyses indicate a low return on government investment in Algeria. See fore example IMF Country Report 04/33; February 10, 2004, and IMF Country Report 03/68, March 12, 2003.

[20] The permanent income framework has been applied previously to a number of countries. For examples, see Tersman (1991), Liuksila et al. (1994), Baskand and Razi (1997), Chalk (1998), Stotsky (1999), Davoodi (2002), Baunsgaard (2002, 2003), Ntamatungiro (2002, 2004), Wakeman-Linn et al. (2004). For earlier applications to Algeria, see Aissaoui (2001) and World Bank (2003).

reducing total wealth. Hydrocarbon revenue is the sum of the decline in oil wealth between periods t and t-1 and the implied return on hydrocarbon wealth in period t-1:

$$r_t = (H_{t-1} - H_t) + i_t H_{t-1} \tag{4}$$

Assuming certainty, the required savings out of oil revenue can be derived from the targeted financial wealth compared to the stock of financial wealth in the previous periods:

$$s_t = \frac{F_t}{1+i_t} - F_{t-1} \tag{5}$$

$$F_t - F_{t-1} = s_t(1+i_t) + i_t F_{t-1} \tag{6}$$

The total hydrocarbon revenues are larger than the required savings to accumulate income-generating assets or to reduce outstanding debt as the interest earned during the period will be added to the financial assets. By rearranging equations (4) and (5) and inserting into (3), an expression for government spending financed by permanent income from hydrocarbon wealth can be derived:

$$r_t - s_t = i_t(H_{t-1} + F_{t-1} + s_t) = i_t(W_{t-1} + s_t) \tag{7}$$

The government intertemporal budget constraint can be written as

$$z_t + i_t(W_{t-1} + s_t) - e_t = W_t - W_{t-1} \tag{8}$$

where z_t is nonhydrocarbon revenue excluding net interest income, which is given by $i_t(W_{t-1} + s_t)$, and e_t stands for the government's primary expenditure and net lending. Primary expenditure excludes interest payments on public debt and includes current spending and public investment in physical and human capital. The difference between revenues and expenditures leads to a change in the government's net worth.

Assuming constant government wealth as in equation (3) and imposing a net non-borrowing constraint, equations (7) and (8) can be rewritten as to represent the primary nonhydrocarbon deficit:

$$PNHB_t = z_t - e_t = -i(W_{t-1} + s_t) \tag{9}$$

Following this upper limit for the nonhydrocarbon deficit will maintain real government wealth constant, as sufficient hydrocarbon revenue is saved to accumulate financial assets. Over time, the targeted savings of hydrocarbon revenues will turn negative and the primary nonhydrocarbon deficit will be financed increasingly by interest revenues from accumulated assets. The return on these assets will ensure that the primary nonhydrocarbon deficits can be sustained even after the hydrocarbon revenues dry up.[21]

Targeting a constant level of hydrocarbon wealth with population growth will lead to falling levels of per capita wealth, which would violate intergenerational equity requirements. To account for this, the above framework can easily include the population growth rate n_t in order to keep real wealth per capita constant over time:

$$W_t = W_{t-1}(1+n_t) \tag{10}$$

Constant real wealth per capita requires that total real wealth grows in line with population. Therefore, a higher share of current hydrocarbon revenue has to be saved and invested in income-generating financial assets.

$$W_t - W_{t-1} = n_t W_{t-1} = n_t(H_{t-1} + F_{t-1}) \tag{11}$$

$$(F_t - F_{t-1}) = (H_{t-1} - H_t) + n_t(H_{t-1} + F_{t-1}) \tag{12}$$

The fiscal expenditure framework for keeping wealth per capita constant can be derived by inserting equations (4) and (6) into (12). Under this rule, government spending financed by permanent income from hydrocarbon wealth should equal the return on total wealth adjusted for the population growth rate plus the interest earned on savings during the current period:

$$r_t - s_t = i_t(H_{t-1} + F_{t-1} + s_t) = (i_t - n_t)W_{t-1} + i_t s_t \tag{13}$$

In this case, the government intertemporal budget constraint is:

$$z_t + i_t(W_{t-1} + s_t) - e_t = W_t - W_{t-1} = n_t W_{t-1} \tag{14}$$

Consequently, the net primary nonhydrocarbon deficit can be written as:

$$PNHB_t = z_t - e_t = -(i_t - n_t)W_{t-1} - i_t s_t \tag{15}$$

51. The permanent income framework has several desirable properties (Davoodi 2002). It is forward-looking in that it assumes that expenditures are financed not by current income but out of permanent income from total government wealth. Following a permanent income framework over the long term will smooth the government spending path of hydrocarbon

---

[21] This implies that strategies aimed at merely stabilizing debt to GDP ratios or even eliminating all debt are ultimately not consistent with fiscal sustainability in the case of a hydrocarbon-based economy (Barnett and Ossowski 2002).

wealth over time. Assuming certainty about the present value of future hydrocarbon revenues, a permanent income-oriented fiscal policy is by construction sustainable.

52. However, critics argue that exactly because of the enormous uncertainties concerning reserves, prices, extraction costs, the rates of return on the savings portfolio, or the appropriate discount rate to reflect society's time preference, there is nothing permanent about the hydrocarbon wealth underlying the calculation of permanent income (Bjerkholt 2002). Additionally, the permanent income framework would call for borrowing towards future earnings in countries that are in an early phase of developing their hydrocarbon resources – a dangerous prescription in view of the volatility and uncertainty of hydrocarbon revenues and perhaps high borrowing costs.[22] Several countries, such as Algeria and Nigeria, borrowed heavily against anticipated future hydrocarbon income and later suffered from major macroeconomic crises when the revenue forecasts turned out to be wrong. Finally, the permanent income framework does not consider social returns from employment creation or physical investment.

53. Consequently, the permanent income framework should be supplemented to account for the fact that the permanent income estimate is afflicted with significant uncertainty. This would generally lead to a more conservative fiscal stance (while accounting for social returns could allow higher expenditure). For example, the permanent income framework could entail a nonborrowing constraint, which would mean that the government would finance its nonhydrocarbon deficit solely from hydrocarbon revenues. The framework should also account for some additional precautionary savings to account for possible downward revisions of permanent income in the future due to changed reserves, market conditions, or technological obsolescence of the natural resource.

54. Finally, estimates of hydrocarbon wealth and permanent income have to be reconsidered and adjusted continuously, as new information about reserves or changing market conditions are obtained. Likewise, results should also be adjusted, in case reliable data on the valuation of government nonfinancial wealth become available.

E. Efficient Management of Hydrocarbon Wealth

55. Managing hydrocarbon wealth efficiently requires portfolio decisions at various levels. First, the authorities have to decide on the rate of depletion of the hydrocarbon reserves, that is, on the speed with which physical resource assets are converted into financial assets. Second, policymakers face the intertemporal optimization problem of how much of the hydrocarbon revenues to spend, and how much to save for wealth preservation for future generations. For this, the permanent income framework discussed above can serve

[22] The most cautious approach would be to follow a "bird-in-hand" fiscal rule, which limits the targeted PNHB to the anticipated returns on already accumulated financial assets (Bjerkholt 2002). This rule implies a zero non-oil balance and a substantial overall surplus.

as a guideline. Third, decisions will have to be made regarding the alternative investments of hydrocarbon savings.

Depletion Rate

56. The decision on the optimal depletion rate depends on the relative returns on the alternative assets in the present and future periods, and it consequently will be largely influenced by the assumptions made concerning the future price path of hydrocarbon products. An argument could be made that in order to reduce the level of uncertainty as well as the dependence on the resource markets, an accelerated rate of depletion should be chosen. Moreover, the Hotelling rule suggests that physical capital has a higher marginal productivity than natural resource capital (Stiglitz 1974, Cairns and Davis 1998). This would justify a rapid depletion of the hydrocarbon reserves in order to finance the build up of physical and human capital to boost the economy's growth (Davoodi 2002).

57. Financial assets created by the sale of hydrocarbon products could be invested in a diversified portfolio, thus reducing risk. Risk diversification could also be achieved by selling off a large share of property rights to the resource endowments in the international market – that is, in principle there is no need to physically extract the natural resource asset first. However, in practice this may not be possible because the market for large-scale sales of natural resource endowments does not exist (Bjerkholt 2002). Similarly, there are also economic, technological, and political restrictions to the extent to which depletion rates can be increased. Mainly, Algerian hydrocarbon production will be limited by upstream investment, sustainable field management, demand developments, and OPEC quotas in the case of oil.

Alternative Investments of Hydrocarbon Savings

58. Regarding the share of hydrocarbon revenues to be saved for long-term wealth preservation purposes, there are three main alternative uses. The authorities could decide to further build up productive capacity in the form of physical and human capital in order to increase the nonhydrocarbon economy's growth potential. On the other hand, they might choose to accumulate financial wealth and invest it either domestically or abroad, or they could prefer to repay outstanding government debt.

Investing in Physical Assets

59. Efficient government investment in productivity-enhancing infrastructure and human capital can be expected to increase the return on private capital and contribute to meeting the key challenges facing Algeria of creating employment and boosting the country's growth potential. However, regarding fiscal sustainability, the financial returns to government investment would have to be rather high. Unlike the private sector, the government's financial return is by and large restricted to what it can retrieve by way of higher tax revenue (Barnett and Ossowski, 2002). In most cases it seems unlikely that investment in physical assets will generate higher financial returns for the government (in the form of higher future

tax revenue) than a respective investment in financial assets (Fischer and Easterly 1990), particularly if tax rates on the realized returns in the private nonhydrocarbon sector are low. Choosing to invest hydrocarbon revenues in public physical assets will therefore generally alter the fiscal sustainability situation.

60. Government capital expenditure could also be seen as a consumer durable generating social welfare and employment, instead of as productive investment generating only financial returns (Barnett and Ossowski 2002). If it can be assumed that the public capital stock is initially at a suboptimal level, giving up some of the initial hydrocarbon wealth in order to allow larger primary nonhydrocarbon deficits could be justifiable for some time until the capital stock reaches its equilibrium level.

61. On the other hand, in the short term the absorptive capacity of the economy may not be sufficient for large-scale domestic investment, which could lead to poor spending quality, inflation and crowding out of the private sector. Injecting a large share of the foreign exchange inflow earned from hydrocarbon exports into the domestic economy could cause the Dutch disease phenomenon by pushing prices of nontradable goods up, thus inducing an appreciation of the real exchange rate and eroding the competitiveness of the nonhydrocarbon tradable goods sector.

62. Since public physical assets are less liquid than financial assets, investment in physical assets should make an allowance for higher precautionary savings. Also, policy makers have to take into account the related implicit commitments, such as future maintenance costs, contained in capital expenditures.

63. Practical experiences with public investments in productive capacity have been rather disappointing in hydrocarbon based economies in general, as well as in Algeria specifically (Nashashibi et al. 1998). Limited institutional capacity, insufficient maintenance and poor management, as well as governance problems caused by non-transparent procedures, low accountability and rent-seeking behavior often lead to poor spending quality. Government investment in the public enterprise sector has been particularly inefficient in Algeria, creating large loss-making public enterprises that have been resistant to productivity enhancing reforms. Furthermore, the needs of state-owned enterprises for credit have reduced the limited financial resources available for private sector development. Instead of creating a reliable government revenue stream, the public enterprise sector posed a growing financial burden on government finances, as repeated attempts at public enterprise restructuring failed (Floerkemeier 2003).

64. From a fiscal sustainability viewpoint, government investment decisions should be based on the return that the government can expect. From this perspective, the problem is a portfolio decision between financial and physical assets (Barnett and Ossowski 2002). From an economic development point of view, however, Algeria has substantial development needs and an insufficient stock of infrastructure capital. The availability of hydrocarbon wealth could lower the financing cost of government investment; however, it would not make investments in the nonhydrocarbon sector more worthwhile as such. Decisions on

government investment projects should thus be made on the basis of cost-benefit criteria, independent of the availability of financial resources from hydrocarbon revenues.

Investing in Financial Assets

65. When the Algerian government decides to accumulate hydrocarbon savings in the form of financial assets, it can invest those assets either domestically or abroad. Given the objective of supporting growth of the domestic economy, the government might have a preference of investing hydrocarbon savings locally. However, there are two important arguments against this. First, investing assets domestically would transmit hydrocarbon revenue volatility to domestic financial markets as the government buys and sells such assets (Davoodi and Fasano 2004). Second, the dangers of the Dutch disease phenomenon connected with large-scale foreign exchange inflows (real exchange rate appreciation leading to a deterioration of competitiveness of the nonhydrocarbon tradable goods sector) would call for sterilizing a large part of hydrocarbon revenues by investing them in financial assets abroad instead of in domestic financial assets.

66. Investing hydrocarbon savings in an international portfolio of financial assets would warrant a stable flow of government income largely unaffected by domestic economic developments. If the available resources are invested in sufficiently liquid assets, the government would ensure fiscal flexibility, should unexpected financing needs arise. Oil producing countries sometimes choose to invest internationally in the downstream hydrocarbon sector or in related industries, such as petrochemicals, in order to secure markets for their products. However, for diversification and risk reduction purposes, investments ought to be independent from or even negatively correlated with the hydrocarbon market. The downside of investing hydrocarbon savings in financial assets abroad lays in the exchange rate risk and the need to foster political acceptance in the presence of pressing domestic investment needs, such as for infrastructure or human development. Especially the latter argument applies in the case of Algeria.

Repaying Debt

67. Countries with substantial external debt normally have to pay a sovereign premium. In this case, the government should use its hydrocarbon revenues to rapidly pay off its expensive debt. Because of the sovereign premium, the government faces two interest rates, a higher one for borrowing and a lower one for its gross savings (Barnett and Ossowski 2002). As long as the debt is positive, the sovereign premium increases the return to savings. Consequently, the government should as much as possible repay its debt ahead of schedule and increase its net savings in order to take advantage of the higher interest rate. Another situation arises in countries with access to concessional credit, where debt service on existing debt might be below the returns that would be achieved by investing hydrocarbon revenues in financial assets.

F. Short- and Medium Term Stabilization

Overview

68. Fiscal policy faces the challenge of how to inject the hydrocarbon resource rent into the economy as fiscal expenditure. The main instrument to avoid a strong real exchange rate appreciation causing Dutch disease is to sterilize part of the foreign exchange inflow by investing hydrocarbon proceeds in foreign assets, or to pay off external debts. Spending on investment rather than consumption could also help in sterilizing parts of the foreign exchange inflows, insofar as capital expenditures have a comparatively high import content. Structural policies encouraging private sector saving can complement fiscal policy in restraining real exchange rate appreciation (Katz et al. 2004). To the extent that increased domestic absorption is permitted during a period of hydrocarbon windfall revenues, monetary policy should accommodate the resulting increase in real money demand through an expansion of money supply in order to limit an excessive appreciation of the real exchange rate (Wakeman-Linn 2004). However, in the view of the limited depth and development of the financial market in Algeria, which constrains the scope and effectiveness of open market operations by the central bank, it remains essential to follow prudent fiscal policies and strengthen coordination of macroeconomic policies between the Ministry of Finance and the central bank.

69. The volatility of oil prices translates directly into volatile fiscal revenues and can severely impact the conduct of fiscal policy in countries, like Algeria, where hydrocarbon proceeds account for a large share of the budget. Because world hydrocarbon prices are beyond the control of the authorities, fiscal policy has to develop strategies confronting unexpected and large swings in fiscal cash flow. As described above, government spending is the main channel transmitting hydrocarbon sector volatility to the nonhydrocarbon sector.

70. In order to prevent the revenue volatility from spilling over into the nonhydrocarbon economy, the use of hydrocarbon revenue should be decoupled from the current earnings. Expenditures should be budgeted independently from current hydrocarbon revenues, and unexpected revenue changes sterilized through changes in public debt levels or financial assets holdings.[23] The implementation of such a fiscal policy could be aided by formulating budgets within a medium-term framework and by introducing fiscal guidelines as an anchor for policymakers. Medium-term budgetary frameworks increase fiscal transparency by revealing future spending implications of present expenditure increases, such as maintenance cost of capital projects, thereby containing short-run pressure for expenditure increases in response to temporarily high hydrocarbon revenues. A fiscal framework linked to an appropriate indicator of the fiscal stance would smooth expenditure reactions to revenue volatility.

---

[23] The ability to absorb unanticipated negative cash flow shocks depends on the robustness of the government's financial position. Exchange rate adjustments or expenditure reductions may be needed in addition to sterilization or financing (Barnett and Ossowski 2002).

Indicators of the Fiscal Policy Stance

71. The primary nonhydrocarbon fiscal balance (PNHB) is the key indicator for assessing the direction and sustainability of fiscal policy in a hydrocarbon resource rich economy. The reasoning for excluding hydrocarbon proceeds is that natural resource revenues are a form of financing rather than income.[24] The PNHB is a variable unaffected by hydrocarbon price volatility and therefore largely under the control of the authorities. It allows the targeting of a stable fiscal policy in line with economic developments in the nonhydrocarbon economy. Changes in the fiscal stance related to hydrocarbon price fluctuations are directly reflected in changes of the PNHB. Hence, the PNHB indicates the impact of fiscal policy on domestic demand.

72. In contrast, the overall balance is affected heavily by the development of hydrocarbon revenues. Targeting a balanced overall balance would lead to a full transmission of hydrocarbon revenue volatility to the nonhydrocarbon economy and consequently be destabilizing. Additionally, this fiscal policy strategy does not account for the gradual depletion of oil wealth, and the overall balance will have to be adjusted dramatically when hydrocarbon resources are exhausted or should they become technologically obsolete.[25]

Fiscal Guidelines

73. The PNHB should be used as the basis of budget determination and should be published in budget documents. It will be negative to the extent that current oil revenue (or income from financial assets from oil revenue saved in the past) is used to finance budget expenditure. The sustainable target value for the PNHB depends on the estimate of the permanent income stream resulting from total hydrocarbon and financial wealth. The specific fiscal framework targeting the PNHB could, however, allow for some flexibility or automatic countercyclical response to shocks affecting the nonhydrocarbon sector.

74. A price-based deficit rule would be a possible alternative to a fiscal guideline targeting a specific PNHB. Such a rule would aim for a balanced overall budget using an estimate of the long-term average, or "permanent", hydrocarbon price. Like the PNHB-based framework, this fiscal rule would eliminate the impact of hydrocarbon price volatility on budget expenditures. In addition, the price-based rule has an advantage in terms of simplicity. It is easily understood and the outcome is readily observable. However, the rule would not be able to fully decouple the budget from all sources of oil revenue volatility, such

---

[24] The PNHB is also preferred to the use of the nonhydrocarbon fiscal balance, because it is not affected by changes in income from official net foreign assets built up over time from oil revenues saved for precautionary and long-term savings motives.

[25] The overall balance is, however, the relevant indicator for assessing the government's financing requirement and fiscal vulnerability.

as changes to production, extraction costs, the taxation regime, and the impact on oil revenue from exchange rate movements (Baunsgaard 2003).

75. Another alternative would be to follow an expenditure rule, according to which fiscal policy would aim at maintaining expenditure in real terms or in real terms per capita. Adherence to this rule would also make the expenditure program independent from hydrocarbon revenue volatility. The advantages of an expenditure rule compared to the PNHB based framework are its simplicity and transparency, which makes it straightforward to explain to the public and easy for the public to monitor observance to the rule, thus enhancing fiscal policy credibility (Wakeman-Linn et al. 2004). Nevertheless, it has to be combined with a permanent financing constraint to guarantee long-run fiscal sustainability (Davoodi and Fasano 2004).

76. Independent from the guideline selected, a strong case can be made for building up a cushion of reserves—which would have to be large enough to temporarily absorb a possible adverse shock to hydrocarbon prices—before fully implementing a rules-based fiscal framework. That is, initially the guideline should be applied in an asymmetric manner until sufficient financial assets have been built up to support adherence to the framework. Only if the government is not liquidity constrained and has sufficient access to credit at reasonable cost, will it be able to absorb unanticipated adverse revenue shocks without forced expenditure adjustments. Even if such a shock should turn out to be prolonged or permanent, a country with a strong financial position could afford to adjust its fiscal stance gradually through a mix of adjustment and financing (Barnett and Ossowski 2002).

Hydrocarbon Funds

77. In response to the difficulties of managing hydrocarbon revenue volatility and to supplement rules-based fiscal spending frameworks, a number of countries have created saving funds or—such as Algeria—revenue stabilization funds (Fasano 2000, Davis et al. 2001). The idea is to institutionalize savings during revenue windfalls and dissavings during price downturns. Liquidity accumulated in a stabilization fund provides fiscal policy with some degree of self-insurance, as international lending particularly to primary commodity producers tends to be positively correlated with commodity export prices (Davoodi and Fasano 2004).

78. However, hydrocarbon funds as such do not constitute fiscal rules and do not place formal restrictions on the conduct of expenditure policies. Several countries experienced incidents in which assets were accumulated in stabilization and saving funds while the government simultaneously increased borrowing to finance an overall deficit. To avoid this paradoxical situation, hydrocarbon funds should be made the only legal source of financing the PNHB (financing fund). To be effective, hydrocarbon funds should not be set apart from the budget process, and they need to be controlled by stringent transparency, fiduciary, and accountability mechanisms.

79. Stabilization funds are difficult to design and operate. Their major flaw is the setting of a reference price that will automatically determine flows into or out of the fund. Often, long-run average prices serve this purpose. However, due to changing realities or political pressures, reference prices tend to be adjusted more or less frequently (as has also happened in Algeria in 2001), calling the very purpose of the stabilization fund into question.

80. In general, financing funds—such as the Norwegian State Petroleum Fund—are preferable to stabilization funds. Financing funds do not have the rigid and arbitrary reference price rules, but serve as a government savings account through which all hydrocarbon revenues are channeled. In turn, the fund serves as the sole financing source of the budget deficit. Consequently, the net inflow into a financing fund equals the overall fiscal balance.

G. Sustainable Use of Hydrocarbon Revenues in Algeria: Long-Term Simulations

81. In the following simulations, the permanent income framework will be applied to Algeria.[26] Projections of the net present value (NPV) of the future hydrocarbon income stream and the resulting permanent income are made for the period 2004 to 2050. The results can serve as a guideline for the long-term sustainable fiscal management of hydrocarbon resources. Due to the significant uncertainty connected with long-term estimations of the NPV of hydrocarbon income, the results should be interpreted cautiously and be updated when new information about recoverable reserves become available, the taxation regime and institutional environment of the Algerian hydrocarbon sector change significantly, or international market developments significantly deviate from the assumptions made.

82. As discussed above, fiscal policy should adopt a rather cautious stance and regard the permanent income estimates as upper limits of the primary nonhydrocarbon balance, while further precautionary savings considerations should be taken into account. To account for uncertainty, several alternative scenarios with differing assumptions concerning recoverable reserves and hydrocarbon prices were carried out. The following subsections explain the methodology applied, describe the underlying assumptions, present the results of the alternative scenarios together with some policy recommendations, and conclude with some considerations about the sensitivity of the simulation results to changing assumptions.

Methodology

83. Algeria produces a variety of hydrocarbon products, each of which accounts for a substantial share of the production and export portfolio: crude oil, condensate, refined products, LPG, LNG, and dry gas. For the present simulations, all products will be

[26] Aissaoui (2001) and World Bank (2003) provide similar applications to Algeria, albeit with somewhat differing methodologies and assumptions. The results presented in these studies are by and large in line with the findings of the present exercise.

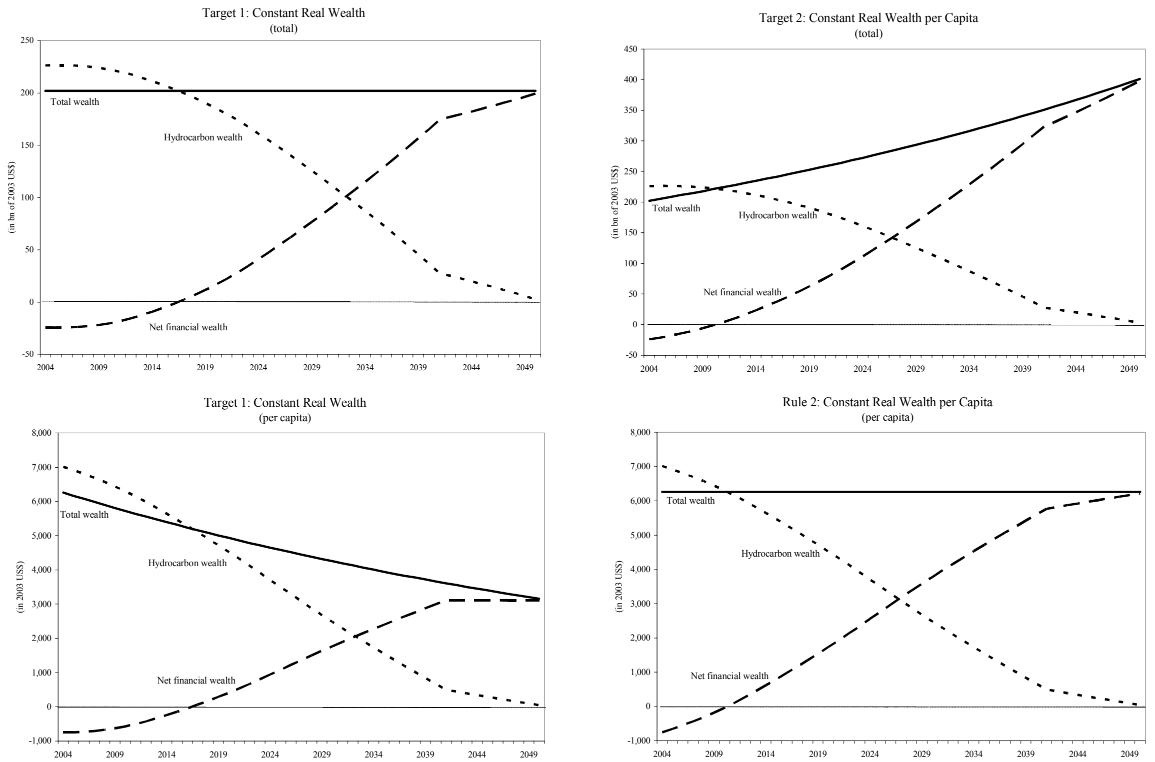
considered. However, prices of the various hydrocarbon products are highly correlated. To simplify the analysis, it seems justifiable to combine them into two groups and use weighted average prices and aggregate volumes for the projections: Crude oil, condensate, natural gas liquids, and refined products are aggregated into “total oil”, while LNG and dry gas are grouped in the category “total gas”.[27, 28] Projections of the NPV of the future revenue stream are carried out for these two categories separately and then added up to arrive at the total hydrocarbon income NPV.

84. Taking the estimates of the NPV of Algeria’s hydrocarbon revenues as a starting point, two alternative permanent income-based fiscal targets of hydrocarbon wealth preservation are considered: (i) constant real wealth, and (ii) constant real wealth per capita (Figure 4). The first target would allow larger nonhydrocarbon deficits over time, but would not account for Algeria’s significant population growth. Depending on the importance policymakers put on intergenerational equity considerations, keeping wealth constant per capita in order to equally distribute wealth across generations might be the preferred choice.

[27] Oil and gas are treated separately because of the different stage of development of the two sub sectors, the dissimilar projected production and consumption paths, and the varying behavior of prices: Gas contracts are usually on a long-term basis with prices being adjusted periodically, following oil prices with a lag of about half a year. Other studies try to aggregate all hydrocarbon products converting the products into barrels of oil equivalents. However, oil equivalents for oil and gas products are no scientific constants (World Bank 2003).

[28] Strictly speaking, already these six product categories are aggregates. Different qualities of crude oil represent genuinely distinct products, as they have different uses and fetch varying (albeit highly correlated) prices. The same holds, of course, for refined products and gas.

Figure 4. Algeria: Alternative Targets for Long-Term Net Government Wealth Preservation 1/



1/ (Example: Mid Price & Probable Reserves Scenario)

Assumptions

85. Alternative simulations are carried out using various assumptions about recoverable hydrocarbon reserves and future hydrocarbon prices. Sensitivity analyses were conducted to evaluate the impact of changes in other variables, such as alternative discount rates, the assumed production profile, government take, shares of exports and domestic consumption of oil and gas, population growth, or the growth of the nonhydrocarbon sector.

Hydrocarbon Reserves

86. Three reserve scenarios are considered: The low case scenario uses current estimates of proven reserves as of January 2003. The mid- and high case scenarios employ probable and possible reserve estimates according to the U.S. Geological Survey (Table 2).[29]

---

[29] Proven, probable, and possible reserves are defined as potential reserves with a 90, 50 and 10 percent probability of recovery, respectively (U.S. Geological Survey 2000).

Table 2. Algeria: Hydrocarbon Reserves

	Total oil (in mn tn)	Crude (in mn tn)	Condens. (in mn tn)	NGL (in mn tn)	Total gas (in bn cm)
Proven	2128.3	1441.3	410.0	277.0	4523.0
Probable	3421.9	2322.7	660.7	438.5	5739.2
Possible	5221.4	3528.7	1003.8	688.9	7439.9

Source: U.S. Geological Survey 2000 and IMF staff estimates.

87. Algeria's hydrocarbon reserves are still considered to be relatively under-explored, and substantial reserve growth can be expected in the future. Therefore, the low case scenario presumably greatly underestimates Algeria's true hydrocarbon potential. Probable oil reserves are 60 percent and possible oil reserves 145 percent higher than the proven reserves in the low case scenario. For gas, the respective assumed increases compared to the low case are around 27 percent and 65 percent.

Hydrocarbon Prices

88. Three different price scenarios are considered (Table 3). In each case, prices are held constant in real terms throughout the projection period. All prices are in in constant 2003 US dollars. The low case scenario assumes an oil price of $15 per barrel (b) and a gas price of $55 per thousand cubic meters (tcm). These very conservative price assumptions roughly correspond to the minimum prices realized during the past 25 years. The mid case scenario is compatible with the average hydrocarbon prices throughout the 1990s, assuming prices of $20/b for oil and $65/tcm for gas. Finally, the high price scenario is oriented at the long term (1980–2004) price average and sets the oil price at $25/b (which simultaneously represents the mid-price of the OPEC target price range) and the gas price at $85/tcm.

89. After a steep increase since the summer of 2003, the average Algerian oil export price reached $39/b in 2004, a much higher price than assumed in the long-term scenarios. However, the International Energy Agency (IEA) currently projects a long-term real oil price of 25$/b, which is consistent with the high price scenario in the present study.

Table 3. Algeria: Hydrocarbon Prices

	Alternative scenarios (constant 2003 US$)			Historical prices (nominal)			
	Low Case 2004-50	Mid Case 2004-50	High Case 2004-50	average 1980-2004	average 1990-99	min 1980-04	max 1980-04
Oil ($/b)	15.0	20.0	25.0	24.8	20.2	14.8	39.2
Gas ($/tcm)	55.0	65.0	85.0	84.2	64.8	53.7	142.3

Sources: Algerian authorities and IMF staff calculations.

Production Profiles

90. The simulations were based on a specific production profile for total oil and gas for each of the reserve scenarios (Table 4; Figure 5). All profiles assume that hydrocarbon reserves are completely depleted at the end of the projection period in 2050. The development of hydrocarbon production is fairly constrained in the low case scenario, especially the production of oil.

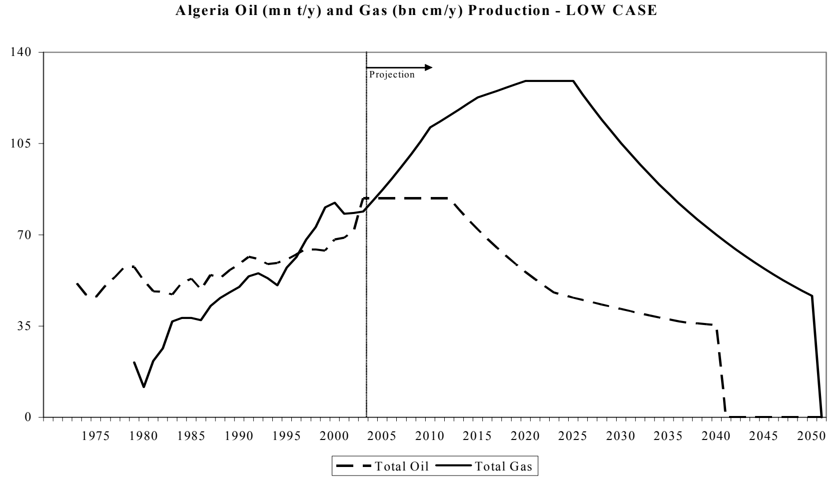
Table 4. Algeria: Production Profiles
(Annual averages)

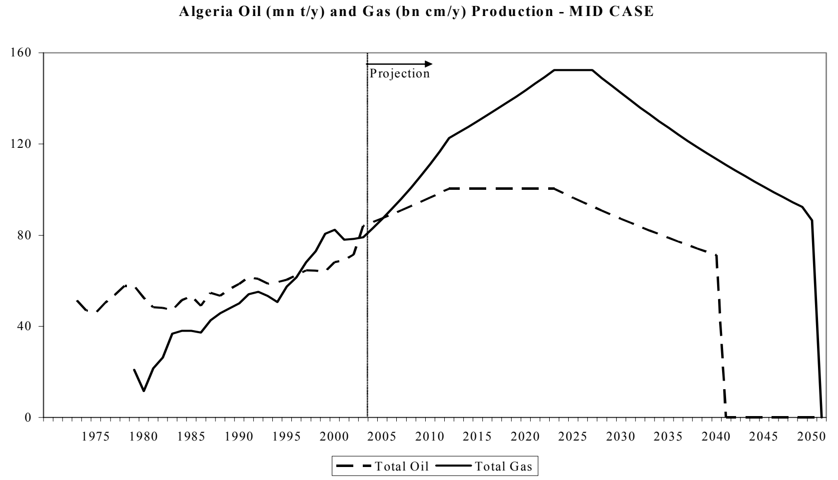
	Projections				Historical production		
	2004-15	2016-30	2031-50	2004-50	1980-2004	1990-99	2000-04
Total oil (b/d)							
Proven	1.6	1.0	0.3	0.9	1.2	1.2	1.5
Probable	1.9	1.9	0.6	1.4			
Possible	2.1	2.6	2.0	2.2			
Total gas (bcm/y)							
Proven	105.5	123.3	65.7	96.2	54.0	60.4	80.1
Probable	108.1	145.7	108.8	122.1			
Possible	110.0	180.3	165.6	158.3			

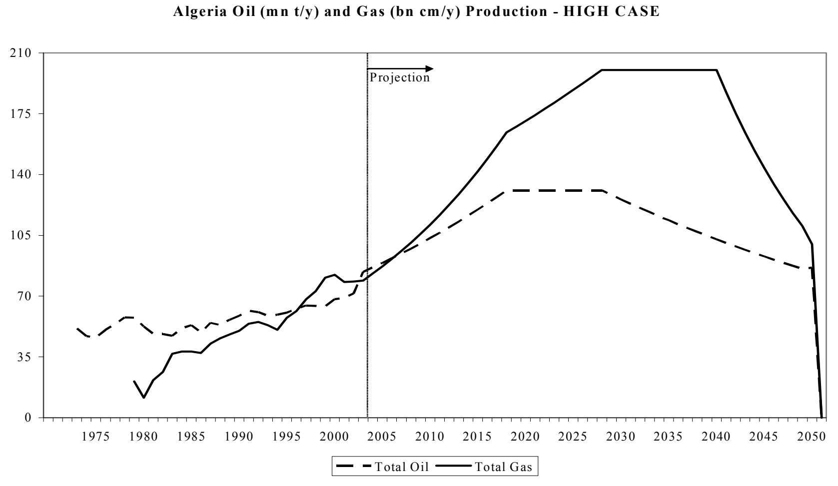
Sources: Algerian authorities, U.S. Energy Information Administration, and IMF staff estimates.

91. The mid case scenario resembles the current production forecasts of official and independent sources. It allows for a further increase in oil production until 2012, and a steep increase of gas production until 2023. Both the mid case and the high case scenarios are in line with the plans of the Algerian Ministry of Energy and Mining to increase natural gas exports to 85bcm by 2010. While oil reserves are assumed to be depleted by 2040 in the low an mid case scenarios, oil production could be maintained at a fairly elevated level throughout 2050 in the high case scenario.

Figure 5. Algeria: Assumed Production Profiles for Alternative Reserve Estimates







Other Assumptions

92. The discount rate for the baseline scenarios is set at 5 percent. Alternative calculations were carried out with interest rates of 4 percent and 6 percent. The population growth rate is assumed to stay constant at the current 1.5 percent, while nonhydrocarbon real GDP growth is assumed at 4 percent throughout the projection period, in line with current staff projections. The simulations presume government hydrocarbon revenues at 63.5 percent of export revenues and domestic hydrocarbon revenues at 12 percent of export revenues. Domestic consumption of oil and gas production is assumed to be constant at 17.5 percent (oil) and 26.5 percent (gas). All shares represent averages realized over recent years.

Main Simulation Results

93. Algeria is endowed with substantial hydrocarbon wealth, which can be best expressed in terms of the net present value of the future government hydrocarbon revenue stream. Assuming the baseline discount rate of 5 percent, the estimates of Algeria's hydrocarbon wealth (in 2003 US dollars) vary from around $138 billion in the most conservative low reserves and low price scenario to $360 billion in the optimistic high reserves and high price scenario. This translates into per capita hydrocarbon wealth of between $4,331 and $11,342 in 2004. Likewise, hydrocarbon wealth amounts to between 207 and 543 percent of GDP or between 326 and 853 percent of nonhydrocarbon GDP (Table 5).

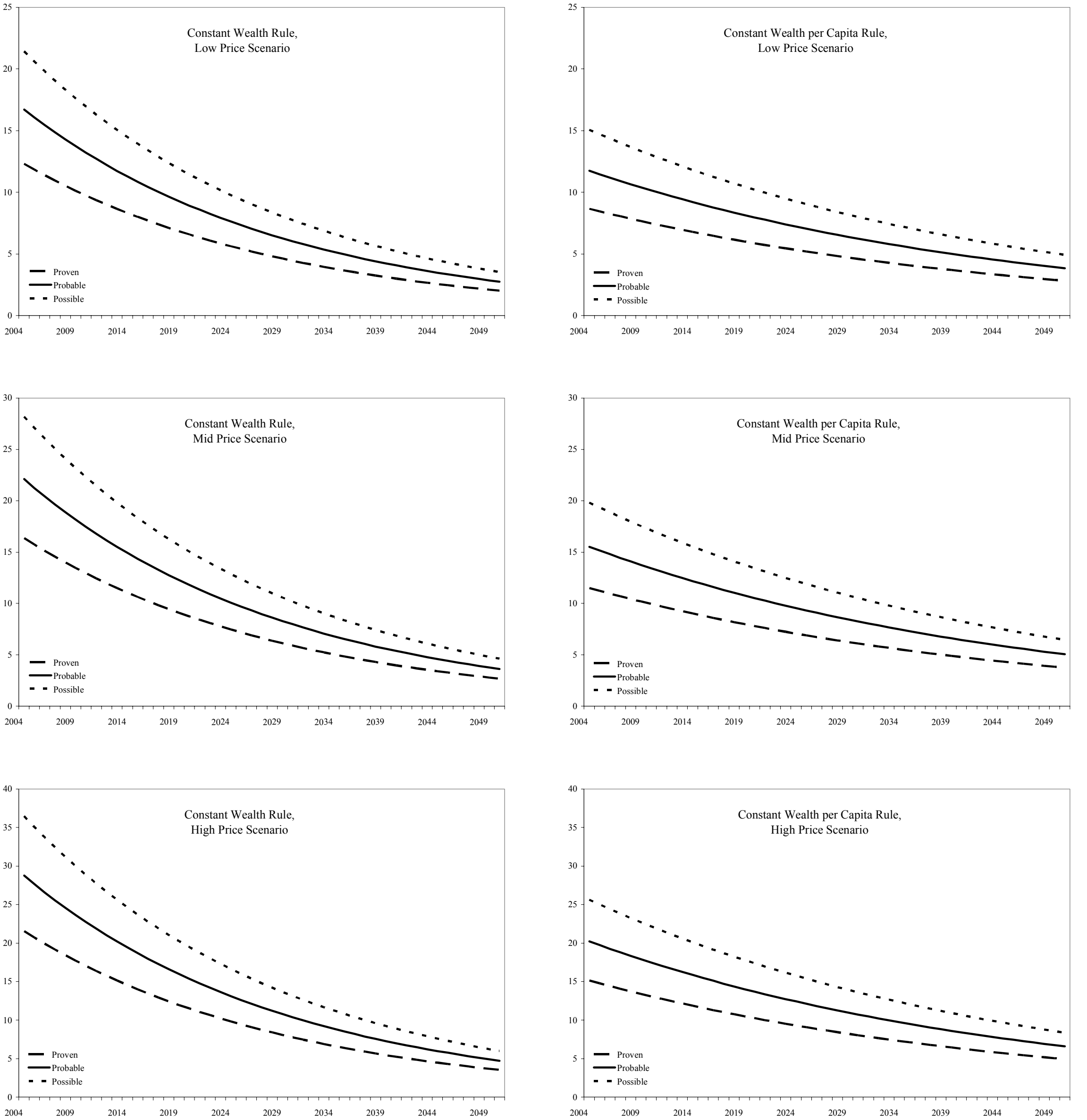
Table 5. Algeria: Net Present Value of Government Hydrocarbon Revenues

Price Scenario	Low Price Scenario			Mid Price Scenario			High Price Scenario		
Reserves Scenario	Proven	Probable	Possible	Proven	Probable	Possible	Proven	Probable	Possible
in 2003 $	137.8	178.4	222.1	175.1	227.9	284.4	222.7	289.4	360.8
in 2003 $ per capita 1/	4,331	5,607	6,982	5,503	7,165	8,940	7,001	9,096	11,342
in percent of 2003 GDP	207.4	268.5	334.4	263.6	343.2	428.2	335.3	435.7	543.2
in percent of 2003 NHGDP	325.6	421.5	525.0	413.7	538.7	672.2	526.4	683.9	852.7

1/ Based on 2003 population estimate

94. Algeria's ample hydrocarbon wealth allows it to permanently run sizable primary nonhydrocarbon deficits. Figure 6 provides estimates of the sustainable PNHB ceilings for the two permanent income-based targets described above. In line with the alternative reserves and price assumptions, nine different scenarios were simulated for each target. As can be expected, results vary widely depending on which assumptions are made. This emphasizes the importance of close monitoring and regular updates of the estimates as conditions develop and new information emerges.

Figure 6. Algeria: Alternative Targets for Sustainable Nonhydrocarbon Primary Deficit
(In percent of nonhydrocarbon GDP)



95. All results are shown in percent of nonhydrocarbon GDP (NHGDP), which is considered to be the most relevant fiscal policy indicator of aggregate demand. The sustainable PNHBs gradually decline as absolute wealth (Target 1) or per capita wealth (Target 2) is kept constant, as the population growth rate is assumed to be lower than the nonhydrocarbon sector growth rate. Tables 6 and 7 summarize the results for the alternative price and reserves scenarios. They also show the average sustainable PNHBs for the near term period 2004–09, which are the most relevant fiscal policy indicators for current planning purposes. As a further reference for the evaluation of a prudent fiscal stance in the longer term, the tables also divide the long-term simulations in three more sub periods, showing the respective average sustainable PNHB estimates.

Table 6. Algeria: Wealth Preservation Target 1. Constant Real Wealth, 2004–50
(PNHB in percent of NHGD) 1/

	Low Price Scenario			**Mid Price Scenario**			**High Price Scenario**		
	Proven	Probable	Possible	Proven	Probable	Possible	Proven	Probable	Possible
2004	12.3	16.7	21.4	16.3	22.0	28.2	21.5	28.7	36.4
2005	11.8	16.0	20.6	15.7	21.2	27.1	20.6	27.6	35.0
2006	11.4	15.4	19.8	15.1	20.4	26.0	19.9	26.5	33.7
2007	10.9	14.8	19.0	14.5	19.6	25.0	19.1	25.5	32.4
2008	10.5	14.3	18.3	13.9	18.8	24.1	18.4	24.5	31.1
2009	10.1	13.7	17.6	13.4	18.1	23.1	17.7	23.6	29.9
Average 2004-09	11.2	15.2	19.5	14.8	20.0	25.6	19.5	26.1	33.1
Average 2004-15	10.0	13.6	17.4	13.3	17.9	22.9	17.5	23.3	29.6
Average 2016-30	5.9	8.0	10.3	7.9	10.6	13.6	10.3	13.8	17.5
Average 2031-50	3.0	4.1	5.2	4.0	5.4	6.9	5.3	7.0	8.9
Average 2004-50	5.7	7.8	10.0	7.6	10.3	13.1	10.0	13.4	17.0
annual change (%)	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8

1/ In 2003, the actual PNHB amounted to 29.7 percent of NHGDP

96. By construction, target 1 would allow for higher PNHB ceilings than target 2. Taking the mid-case reserves scenario (probable reserves) as a reference for the following discussion, the PNHB ceiling would reach 16.7 percent, 22 percent, or 28.7 percent of NHGDP in 2004, depending on the long-term hydrocarbon price assumptions. Throughout the simulation period, these PNHB ceilings would fall by 3.8 percent annually and be reduced to 2.7 percent, 3.6 percent, or 4.7 percent of NHGDP in 2050, when all hydrocarbon reserves are depleted. Over the entire period, the constant wealth target would allow for an average sustainable PNHB ceiling of 7.8 percent ($15 scenario), 10.3 percent ($20 scenario), or 13.4 percent ($25 scenario), respectively.

Table 7. Algeria: Wealth Preservation Target 2: Constant Real Wealth Per Capita, 2004–50
(PNHB in percent of NHGDP) 1/

	Low Price Scenario			Mid Price Scenario			High Price Scenario		
	Proven	Probable	Possible	Proven	Probable	Possible	Proven	Probable	Possible
2004	8.6	11.7	15.0	11.4	15.4	19.7	15.0	20.1	25.5
2005	8.4	11.4	14.6	11.1	15.1	19.2	14.7	19.6	24.9
2006	8.2	11.1	14.3	10.9	14.7	18.8	14.3	19.1	24.3
2007	8.0	10.9	13.9	10.6	14.3	18.3	14.0	18.7	23.7
2008	7.8	10.6	13.6	10.4	14.0	17.9	13.6	18.2	23.1
2009	7.6	10.3	13.3	10.1	13.7	17.4	13.3	17.8	22.6
Average 2004-09	8.1	11.0	14.1	10.8	14.5	18.6	14.2	18.9	24.0
Average 2004-15	7.5	10.2	13.2	10.0	13.5	17.3	13.2	17.6	22.4
Average 2016-30	5.4	7.4	9.5	7.2	9.8	12.5	9.5	12.7	16.1
Average 2031-50	3.6	4.9	6.2	4.7	6.4	8.2	6.2	8.3	10.6
Average 2004-50	5.2	7.0	9.0	6.9	9.3	11.9	9.1	12.1	15.4
annual change (%)	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4

1/ In 2003, the actual PNHB amounted to 29.7 percent of NHGDP

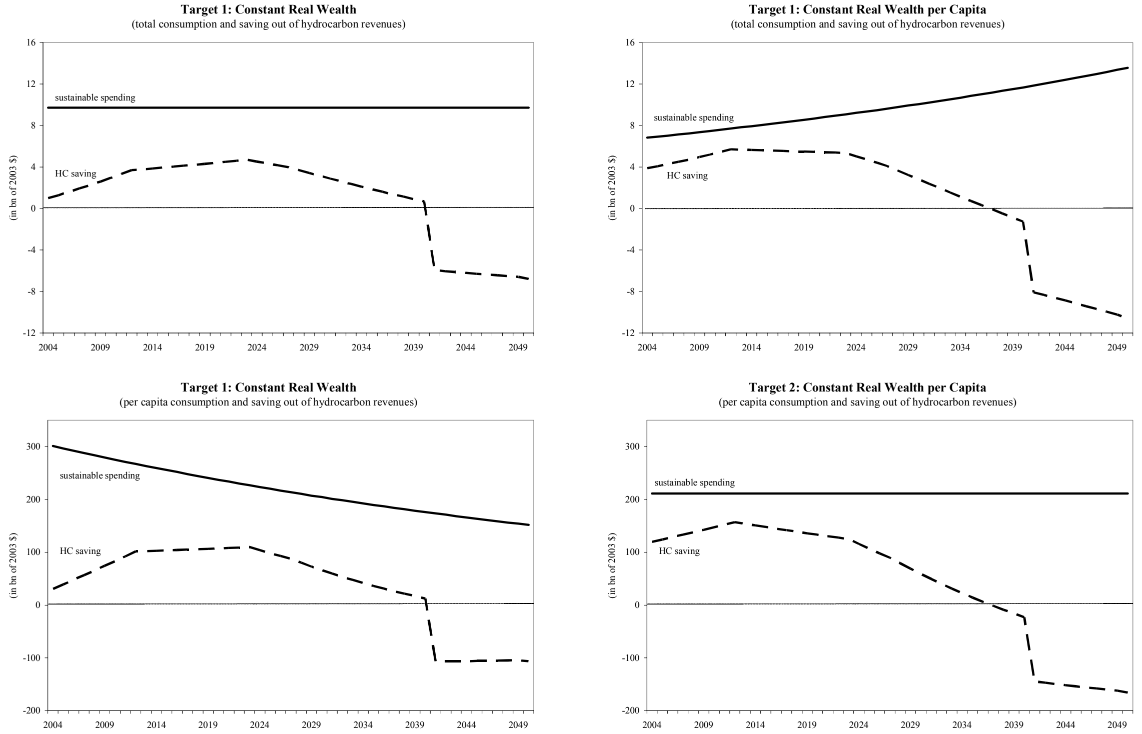
97. Keeping wealth constant per capita (target 2) would substantially reduce the initial PNHB ceiling compared to the constant wealth target. Depending on the oil and gas price assumptions, it would reach only 11.7 percent ($15 scenario), 15.4 percent ($20 scenario), or about 20 percent ($25 scenario) of NHGDP, respectively. However, since more income-generating assets are being accumulated over time, the sustainable PNHB ceilings decline only by 2.4 percent annually during the simulation period and would still amount to between 3.8 and 6.6 percent of NHGDP in 2050.

98. Total government spending out of hydrocarbon revenues would be constant in real dollar terms if a policy of real wealth preservation is followed. Per capita spending would decrease continually as the population expands. If government adheres to a policy of keeping real wealth constant per capita, total hydrocarbon spending would increase over time, while spending per capita would be equal over all periods (Figure 7).

Sensitivity of Simulation Results

99. The main part of the analysis considered alternative hydrocarbon reserves and price scenarios. The elasticity of the sustainable PNHB to price changes depends on the originally assumed price level. A one percent change in assumed long-term real hydrocarbon prices changes the sustainable PNHB by 1.15 percent in the low-price scenario, 0.74 percent in the mid-price scenario, and 1.09 percent in the high-price scenario, respectively.

Figure 7. Algeria: Alternative Targets for Long-Term Net Government Wealth Preservation Development of Government HC Spending and Savings Paths 1/



1/ (Example: Mid Price & Probable Reserves Scenario)

100. However, results may also vary when the assumed values of the other parameters are changed, for example the interest rate, the depletion profile, or the NHGDP growth rate. Consequently, it would be helpful to analyze how sensitive the simulation results react to changes in these parameters.

101. Probably the most interesting case to consider is the effect of changes in the real interest rate on both the value of hydrocarbon wealth and earnings on financial wealth. Other things being equal, lowering the discount rate from 5 to 4 percent increases the net present value of future hydrocarbon revenues. The sustainable PNHB, however, decreases nevertheless, because earnings on accumulated financial wealth are lower. Taking the mid-case reserves and prices scenario as a reference case, the upper PNHB ceiling for 2004 decreases from 22.0 percent to under 20.7 percent in the constant wealth case. Results are more pronounced in the constant wealth per capita case, in which the sustainable PNHB drops from 15.4 percent to 12.9 percent. Of course, sustainable PNHBs would correspondingly increase if a higher discount rate, say 6 percent, is assumed. In constant wealth terms, the PNHB ceilings would rise slightly to 22.8 percent, while it would jump to 17.1 percent in the constant wealth per capita case. The impact of changes in the assumed interest rates can best be described in terms of elasticities: In each year, a one percent

increase in the interest rate would increase the sustainable PNHB limit by 0.23 percent in the constant wealth case and by 0.65 percent in the constant wealth per capita case. A correspondent reduction of the interest rate would trim down the PNHB limit by about the same rate.

102. The impact of changes in the other assumed parameter values are as follows (in each case, the mid-price & probable reserves scenario is considered):

- Alternative assumptions about the nonhydrocarbon growth rate leave the net present value of government hydrocarbon revenues unaltered, but they of course change the sustainable PNHBs expressed in NHGDP. The higher the assumed NHGDP growth rate, the lower the respective PNHB ratios, and vice versa. In the short run, the impact on the results of the simulations is rather limited with respect to both targets: A one percent increase in the nonhydrocarbon economy's growth rate would reduce the average 2004-2009 PNHB limit by only 0.13 percent, irrespective of the wealth target considered. However, as the differences in the growth rate accumulate from year to year, the effect becomes more pronounced over time. It reaches 0.23 percent in 2009, and averages at 0.66 percent over the entire simulation period.

- An increase in the assumed population growth rate would understandably only reduce the PNHB ceiling when a constant wealth per capita is targeted. The size of the effect is also not very strong: A one percent increase in the population growth rate would reduce the sustainable PNHB by 0.43 percent in 2004. This effect would slowly diminish in later years. The average reduction of the PNHB in the period 2004-09 would be 0.39 percent.

- Changes in the government take of hydrocarbon export revenues have a much more pronounced adverse effect on the fiscal sustainability. A one percent reduction in the effective tax rate of hydrocarbon exports would reduce the sustainable PNHB limit by 1.12 percent over all periods. This effect would be even stronger if lower average hydrocarbon prices would be assumed.

- Increasing domestic consumption shares of oil and gas by one percent, thus reducing the volumes available for higher taxed exports would have the same quantitative effect as a reduction in the effective tax rate (elasticity of 1.12).

- Reasonable changes in the assumed production profile would have only modest effects on the sustainable PNHB. Everything else being equal, the faster the hydrocarbon reserves are depleted and converted into interest bearing financial assets, the higher the PNHB ceilings become.

H. Medium-Term Adjustment to Long-Term Sustainability

Previous Fiscal Policy Stance

103. Supported by continually high hydrocarbon prices since 2000, the Algerian government has pursued an expansionary fiscal policy in recent years. An Economic Recovery Program (ERP) was implemented between 2001 and 2004 with the objective to support growth in the absence of a marked pickup in private sector activity, and to provide for economic reconstruction and social needs.[30] The PNHB increased from 22 percent of NHGDP in 1999 to almost 30 percent in 2003, and is expected to rise further to about 32 percent of NHGDP in 2004.

104. The expansionary fiscal stance of the past years has contributed to an increase in real GDP and job creation. However, unemployment is still very high (estimated at about 24 percent in 2003), and demand driven gains might turn out to be of a transitory nature.[31] Although the existence of infrastructure bottlenecks would justify public investment, the recent surge in capital expenditure from 13 percent of NHGDP in 2001 to 19 percent in 2004 could possibly lead to public investment in projects with low economic profitability. A sustained improvement in Algeria's growth performance requires an acceleration of productivity-enhancing structural and institutional reforms. Sustainable economic growth and employment creation will be achievable only by developing a strong private nonhydrocarbon sector.

105. The current expansionary fiscal policy carries risks. It transmits hydrocarbon sector windfall revenues into the Algerian economy, thus increasing the role of the state in the economy, possibly leading to a real appreciation of the exchange rate with the effect of a deteriorating competitiveness of the nonhydrocarbon traded goods sector (Dutch disease). Furthermore, fiscal vulnerability to a possible future downturn in hydrocarbon prices increases.

106. At the same time, and under the assumptions made in the above long-term simulations, the recent fiscal stance appears to be unsustainable in the medium term. Depending on the long-term price assumptions, and taking the mid-case reserves scenario as a reference, the government would have to limit the 2004 primary nonhydrocarbon deficit to between about 12 and 20 percent of NHGDP in order to keep total real wealth per capita constant (Table 5). Achieving long-term fiscal sustainability would therefore require a significant fiscal adjustment of the current fiscal stance.

---

[30] In the context of the 1994–98 IMF supported adjustment program and a period of low hydrocarbon prices, fiscal policy was tightened during the second half of the 1990s.

[31] See IMF Country Report 04/33, February 10, 2004.

Modified Assumptions

107. The baseline scenarios might be considered overly restrictive in view of actual oil and gas market developments. Taking into account the presently very high hydrocarbon prices and the fairly favorable WEO oil price projections for the medium term—forecasting an only modest decline until 2009—it seems justified to make some amendments to the long-term simulations which would warrant higher limits for the sustainable PNHB.

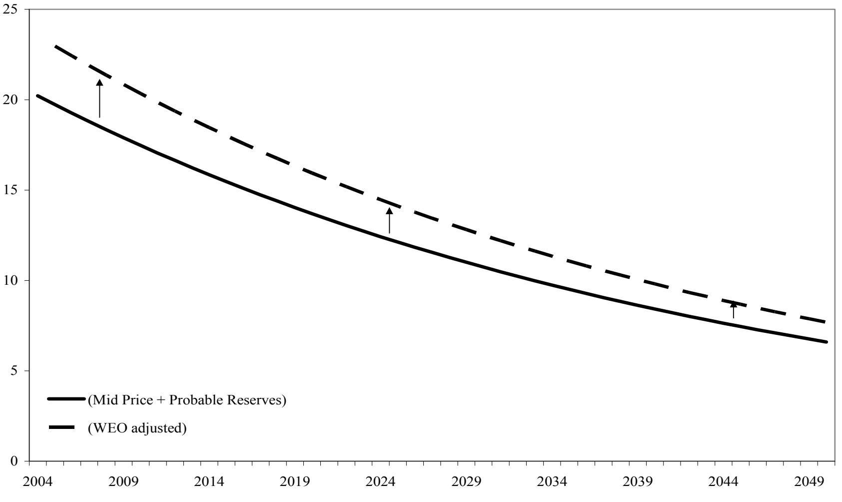
108. In the following, an illustrative adjustment scenario, based on a modified high price and mid reserves case, will be presented. It is supposed that the government targets to preserve net wealth per capita in the long run.

109. For the years 2004–09, the simulations use current WEO projections for the development of hydrocarbon prices. After that, it is assumed that hydrocarbon prices move smoothly downward and reach the original high case prices ($25 per barrel for oil and $85 per tcm in the case of gas, respectively) in 2013 and stay at that level throughout the remaining simulation period.

Transition Scenario

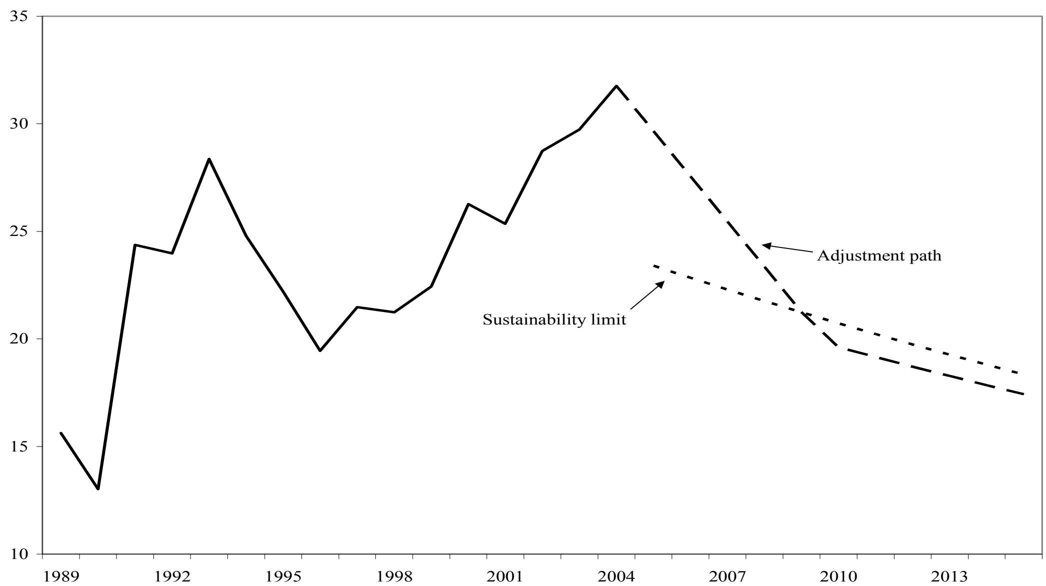
110. The consideration of higher hydrocarbon prices in the short- to medium term significantly increase the sustainability limits of the PNHB compared to the baseline case (Figure 8).

Figure 8. Algeria: Constant Wealth per Capita Framework,
Scenario Adjusted for WEO Oil Price Projections,
Sustainable Primary Nonhydrocarbon Deficits
(In percent of NHGDP)



111. However, a medium-term adjustment of the fiscal policy stance from its current level is needed even when the presently higher hydrocarbon prices are taken into account. The authorities could aim at reducing the PNHB gradually from the current level to a more conservative fiscal stance that would be more in line with the longer term estimates of the sustainable PNHB. Considering that it will not be feasible for fiscal policy to adjust immediately to its long-term sustainable path, the transition scenario also slightly relaxes the original condition of wealth preservation. It is supposed that the government aims at stabilizing wealth at its end-2004 level instead of the originally targeted end-2003 level and plans to reach sustainable NHBP levels within five years, i.e. by 2009 (Figure 9).[32]

Figure 9. Algeria: Nonhydrocarbon Primary Balance (In percent of NHGDP)
Actual and Sustainable Paths under Alternative Price Assumptions
Scenarios: Adjustment to Sustainable Path after Five Years



112. Spending now more than is warranted by the wealth preservation condition implies spending somewhat less in future periods. However, the five-year adjustment period is relatively short, and the scenario allows for a long period of catching up to the originally targeted level of wealth, which will be reached only at the end of the simulation timeframe, in 2050. Therefore, the suggested primary nonhydrocarbon deficits are found to be only slightly lower than the originally targeted sustainability limits.

[32] A five-year adjustment phase was chosen after consultation with the Algerian authorities, who considered this transition period as feasible.

Table 8 summarizes the results of the modified scenario and compares the recommended adjustment of the fiscal stance with the long-term sustainable and the actually projected ones.

Table 8. Algeria: Projected Hydrocarbon Spending under Five-Year Adjustment Scenario

	2004	2005	2006	2007	2008	2009
Oil Price (in $)	38.5	42.8	38.3	36.0	35.0	34.0
HC Revenue (bn DA)	1,569	1,874	1,809	1,877	1,873	1,899
Current policies 1/						
gov. HC primary spending (bn DA)	1,148	1,206	1,209	1,188	1,174	1,150
gov. HC primary saving (bn DA	421	668	600	689	699	749
Implied budgeted oil price ($/b) 2/	31.1	30.3	28.3	25.4	24.6	23.3
NHBP (in % of GDP)	19.3	17.8	17.2	15.9	15.0	13.9
NHBP (in % of NHGDP)	31.8	30.4	28.2	25.7	23.4	21.2
Suggested adjustment path						
gov. HC primary spending (bn DA)	1,148	1,177	1,182	1,179	1,168	1,149
gov. HC primary saving (bn DA)	421	697	627	699	705	749
Implied budgeted oil price ($/b) 2/	28.2	29.6	27.7	25.2	24.5	23.2
NHPB (in % of GDP)	19.3	17.3	16.9	15.8	14.9	13.9
NHPB (in % of NHGDP)	31.8	29.7	27.5	25.4	23.3	21.2
Sustainability limits (const. wealth per capita) 3/						
gov. HC primary spending (bn DA)		929	980	1,033	1,089	1,149
gov. HC primary saving (bn DA)		945	829	845	784	749
Implied budgeted oil price ($/b) 2/		24.0	23.4	22.4	23.0	23.2
NHPB (in % of GDP)		15.0	14.7	14.4	14.1	13.8
NHPB (in % of NHGDP)		23.4	22.8	22.3	21.8	21.2
Memorandum item:						
GDP (in bn DA)	5,939	6,795	7,014	7,464	7,831	8,278
NHGDP (in bn DA)	3,614	3,970	4,292	4,633	5,006	5,414

Sources: Algerian authorities and IMF staff estimates.

1/ Excluding the possible additional budgetary impact of the second Economic Recovery Program 2005-08 and quasi-fiscal deficits in the public enterprise sector.

2/ The implied budgeted oil price is derived from the expenditure projected to be spent out of HC revenues.

3/ Scenario: High price (25 $/b, adjusted for WEO price assumptions) and probable reserves; and stabilization of hydrocarbon wealth at end of 2004 level.

113. The adjustment scenario suggests a significant fiscal adjustment (equivalent to 10.6 percent of NHGDP) compared to the current fiscal stance within a period of five years. This scenario is in fact broadly in line with the current budgetary projections of the Algerian authorities (table 8). Nevertheless, it is also important to emphasize that the fiscal policy stance recommended here is based on relatively optimistic assumptions about the medium-

and long-term development of hydrocarbon prices. Additionally, the scenario does not make any allowances for precautionary savings, the consideration of which is strongly recommended with a view to the significant uncertainties about future developments about prices and reserves.

I. Summary and Concluding Remarks

114. Algeria is well endowed with hydrocarbon wealth, which – if well managed – allows the country to run sizable non-hydrocarbon deficits that can be used to finance economic development, structural change and to reduce unemployment. It can be expected that the Algerian hydrocarbon industry will continue to grow dynamically and remain a major source of government revenue in the decades to come.

115. However, as other oil and gas producing countries, Algeria faces several macroeconomic policy challenges both in the short and long term with respect to the management of its natural resource wealth. In a short- to medium term perspective, fiscal policy has to deal with high volatility of hydrocarbon revenues, as well as with the impact of substantial foreign exchange inflows in the context of limited absorptive capacity of the domestic economy. In the long term, policymakers have to consider the exhaustibility of hydrocarbon resources with important implications for fiscal sustainability and the distribution of hydrocarbon wealth across generations. Equally important, the Algerian authorities face the challenge how to best use the country's hydrocarbon wealth to tackle the daunting tasks of attaining higher growth and reducing unemployment.

116. In the past, Algeria has not at all times been successful in managing these policy challenges. Fiscal policy has often been excessively expansionary and public expenditures highly correlated with hydrocarbon revenues, thus increasing economic uncertainty, causing high adjustment costs for frequent factor reallocation, and damaging nonhydrocarbon private sector development. At the same time, the public sector has not always been able to use hydrocarbon income productively in the form of revenue- as well as employment creating and growth enhancing investments.

117. This paper aims to provide some guidelines for the efficient fiscal management of hydrocarbon wealth in Algeria. It presents strategies and policy instruments to tackle the macroeconomic policy challenges discussed above which would enable the country to reap the potential benefits of its natural resource wealth. Specifically, the paper suggests:

- Preserving government net wealth and distributing it equally across generations by saving part of hydrocarbon revenues in the form of financial assets;

- Introducing a permanent income hypothesis (PIH) based fiscal framework for ensuring long-run fiscal sustainability, with the nonhydrocarbon primary deficit being the main fiscal policy variable;[33]
- Gradually adjusting the fiscal stance, especially expenditure, to a sustainable level according to the appropriate wealth target chosen by the authorities;
- Stabilizing expenditures a PNHB level considered as sustainable, and decoupling public spending from current hydrocarbon revenue to avoid transmission of hydrocarbon sector volatility into other sectors of the economy and vulnerability to hydrocarbon price fluctuations over the medium term;
- Spending judiciously to create jobs and raise nonhydrocarbon growth; and
- Sterilizing large foreign exchange inflows by investing hydrocarbon receipts in financial assets abroad.

118. Fiscal guidelines as those discussed above can be constructive policy instruments for the efficient fiscal management of hydrocarbon revenues. Properly designed and implemented, they can aid policymakers avoiding unsteadiness of the fiscal policy stance in the presence of volatile hydrocarbon prices. Regarding fiscal sustainability and intergenerational equity considerations, fiscal guidelines such as the permanent income-based nonhydrocarbon primary deficit framework can serve as useful guiding principles for medium- to long-term budget planning.

119. However, the formulation of fiscal guidelines does not by itself imply a credible fiscal policy (Kopits 2001). Fiscal guidelines by themselves cannot prevent the destabilizing and unsustainable policy choices that are so regularly taken during hydrocarbon booms with potentially huge windfall revenues (Bjerkholt 2002). The sudden availability of unanticipated financial resources makes additional spending tempting, and increasing pressure from diverse political interest groups easily leads to reluctant adherence to or to a softening or even complete abolition of the rules-based fiscal frameworks.

120. The main objective of preannounced, formal, and legislated fiscal frameworks is to increase the credibility of fiscal policy by constraining the scope of action of policymakers and increasing public awareness if deviations from prudent fiscal policies should arise (Kopits and Symansky 1998). It is crucial that the implementation of fiscal guidelines will be backed by firm political support and public scrutiny, and that they be complemented by sanctions and supporting measures to increase transparency and accountability of fiscal policy. If this is not the case, the introduction of rules-based fiscal frameworks can actually

[33] Alternatively, the authorities could consider the application of non-PIH based rules, such as expenditure-, or oil price-based rules.

do more harm than good, for example by encouraging the use of creative accounting (Milesi-Ferretti 2000), the resort to off-budget expenditure programs and transparency-reducing legal loopholes, or to paradoxical situations such as the accumulation of revenues in hydrocarbon funds with simultaneous borrowing for expenditure programs (Clemente, Faris and Puente 2002).

REFERENCES

Aissaoui, Ali, 2001, "Algeria: The Political Economy of Oil and Gas," (Oxford University Press).

Al-Faris, A. F., 2002, "Public Expenditure and Econoic Growth in the Gulf Cooperation Council Countries", Applied Economics, 34, pp. 1187-93.

Alier, Max, and Martin Kaufman, 1999, "Nonrenewable Resources: A Case for Persistent Fiscal Surpluses," IMF Working Paper 99/44 (Washington: International Monetary Fund).

Bailén, J. and V. Kramarenko, 2004, "Issues in Medium-Term Management of Oil Wealth", Islamic Republic of Iran, Selected Issues Paper, mimeo (Washington: International Monetary Fund).

Barnett, Steven, and Rolando Ossowski, 2002, "Operational Aspects of Fiscal Policy in Oil-Producing Countries," IMF Working Paper 02/177 (Washington: International Monetary Fund).

_____, 2003, "What Goes Up ... Why oil-producing states must husband their resources", Finance & Development, 40, No. 1 (March), pp. 36-39.

Barro, Robert J. and Xavier Sala-i-Martin, 1995, Economic Growth, (New York: McGraw-Hill).

Bascand, Geoffrey, and Assaf Razin, 1997, "Indonesia's Fiscal Position: Sustainability Issues," Macroeconomic Issues Facing ASEAN Countries, ed. John Hicklin, David Robinson, and Anoop Singh (Washington: International Monetary Fund).

Baunsgaard, Thomas, 2002, "Fiscal Policy Rules" Nigeria – Selected Issues and Statistical Appendix, IMF Country Report 03/60 (Washington: International Monetary Fund).

_____, 2003, "Fiscal Policy in Nigeria: Any Role for Rules?," IMF Working Paper 03/155 (Washington: International Monetary Fund).

Bjerkholt, Olav, 2002, "Fiscal Rule Suggestions for Economies With Non-Renewable Resources", paper prepared for the conference "Rules-Based Fiscal Policies in Emerging Market Economies," Oaxaca, Mexico.

Cairns, Robert D. and Graham A. Davis, 1998, "Economic theory and the valuation of mineral reserves," OPEC Review 22, No. 3 (September), pp. 169-83.

Chalk, Nigel, 1998, "Fiscal Sustainability with Non-Renewable Resources," IMF Working Paper 98/26, (Washington: International Monetary Fund).

Clemente, Lino, Robert Faris, and Alejandro Puente, 2002, "Natural Resource Dependence, Volatility and Economic Performance in Venezuela: The Role of a Stabilization Fund," Andean Competitiveness Project, February.

Corden, W. M., “Booming Sector and Dutch Disease Economics: A Survey,” Oxford Economic Papers, 36, pp. 359-80.

Corden, W. M. and J. Peter Neary, “Booming Sector and De-Industrialization in a Small Open Economy,” Economic Journal (December1982), pp. 825-48.

Daniel, James, 2001, “Hedging Government Oil Price Risk,” IMF Working Paper 01/185 (Washington: International Monetary Fund).

Davis, Jeffrey, Rolando Ossowski, James Daniel, and Steven Barnett, “Stabilization Funds for Nonrenewable Resources: Experience and Fiscal Policy Implications,” Occasional Paper No. 205 (Washington: International Monetary Fund).

Davoodi, Hamid, 2002, “Assessing Fiscal Vulnerability, Fiscal Sustainability, and Fiscal Stance in a Natural Resource Rich Country,” Republic of Kazakhstan – Selected Issues and Statistical Appendix, IMF Country Report 02/64 (Washington: International Monetary Fund).

Davoodi, Hamid and Ugo Fasano, 2004, “Issues in Fiscal Policy Analysis in Oil-Producing Countries”, mimeo (Washington: International Monetary Fund).

Economist Intelligence Unit, 2004, “Algeria: Country Profile 2004/05” (London: EIU).

Energy Information Agency, 2004, “Algeria: Country Analysis Brief” (Washington: U.S. Department of Energy).

Engel, Eduardo, and Rodrigo Valdes, 2000, “Optimal Fiscal Strategy for Oil Exporting Countries,” IMF Working Paper 00/118 (Washington: International Monetary Fund).

Fasano, Ugo, 2000, “Review of the Experience with Oil Stabilization and Savings Funds in Selected Countries,” IMF Working Paper 00/112 (Washington: International Monetary Fund).

Fasano, U. and Q. Wang, 2001, “Fiscal Expenditure Policy and Non-Oil Economic Growth: Evidence from GCC Countries”, IMF Working Paper 01/195 (Washington: International Monetary Fund).

Fischer, Stanley, and William Easterly, 1990, “The Economics of the Government Budget Constraint,” World Bank Research Observer, 5, No. 2, pp. 127-42.

Floerkemeier, Holger, 2003, “Replacing Bank Credit to Loss-Making Public Enterprises with Temporary Budget Subsidies in the Context of a Restructuring Program”, Algeria Selected Issues and Statistical Appendix, IMF Country Report 04/31 (Washington: International Monetary Fund).

Gil-Alana, Luis A., 2001, “A fractionally integrated model with a mean shift for the US and UK real oil prices,” Economic Modeling, 18, pp. 643-658.

Haider, Ghazi M., 2000, “World Oil Reserves: Problems in Definition and Estimation,” OPEC Review 24, No. 4 (December), p.305-27.

Hausmann, Ricardo, and Roberto Rigobon, 2002, "An Alternative Interpretation of the 'Resource Curse': Theory and Policy Implications," NBER Working Paper No. 9424, Cambridge.

Katz, Menachem, Ulrich Bartsch, Harinder Malothra, and Milan Cuc, 2004, "Lifting the Oil Curse – Improving Petroleum Revenue Management in Sub-Saharan Africa," (Washington: International Monetary Fund).

Kopits, George, 2001, "Fiscal Rules: Useful Policy Framework or Unnecessary Ornament?," IMF Working Paper 01/145 (Washington: International Monetary Fund).

_____, and Steven Symansky, 1998, Fiscal Policy Rules, IMF Occasional Paper No. 162, (Washington: International Monetary Fund).

Liuksila, Claire, Alejandro Garcia, and Sheila Bassett, 1994, "Fiscal Policy Sustainability in Oil-Producing Countries," IMF Working Paper 94/137 (Washington: International Monetary Fund).

Milesi-Ferretti, Gian M., 2000, "Good, Bad or Ugly? On the Effects of Fiscal Rules with Creative Accounting," IMF Working Paper 00/172 (Washington: International Monetary Fund).

Nashashibi, Karim, Patricia Alonso-Gamo, Stefania Bazzoni, Alain Féler, Nicole Laframboise, and Sebastian Paris Horvitz, 1998, "Algeria: Stabilization and Transition to the Market," IMF Occasional Paper 165 (Washington: International Monetary Fund).

Ntamatungiro, Joseph, 2002, "Analysis of Fiscal and Debt Sustainability," Gabon: Selected Issues and Statistical Appendix, IMF Country Report 02/94 (Washington: International Monetary Fund).

______, 2004, "Fiscal Sustainability in Heavily Indebted Countries Dependent on Nonrenewable Resources: The Case of Gabon," IMF Working Paper 04/30 (Washington: International Monetary Fund).

Okogu, Bright E., 2002, "Issues in Global Natural Gas: A Primer and Analysis," IMF Working Paper 02/40 (Washington: International Monetary Fund).

Sachs, Jeffrey D, and Andrew M. Warner, 1995, "Natural Resource Abundance and Economic Growth," NBER Working Paper No. 5398 (Cambridge, Massachusetts: National Bureau of Economic Research).

Solow, Robert M., 1986, "On the Intergenerational Allocation of Natural Resources," Scandinavian Journal of Economics, 88 (June), pp. 141-49.

______, 1974, "Intergenerational Equity and Exhaustible Resources," The Review of Economic Studies, 41, pp. 123-37.

Stiglitz, Joseph, 1974, "Growth with Exhaustible Natural Resources: Efficient and Optimal Growth Paths," The Review of Economic Studies, 41, pp. 123-137.

Stotzky, Janet, 1999, “The Fiscal Sustainability of Energy Resources,” Trinidad and Tobago: Selected Issues and Statistical Appendix, IMF Country Report 99/67 (Washington: International Monetary Fund).

Talvi, Ernesto, and Carlos A. Végh, 2000, “Tax base variability and procyclical fiscal policy,” NBER Working Paper No. 7499, Cambridge.

Tersman, Gunnar, 1991, “Oil, National Wealth, and Current and Future Consumption Possibilities,” IMF Working Paper 91/60 (Washington: International Monetary Fund).

U.S. Geological Survey, 2000, “World Petroleum Assessment 2000 – Description and Results” (Washington: U.S. Department of the Interior).

Wakeman-Linn, Chonira Aturupane, Stephan Danninger, Koba Gvenetadze, Niko Hobdari, and Eric Le Borgne, 2004, “Managing Oil Wealth: The Case of Azerbaijan”, (Washington: International Monetary Fund).

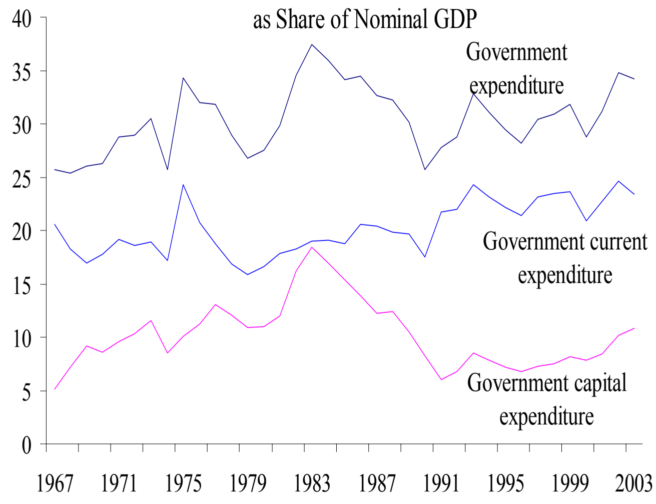
World Bank, 2003, “People’s Democratic Republic of Algeria: A Medium-Term Macroeconomic Strategy for Algeria – Sustaining Faster Growth With Economic and Social Stability” (Washington: World Bank).

II. RELATIONSHIP BETWEEN GOVERNMENT EXPENDITURE AND GDP[34]

Government expenditure in Algeria has moved with hydrocarbon production. This chapter examines whether government expenditure has induced growth during the period 1967–03. It finds that movements in real government capital expenditure have an impact on real nonhydrocarbon GDP (NHGDP) and, as one would expect, that real government current expenditure follows real hydrocarbon GDP (HGDP).

A. Introduction

Figure 1. Algeria: Nominal Government Expenditure as Share of Nominal GDP



1. **Since independence in 1962, Algeria's government policy has largely focused on government expenditure as a means to develop the economy and generate employment for its burgeoning population.**[35] Government expenditure averaged about 30 percent of GDP during 1967–2003, and was financed in large part by hydrocarbon revenue and, when these declined, external borrowing. Government capital expenditure, in the 1970s and early 1980s, was largely concentrated on large scale public investment projects and was channeled towards heavy industry, with the underlying belief that strong forward and backward linkages would stimulate growth in other sectors. Though the investment drive existed in earlier years, the oil price hike of 1979 provided an opportunity to raise government investment considerably. Government capital expenditure increased from about 5 percent of GDP in 1967 to its peak of about 18 percent in 1983 (Figure 1). In the late 1980s, in the face of civil strife, government expenditure was increasingly reoriented towards current expenditure and government capital expenditure declined to about 6 percent of GDP by 1991. Since then, it has gradually recovered to about 11 percent of GDP in 2003. Government current expenditure also fluctuated during the period moving from about 21 percent of GDP in 1967 to about 23 percent in 2003.

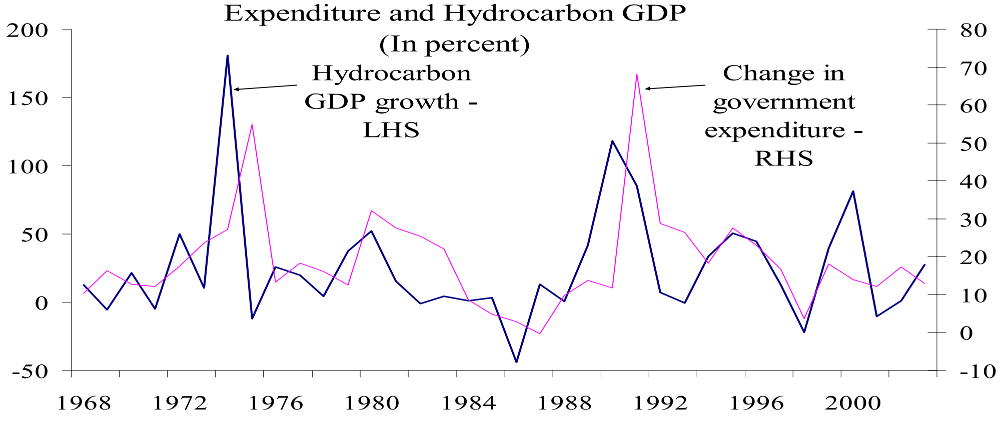
---

[34] This paper was prepared by Nkunde Mwase.

[35] Gelb (1988), Nashashibi *et al* (1998)

2. **Government expenditure depends strongly on hydrocarbon budgetary revenue.** Movements in nominal government expenditure and previous year's nominal HGDP growth display a strong correlation, of about 0.75, between 1967 and 2003 (Figure 2). Real government expenditure as a share of real NHGDP has increased from 16 percent in 1967 to over 50 percent in 2003. Real NHGDP growth has averaged about 4 percent per year between 1967 and 2003. This chapter examines the government expenditure/growth nexus in Algeria.

Figure 2. Algeria: Change in Nominal Government Expenditure and Hydrocarbon GDP (In percent)



3. **It is unclear *a priori* whether increases in government expenditure induce higher output, and therefore reduce unemployment, or whether government expenditure has responded to the level of output.** The literature remains divided over the relationship between government expenditure and changes in real GDP.[36] One view is that government expenditure is a policy instrument to be used to increase output. Others consider that public expenditure is endogenous and follows economic growth. This latter proposition, known as Wagner's law, is taken to mean that government expenditure increases endogenously in order to meet the protective, administrative and educational functions of the state.[37] Empirical studies on the relationship between government expenditure and growth in hydrocarbon-rich countries are limited. Ghali and Al-Shamsi (1997) find evidence in favor of the first view, while Al-Faris (2002) and Ghali (1997) find evidence in support of Wagner's law. Fasano and Wang (2001) find no conclusive evidence of causality in GCC countries.

4. **This study finds that movements in real government capital expenditure induce real NHGDP growth while movements in real government current expenditure do not.** This observation is consistent with recent empirical studies that find a strong and fairly robust impact of government capital expenditure on growth.[38] With regards to a causal

[36] Ahsan (1996), Park (1996)

[37] Wagner (1967)

[38] Easterly and Rebelo (1993), Khan and Kumar (1997), La Feeara and Marcellino (2000), Calderón and Servén (2003), and Milbourne and others (2003)

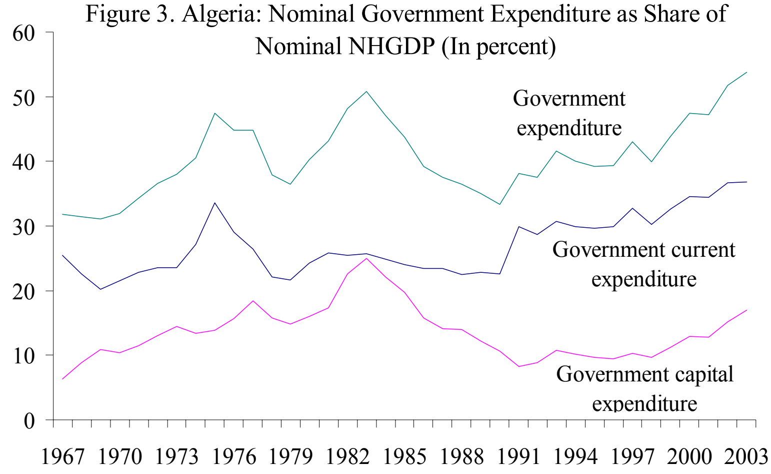
relationship from NHGDP to government expenditure, the results are inconclusive. This result is not surprising given that high oil revenues and external borrowing have insulated government expenditure from developments in the nonhydrocarbon sector.

5. **The findings support the idea that government capital expenditure can be used as an instrument to stimulate growth and reduce unemployment.** Increases in government capital expenditure would also entail some increase in current expenditure, in particular wages and other recurrent spending needed to make the public investment productive.

6. **The paper is organized as follows:** Section B describes the trends in government expenditure and GDP in Algeria. Section C presents the empirical findings. Section D concludes. The appendices discuss the econometric methodology utilized and present details of the empirical results.

B. Developments in Government Expenditure and GDP

Figure 3. Algeria: Nominal Government Expenditure as Share of Nominal NHGDP (In percent)

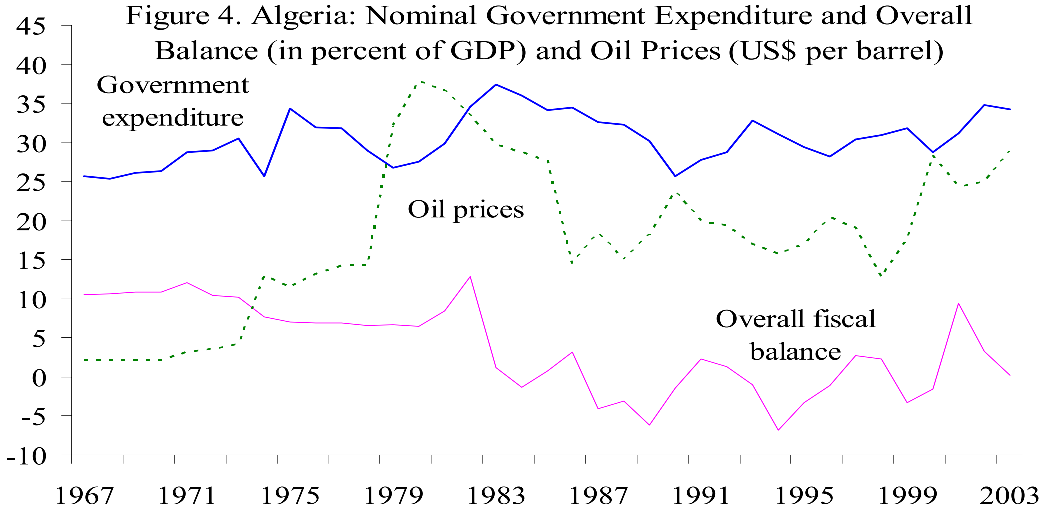


7. **Despite the decline in hydrocarbon prices that started in 1981, government expenditure remained high, at about 30 percent of GDP,** and was increasingly financed by external borrowing.[39] The emergence of large fiscal imbalances and the associated buildup of external debt prompted the government to undertake a fiscal adjustment in the context of two Fund-supported programs, in 1989 and 1991, and capital expenditure reached its lowest level since 1967 in 1991, of about 8 percent of NHGDP (Figure 3). However in 1992, in the face of political uncertainties and civil strife, the government adopted an expansionary fiscal policy aimed at stimulating economic growth. Fiscal deficits mounted and reserve losses accelerated, partly reflecting the reluctance to adjust the exchange rate, in the face of declining hydrocarbon prices (Figure 4).[40]

[39] Nashashibi *et al* (1998).

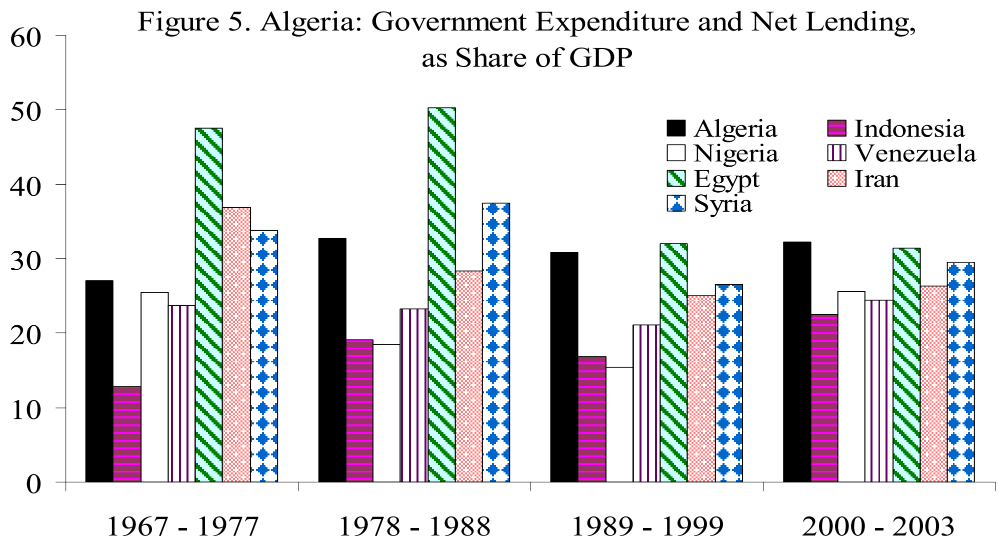
[40] The government was unwilling to adjust the exchange rate because it wanted to contain the cost of external debt service, which in 1992–93 amounted to 80 percent of export proceeds.

Figure 4. Algeria: Nominal Government Expenditure and Overall Balance (in percent of GDP) and Oil Prices (US$ per barrel)



8. **The country embarked on two Fund-supported program in 1994 and 1995 during which both demand management and structural reforms were implemented.**[41] Real wages were reduced and layoffs occurred in the context of public enterprise restructuring. Nevertheless, government expenditure remained high, also relative to other hydrocarbon countries, averaging over 32 percent of GDP between 2000 and 2003. Figure 5 presents government expenditure and net lending in Algeria and six other hydrocarbon exporters.

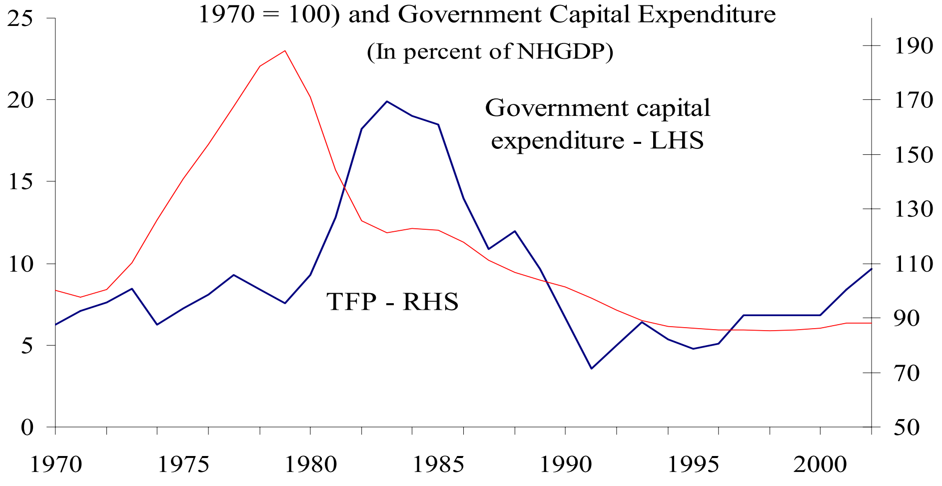
Figure 5. Algeria: Government Expenditure and Net Lending, as Share of GDP



[41] The 1995 program was a three year Fund-supported program

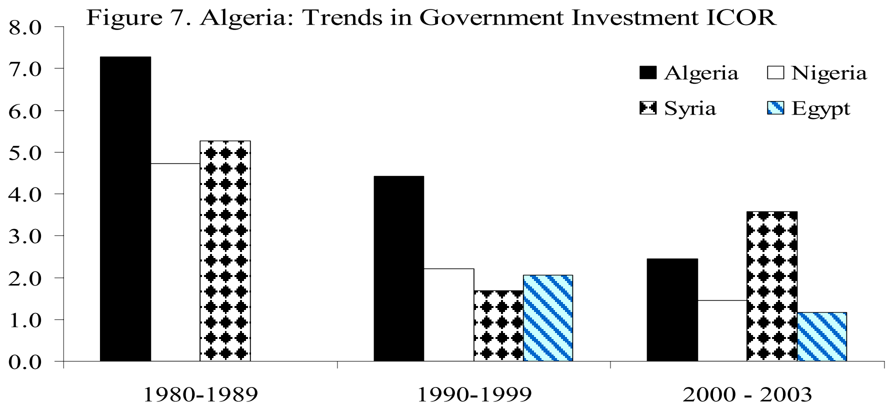
9. **Despite high government expenditure during most of the period, the total factor productivity (TFP) of the economy and the efficiency of government investment have been low,** with TFP growth even turning negative during periods characterized by large increases in government investment. Figure 6 charts TFP for the nonhydrocarbon economy. To quantify TFP, a Cobb Douglas production function is used with physical and human capital, and labor as factors of production.[42]

Figure 6. Algeria: Evolution of TFP of NHGDP (3 - year moving average, 1970 = 100) and Government Capital Expenditure (In percent of NHGDP)



10. **Algeria had a high government ICOR in the 1980s, averaging over 7; however it declined to an average of 2.4 between 2000 and 2003.** Nevertheless, the government ICOR remains high relative to other oil producing countries, suggesting that a higher level of government investment is needed relative to other countries to obtain a similar growth rate (Figure 7). A high ICOR is associated with low efficiency because it implies that for a given level of investment the resulting change in GDP growth is low. The ICORs are calculated by summing government investment over a 9-year period and scaling this by the change in GDP during the same period. However, for the period after 1999, a four-year period is utilized.

[42] Drawing on Bosworth and Collins (2003), the production function is based on the assumption of a factor share of 0.35 for physical capital and 0.65 for labor and human capital combined. Human capital is proxied by the average years of schooling for the population. Data for human capital is taken from Barro and Lee (2000) and Cohen and Soto (2001). Capital stock is generated using the perpetual inventory method with the initial capital data obtained from Nehru and Dhareshwar (1993). In light of the high share of government and public sector investment in total investment, total investment is utilized.



C. Causality Testing of Government Expenditure and GDP

11. **In light of the apparent low productivity of government capital expenditure and the large share of government expenditure in GDP, it is important to determine whether government expenditure induces movements in NHGDP.** In view of the possibility that the sub-components of government expenditure may have differential impact on economic growth, the paper also breaks down government expenditure into current (Gcons) and capital expenditure (Gcap). Annual data for the period 1967–2003 are from the Algerian authorities, IMF and IFS. All variables are expressed in logarithms. (The econometric methodology employed in estimating the model and testing for Granger causality is explained in Appendix III).

12. **Various technical approaches have been developed to examine the direction of causality.** Due to the sensitivity of Granger causality tests to misspecification of the model and the robustness of the rank-transformed model of Holmes and Hutton (1988) to misspecification, the paper restricts discussion of findings to those from the rank-transformed model.[43] This is particularly important given the significant structural changes in the Algerian economy during the period 1967–03. However, in order to illustrate how a simple monotonic transformation, such as replacing variables with their ranks, can affect the power of Granger-causality tests the results from standard approaches, Ordinary Least Squares (OLS) and Vector Error Correction Model (VECM), are also presented. (See Appendix II for discussion of the models).

13. **The results indicate that there is a one-way causal relationship from real government capital expenditure to real NHGDP** (Model 2a in Table 1). The data do not support the existence of a causal relationship from government current expenditure to NHGDP.

---

[43] Examination of alternative approaches to estimate causal relationships suggests that rank order transformation should be employed in order to address the sensitivity and weaknesses of standard approaches in the presence of functional form misspecification, heteroscedasticity and non-normality of errors.

Table 1. Results from Causality Tests on Government Expenditure and NHGDP1/

Model	Determining direction of granger causality between government expenditure and NHGDP	Rank (a)	OLS (b)	VECM (c)
1	Does current expenditure Granger-cause NHGDP?	No	No	No
2	Does capital expenditure Granger-cause NHGDP?	Yes*	No	No
3	Does expenditure Granger-cause NHGDP?	Yes**	No	No
4	Does NHGDP Granger-cause current expenditure?	No	No	Yes**
5	Does NHGDP Granger-cause capital expenditure?	No	No	No
6	Does NHGDP Granger-cause expenditure?	No	No	No

1/ * and ** denotes rejection of the null of no causality at 5 percent and 1 percent, respectively. The values in parenthesis indicate probabilities of Wald tests.

14. **The findings imply that government capital expenditure can be utilized to increase NHGDP.** Since capital expenditure tends to be channeled towards investment projects and current expenditure towards wages and consumer subsidies, the findings are consistent with observations that over the long-run, investment tends to have a higher impact on growth than consumption.[44] Nevertheless, for increases in capital expenditure to be fully productive, current expenditure on maintenance and operations will also have to be increased. Therefore, the absence of a causal relationship running from current expenditure to NHGDP implies less a need to curtail current expenditure than a need for efficient resource allocation to ensure that current expenditure is in line with what is required to make government capital expenditure productive.

15. **Real HGDP growth induces movements in real government current expenditure but not capital expenditure** (Model 4a in Table 3)**.** While capital expenditure had the long-run objective of diversifying the economy, the large share of public sector investment that has flowed to the hydrocarbon sector resulted in strong causal relationship from real capital expenditure to real HGDP (Model 2a in Table 3).

Table 2. Results from Causality Tests on Government Expenditure and HGDP 1/

Model	Determining direction of granger causality between government expenditure and NHGDP	Rank (a)	OLS (b)
1	Does current expenditure Granger-cause HGDP?	No	No
2	Does capital expenditure Granger-cause HGDP?	Yes**	No
3	Does expenditure Granger-cause HGDP?	Yes*	No
4	Does HGDP Granger-cause current expenditure?	Yes*	No
5	Does HGDP Granger-cause capital expenditure?	No	No
6	Does HGDP Granger-cause expenditure?	No	No

1/ * and ** denotes rejection of the null of no causality at 5 percent and 1 percent, respectively. The values in parenthesis indicate probabilities of Wald tests.

[44] See Eken and others (1997) for a discussion of the theoretical and empirical literature.

D. Conclusion

16. **This study finds a one-way causal relationship from government capital expenditure to NHGDP.** These results are obtained using the approach that is most robust to misspecification. There is no conclusive causal relationship from NHGDP to government expenditure, current and capital. This suggests that government capital expenditure can be used as a policy instrument to stimulate growth. Since government capital expenditure requires recurrent spending, current expenditure would be required in order to utilize and maintain the projects undertaken. This suggests that there is a need for an efficient allocation of government expenditure and hence underscores the importance of conducting public expenditure reviews.

17. **However, given that capital expenditure is already high, further increases in capital expenditure may not necessarily translate into higher growth**. The models provide no guidance on the extent to which increasing government capital above the currently high level would improve growth.

Definition of Variables

HGDP = the log of nonhydrocarbon GDP in real terms. The real hydrocarbon GDP series is generated by deflating nominal hydrocarbon GDP with the hydrocarbon GDP deflator. For earlier years where the hydrocarbon GDP deflator is unavailable, the GDP deflator is utilized.

NHGDP = the log of nonhydrocarbon GDP in real terms. The real nonhydrocarbon GDP series is generated by deflating the nominal nonhydrocarbon GDP with the nonhydrocarbon GDP deflator. For earlier years where nonhydrocarbon GDP deflator is unavailable, the GDP deflator is utilized.

Gcons = the log of government current expenditure in real terms. The real government current expenditure series is generated by deflating the nominal government current expenditure, excluding net lending, by the consumer price index (CPI).

Gcap = the log of government capital expenditure in real terms. The real government capital expenditure series is generated by deflating the nominal government capital expenditure by the investment deflator. For earlier years where investment deflator is unavailable, a proxy using share of CPI and GDP deflator is utilized to deflate the series.

Gexp = the log of total government expenditure in real terms. The real government expenditure series is generated by taking the sum of Gcap and Gcons.

A. Rank Transformation

A critical failing of Vector Error Correction Models (VECM) and other standard models is that results from the parametric statistical techniques are sensitive to the functional form specification of the estimating equations, to the lag structure specified, and to filtering techniques used to achieve stationary variables (Bessler and Kling, 1984; Nelson and Kang, 1984; Holmes and Hutton, 1988).

A rank order transformation of the variables prior to Granger testing provides causality results which are robust to functional form specification and to possible heteroscedasticity and non – normality of the error structure in the estimation equation (Holmes and Hutton, 1988).[45] In testing for causality it is important to use a methodology that requires the fewest assumptions about the nature of a relationship which may not even exist.

The qualitative relationship between the variables before rank transformation is equivalent to that between the rank transformed variables. Holmes and Hutton (1988) argue that if Y is a function of X, any strictly monotonic transformation of some or all of the variables in (X,Y) will not eliminate this causal or functional relationship. This invariance to a monotonic transformation encompasses rank transformation. Therefore if X causes Y,

$$R(Y) = F[R(X)];\ \text{where } F = R f R^{-1} \qquad (3)$$

Since economic theory does not generally specify a particular functional form, this suggests that qualitative inferences (that is, zero and sign restrictions) can and should be pursued using a rank transformed model similar to equation 3.

In the multiple rank F test, the (set of) Y(s) and X(s) in a parametric model

$$Y = X\beta + u - \bar{u} = X\tilde{\beta} + u \qquad (4)$$

(where $Y = y - \tilde{y}$ and $X = x - \tilde{x}$)

are replaced by their ranks where $R(\cdot)$ is the rank of a variable.

$R(\cdot)$ is defined as a vector of the deviations of ranks of a variable from the means of the ranks, $r(Y_i)$, of a variable Y_i over N observations (i = 1,......,N). The rank of Y measured in deviations is $(r(Y_1), ...r(Y_N)) = R(Y)$ and the ranks of each of the (k-1) variables in the matrix $X = [X_1, ..., X_{k-1}]$ are $R(X) = [R(X_1), ...,R(X_{k-1})]$. This results in the multiple rank equation

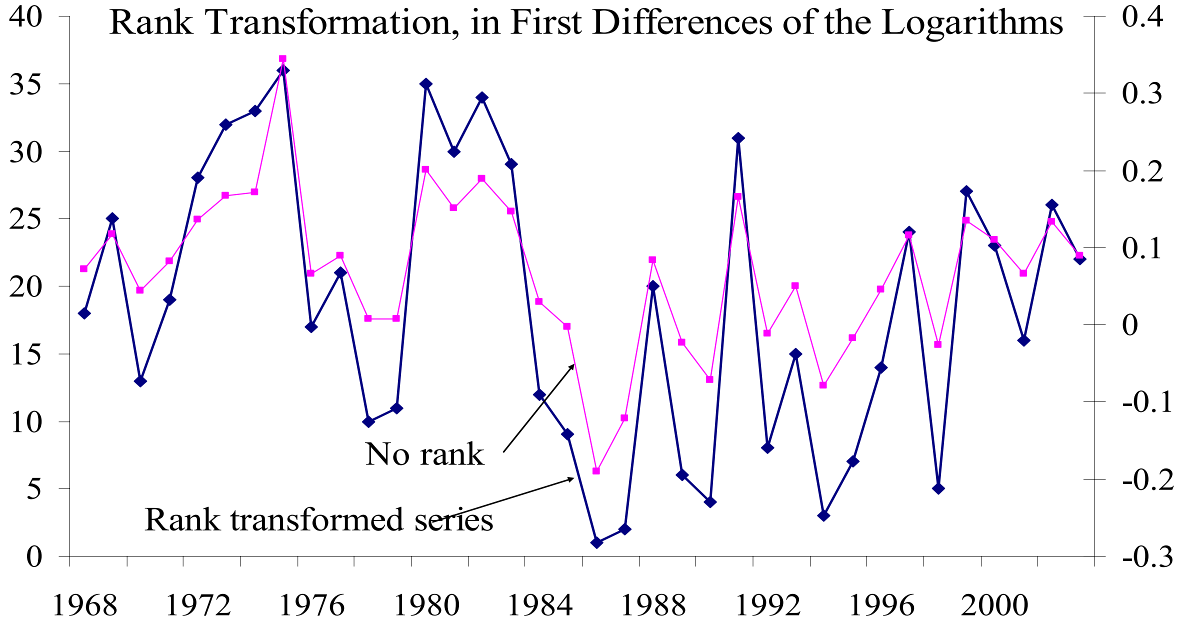
[45] Holmes and Hutton (1988) present a small sample multiple rank test attributable to Porter and McSweeney (1974), Conover and Iman (1982). The results extend to the inferences of lagged dependent variable models common to econometric studies, for example, prima facie granger causality.

$$R(Y) = R(X)c(\beta) + \mu \qquad (5)$$

$C(\beta) = (C_1(\beta_1), \ldots\ldots C_{k-1}(\beta_{k-1}))$ is such that, under the alternative hypothesis, if each X_i is ranked from lowest (being 1) to highest (being N) then $\beta_i C(\beta_i) \geq 0$ and under the null hypothesis $\beta_i C(\beta_i) = 0$ if and only if $\beta_i = 0$.

Multiple rank F test involves OLS estimation of equation 5 followed by performance of tests based on the residual variances from these rank regressions. Conover and Iman (1982) report that in small samples with stochastic X, the multiple rank F-test is robust against non normality of errors, while for the normal distribution, the loss in power associated with ranks versus raw data is slight. Furthermore, the power advantages of the multiple rank F-test increase the more extreme the departures from the assumptions of normality and homoscedasticity and as the relationship between the variables weakens. (Holmes and Hutton, 1990) Figures 8 illustrates the impact of rank transformation using the government expenditure series.

Figure 10. Algeria: Real Government Expenditure with and without Rank Transformation, in First Differences of the Logarithms



B. Granger Causality

The paper utilizes the tests for Granger (1980) prima facie causal relationship, as opposed to tests for a Granger (1969) causal relationship, between output, and aggregate government current and capital expenditures. The distinction between prima facie and direct causal relationship is important in a stochastic setting. A (set of) variable(s) X is a prima facie cause of another (set of) variable(s) Y if X *precedes* Y in time and if $P(Y \mid X) \neq P(Y)$. It is not possible to establish that a causal relationship exists as long as it is possible to conceive of other potential prima facie causes which have not been included in the model being analyzed.

A. Methodology for Testing for Granger Causality

NHGDP is Granger-caused by government expenditure if increases in government expenditure precede an increase in NHGDP. Granger-causality is investigated by estimating the following equations

$$dNHGDP_t = a + \alpha_1 dGexp_{t-i} + \beta_1 dNHGDP_{t-i} \quad (1a)$$
$$dGexp_t = a + \alpha_2 dNHGDP_{t-i} + \beta_2 dGexp_{t-i} \quad (1b)$$

Equations 1a and b must be tested to determine the direction of causality between the variables and establish whether Granger-causality, if it exists, is one-way or bi-directional, where Gexp is log of real government expenditure, α_1 is the long-run constant elasticity of real NHGDP with respect to real government expenditure and α_2 is the converse. All the variables are in differences.

If movements in government expenditure are induced by HGDP developments then HGDP Granger-causes government expenditure. To test for Granger causality, equations 2a and b are estimated where α_3 captures the elasticity of real government expenditure with respect to real HGDP and α_4 the converse.

$$dGexp_t = a + \alpha_3 dHGDP_{t-i} + \beta_3 dGexp_{t-i} \quad (2a)$$
$$dHGDP_t = a + \alpha_4 dGexp_{t-i} + \beta_4 dHGDP_{t-i} \quad (2b)$$

Table 3 illustrates the specification of the models under the different approaches: rank-transformed model, VECM, and OLS.

B. Summary of Econometric Details and Empirical Results

I. Unit Root tests

Since causality tests are based on the assumption of the existence of stationary stochastic processes, the empirical investigation begins with an analysis of the time series properties of the variables. The Augmented Dickey Fuller (ADF) test is used to determine the order of integration. All the variables are found to be integrated of order one (Table 4). Given these findings, both the rank transformed model and the standard OLS model are estimated using differenced stationary series.

Table 3. Causality Testing: Model Specification 1/

	Specification for Testing
Approach	
1. Holmes and Hutton (1988)	**$NHGDP_t \rightarrow Gcons_t$,** (1a), **$NHGDP_t \rightarrow Gcap_t$** (1b)
	$dR(Gcons_t) = \sum^{n}_{i=1} b_i dR(Gcons_{t-i}) + \sum^{m}_{i=1} a_i dR(NHGDP_{t-i}) + \varepsilon_t$ (1a)
	$dR(Gcap_t) = \sum^{n}_{i=1} b_i dR(Gcap_{t-i}) + \sum^{m}_{i=1} a_i dR(NHGDP_{t-i}) + \varepsilon_t$ (1b)
	$Gcons_t \rightarrow NHGDP_t$ and $Gcap_t \rightarrow NHGDP_t$
	$dR(NHGDP_t) = \sum^{p}_{i=1} a_j dR(NHGDP_{t-i}) + \sum^{q}_{i=1} b_i dR(Gcons_{t-i}) + \sum^{s}_{i=1} c_i dR(Gcap_{t-i}) + w_t$ (1c)
2. Granger (1969) OLS	**$NHGDP_t \rightarrow Gcons_t$ (2a), $NHGDP_t \rightarrow Gcap_t$ (2b)**
	$dGcons_t = \sum^{m}_{j=1} b_j dGcons_{t-j} + \sum^{n}_{j=1} a_j dNHGDP_{t-j} + v_t$ (2a)
	$dGcap_t = \sum^{n}_{i=1} b_i dGcap_{t-i} + \sum^{m}_{i=1} a_j dNHGDP_{t-i} + \varepsilon_t$ (2b)
	$Gcons_t \rightarrow NHGDP_t$ and $Gcap_t \rightarrow NHGDP_t$
	$dNHGDP_t = \sum^{p}_{i=1} a_i dNHGDP_{t-i} + \sum^{q}_{i=1} b_i dRGcons_{t-i}) + \sum^{s}_{i=1} c_i dGcap_{t-i} + w_t$ (2c)
	$NHGDP_t \rightarrow Gcons_t$, $NHGDP_t \rightarrow Gcap_t$, $Gcons_t \rightarrow NHGDP_t$, and $Gcap_t \rightarrow NHGDP_t$
3. Granger (1986) VECM	$dGcons_t = \sum^{n}_{i=1} a_{1i} dGcons_{gt-1} + \sum^{n}_{i=1} b_{1i} dGcap_{gt-1} + \sum^{m}_{j=1} c_{1i} dNHGDP_{t-j} + dECT_{t-1} + \mu_{2t}$ $dGcap_t = \sum^{n}_{i=1} a_{2i} dGcons_{gt-1} + \sum^{n}_{i=1} b_{2i} dGcap_{gt-1} + \sum^{m}_{j=1} c_{2i} dNHGDP_{t-j} + dECT_{t-1} + \mu_{2t}$ $dNHGDP_t = \sum^{n}_{i=1} a_{3i} dGcons_{gt-1} + \sum^{n}_{i=1} b_{3i} dGcap_{gt-1} + \sum^{m}_{j=1} c_{3i} dNHGDP_{t-j} + dECT_{t-1} + \mu_{2t}$ (3)

1/ $R(\cdot)$ represents a rank order transformation. ECT refers to the error correction term, G reflects government expenditure implying that both government current expenditure (Gcons) and government capital (Gcap) expenditure are estimated. All the models can be written with total government expenditure (Gexp).

Table 4. Augmented Dickey – Fuller Test Results for Unit Roots 1/

	HGDP	NHGDP	Gexp	Gcons	Gcap
Levels	-2.23 ^{c2}	-2.04 ^{c2}	-1.86 ^{c1}	-0.66 ^{c0}	-1.91 ^{c1}
First difference	4.69 ^{1}***	-1.94*^{2}	-3.05 ***	-3.87*** ^{0}	-3.66*** ^{0}

1/ *, **, and *** denotes significance at 10 percent, 5 percent, and 1 percent, respectively. The Schwartz Information Criteria (SIC) is used to select the lag structure. The values in superscript indicate number of lags, presence or absence of constant (c).

II. Rank Transformed Model

Current and lagged values of the differences series on HGDP, NHGDP, Gcap, Gcons and Gexp in each model are treated as separate variables when calculating their ranks, for example, R($Gcons_t$) and R($Gcons_{t-1}$).

In specifying the model, the lagged differences are included to ensure that residuals are white noise and to capture proxy for other explanatory variables not included in the model.[46] The Akaike Information Criteria and Schwartz Information Criteria are used to select an "optimal" univariate lag length.

Does Government Expenditure induce NHGDP?

F-tests on the model strongly reject the null of no causality between government capital expenditure and NHGDP. However, inconclusive results are obtained from NHGDP to government expenditure, current or capital. The findings imply that there is uni-directional causality from government capital expenditure to NHGDP (Table 5).

Table 5. Causality Tests on OLS Estimates Employing Ranks 1/

	dNHGDP$_t$	**dGcons$_t$**	**dGcap$_t$**	**dGexp$_t$**
Wald test: R($dGcons_{t-1}$)→ dNHGDP				
Wald test: R($\sum^{2}_{t-1}$dGcap) → dNHGDP	6.65* (0.01)			
Wald test: R($\sum^{2}_{t-1}$dGexp) → dNHGDP	5.94** (0.00)			
Wald test: R($\sum^{5}_{t-1}$dNHGDP) → dGcons		2.68 (0.07)		
Wald test: R($\sum^{7}_{t-1}$dNHGDP) → dGcap			11.29 (0.13)	
Wald test: R($\sum^{7}_{t-1}$dNHGDP) → dGexp				1.41 (0.27)

1/ * and ** denotes rejection of the null of no causality at 5 percent and 1 percent, respectively. The values in brackets indicate probabilities of Wald tests.

Does HGDP induce government expenditure?

[46] Holmes and Hutton (1990), Ahsan *et al* (1996), Sinha (1998), Al-Faris (2002),

F-tests indicate presence of one-way causality from HGDP to government current expenditure and one-way causality from capital expenditure to HGDP (Table 6).

Table 6. Causality Tests on OLS Estimates Employing Ranks 1/

	$dHGDP_t$	**$dGcons_t$**	**$dGcap_t$**	**$dGexp_t$**
Wald test: $R(\sum^{2}_{t-1} dGcons) \rightarrow dHGDP$				
Wald test: $R(\sum^{2}_{t-1} dGcap) \rightarrow dHGDP$	4.61** (0.00)			
Wald test: $R(\sum^{2}_{t-1} dGexp) \rightarrow dHGDP$	4.24* (0.01)			
Wald test: $R(\sum^{5}_{t-1} dHGDP) \rightarrow dGcons$		3.44* (0.02)		
Wald test: $R(\sum^{7}_{t-1} dHGDP) \rightarrow dGcap$			1.02 (0.45)	
Wald test: $R(\sum^{7}_{t-1} dHGDP) \rightarrow dGexp$				1.40 (0.29)

1/ * and ** denotes rejection of the null of no causality at 5 percent and 1 percent, respectively. The values in brackets indicate probabilities of Wald tests.

III. OLS Model

Having established that the series is a unit root process, differenced stationary series are utilized where both the AIC and SIC information are utilized to select model with the "optimal" lag length.

Does government expenditure induce NHGDP?

F -tests do not reject the null of no causality therefore the OLS model does not find causality from government expenditure, current or capital, to NHGDP. Within the OLS context pair-wise granger causality tests are performed on the variables (Table 7).

Table 7. Causality Tests on OLS Model 1/

	F- statistic
*d*NHGDP→*d*Gcons	0.48
*d*Gcons→ *d*NHGDP	(0.70)
*d*NHGDP→*d*Gcap	0.40
*d*Gcap→ *d*NHGDP	(0.67)
*d*NHGDP→*d*Gexp	0.94
*d*Gexp→ *d*NHGDP	(0.46)

1/ Probability in brackets. * indicates significance at the 5 percent level. The null hypothesis is that *x* does not prima facie Granger-cause *y* in the first regression and the *y* does not Granger-cause *x* in the second regression.

Does HGDP induce government expenditure?

Similarly, the results do not reject the presence of causality from HGDP to any other government expenditure variables. (Table 8).

Table 8. Causality Tests on OLS Model 1/

	F- statistic
*d*HGDP→*d*Gcons	2.18
*d*Gcons→ *d*HGDP	(0.10)
*d*HGDP→*d*Gcap	0.23
*d*Gcap→ *d*HGDP	(0.88)
*d*HGDP→*d*Gexp	1.42
*d*Gexp→ *d*HGDP	(0.26)

1/ Probability in brackets. * indicates significance at the 5 percent level. The null hypothesis is that *x* does not prima facie Granger-cause *y* in the first regression and the *y* does not Granger-cause *x* in the second regression.

IV. VECM Model

The Johansen trace and maximal eigenvalue statistics confirm the existence of a long run relation between NHGDP, government current and capital expenditure.

Does government expenditure Granger-cause NHGDP?

The findings indicate suggest that government expenditure is positively related to NHGDP (Table 9 and 10). The sign on the error correction term, α, confirms the existence of a long – run relation between government expenditure and NHGDP providing support to the Granger representation theorem.[47] Moving to the estimation of the cointegrating relationship, Tables 9 and 10 present the normalized cointegrating vector (β) and the corresponding adjustment coefficients, the error correction term, (α).

Government capital expenditure is weakly exogenous consistent with observations that government expenditure decisions in oil rich economies tend to be influenced by hydrocarbon revenues, therefore hydrocarbon GDP.[48] The t-statistics indicate that both NHGDP and government capital expenditure are weakly exogenous (Tables 9 and 10).

[47] Baneerjee, Hendry and Smith (1986), Engle and Granger (1987), and Kremers, Ericsson and Dolado (1992)

[48] Gelb (1988) and Auty (2001)

Table 9. Normalized Cointegration Vector and Weak Exogeneity tests 1/

	NHGDP	Government expenditure	
		Current	Capital
β	1	-1.12	-0.18
		[-7.52]	[-4.43]
α	-0.11	0.90	0.27
	(-0.79)	[4.27]	[0.75]

1/ Model has lag length of 3. Equation includes an unreported constant. t.statistics are in parenthesis.

Table 10. Normalized Cointegration Vector and Weak Exogeneity Tests 1/

	NHGDP	Gexp
β	1	-0.81
		[-10.11]
α	-0.13	0.59
	(-1.20)	[3.56]

1/ Model has lag length of 3. Equation includes an unreported constant. t.statistics are in parenthesis.

Causality tests indicate that NHGDP has a causal effect on government current expenditure. There is no evidence of causality between the other variables. Therefore, on the basis of the VECM, it can be concluded that there is unidirectional causality from NHGDP to government current expenditure (Tables 11 and 12).

Table 11: VECM Pairwise Granger Causality Tests 1/

	D(NHGDP)	D(GCONS)	D(GCAP)
D(GCONS)	1.67		4.26
	(0.64)		(0.23)
D(GCAP)	1.84	4.10	
	(0.61)	(0.25)	
D(NHGDP)		13.12**	1.74
		(0.00)	(0.63)
All	4.00	14.28*	6.67
	(0.68)	(0.03)	(0.35)

1/ χ^2 presented. P-values in brackets. Column headings are the dependent variable of the equation under consideration. The null is exclusion of lags of the variable specified. Rejection of the null implies rejection of Granger-causality. 'All' refers to exclusion of all the endogenous variables from the VECM, other than the lags of the dependent variable. * and ** denotes significance at 5 percent, and 1 percent, respectively.

Table 12: VECM Pairwise Granger Causality Tests 1/

	D(NHGDP)	D(Gexp)
D(Gexp)	1.63 (0.65)	
D(NHGDP)		6.73 (0.08)

1/ χ^2 presented. P-values in brackets. Column headings are the dependent variable of the equation under consideration. The null is exclusion of lags of the variable specified. Rejection of the null implies rejection of Granger-causality. *, and ** denotes significance at 5 percent, and 1 percent, respectively.

Does HGDP induce government expenditure?

Cointegration tests on both two variable model, Gexp and HGDP and three variable model, Gcap, Gcons and HGDP, do not reject null of no cointegration therefore a VECM is not modeled.

References

Ahsan, S.M., 1996, "Cointegration and Wagner's Hypothesis: Time Series Evidence for Canada," *Applied Economics,* Vol. 28, pp. 1055–58.

Al-Faris, A.F, 2002, "Public Expenditure and Economic Growth in the Gulf Cooperation Council Countries," *Applied Economics*, Vol. 34, pp. 1187–93.

Auty, R.M, and A. H. Gelb, 2001, "Political Economy of Resource-Abundant States," in *Resource Abundance and Economic Development*, ed. by R.M. Auty; study prepared for the World Institute for Development Economics Research of the United Nations University (New York: Oxford University Press).

Barro, R., and Jong-Wha Lee, 2000, "International Data on Educational Attainment, Updates and Implications." *NBER Working Paper* 7911. (Cambridge, MA: National Bureau of Economic Research).

Baneerjee, A., D.F. Hendry, and G.W. Smith, 1986, "Exploring Equilibrium Relationships in Economics through Static Models: Some Monte Carlo Evidence," *Oxford Bulletin of Economics and Statistics*, Vol. 48, pp. 253–77.

Bosworth, B., and S. Collins, 2003, "The Empirics of Growth: An Update," (unpublished; Washington: Brookings Institution and Georgetown University).

Calderón, C., and L. Servén, 2003 "Infrastructure Compression and Public Sector Solvency in Latin America" in *The Limits of Stabilization – Infrastructure, Public Deficits, and Growth in Latin America,* ed. By W. Easterly and L. Servén (Washington: World Bank).

Cohen, D., and M. Soto, 2001, "Growth and Human Capital: Good Data, Good Results," *OECD Technical Papers* 179, (Organization for Economic Cooperation and Development).

Conover, W.J., and R. L. Iman, 1982, "Analysis of Covariance Using the Rank Transformation" *Biometrics*, Vol. 38, pp. 715–24.

Easterly, W., and S. Rebelo, 1993, "Fiscal Policy and Economic Growth," *Journal of Monetary Economics*, Vol. 32, (December), pp. 417–58.

Eken, S., T. Helbling, and A. Mazarei, 1997, "Fiscal Policy and Growth in the Middle East and North Africa Region," IMF Working Paper 97/101 (Washington: International Monetary Fund).

Engle, R.F., and C.W.J. Granger, 1987, "Co-integration and Error Correction Representation, Estimation, and Testing," *Econometrics*, Vol. 55 (March), pp. 251–76.

Fasano, Ugo, and Q. Wang, 2001, "Fiscal Expenditure Policy and Non-oil Economic Growth: Evidence from the GCC Countries," IMF Working Paper 01/195 (Washington: International Monetary Fund).

Gelb, A., 1988, *Oil Windfalls: Blessing or curse?* A World Bank Research Publication (New York: Oxford University Press).

Ghali, K.H., 1997, "Government Spending and Economic Growth in Saudi Arabia", *Journal of Development Economics,* Vol. 22, pp 165–72

_____, and Al-Shamsi, F, 1997, "Fiscal Policy and Economic Growth: A Study Relating to the United Arab Emirates", *Economia Internazional*, Vol. 50, pp 519–33

Granger, C.W.J., 1969, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," *Econometrica,* Vol. 37, pp 424–38.

———, 1980, "Testing for Causality: A Personal Viewpoint," *Journal of Economic Dynamics and Control*, Vol. 2, pp. 329–52.

———, 1986, "Developments in the Study of Cointegrated Economic Variables," *Oxford Bulletin of Economics and Statistics* (August), pp. 213–28

Holmes, J.M., and P.A. Hutton, 1988, "A Functional-Form, Distribution-Free Alternative to Parametric Analysis of Granger Causal Models," *Advances in Econometrics* Vol. 7, pp. 211–225.

——————, 1990, "On the Causal Relationship between Government Expenditures and National Income," *The Review of Economics and Statistics,* Vol. 72, pp. 87–95.

Khan, M.S., and M.S. Kumar, 1997, "Public and Private Investment and the Growth Process in Developing Countries," *Oxford Bulletin of Economics and Statistics,* Vol. 59, pp. 69–88.

Kremers, J.J.M., N.R. Ericsson, and J. J. Dolado, 1992, "The Power of Integration Tests," *Oxford Bulletin of Economics and Statistics,* Vol. 54, pp. 325-48

La Feeara, E., and M. Marcellino, 2000, "TFP, Costs, and Public Infrastructure: An Equivocal Relationship," *IGIER Working Paper* No. 176 (Milan, Italy: Innocenzo Gasparini Institute for Economic Research).

Milbourne, R., G. Otto and G. Voss, 2003, "Public Investment and Economic Growth," *Applied Economics,* Vol. 35 pp 527–540

Nashashibi, K., P. Alonso-Gamo, S. Bazzoni, A. Féler, N. Laframboise, and A. P. Horvitz, 1998 "Algeria: Stabilization and Transition to the Market," IMF Occasional Paper 165 (Washington: International Monetary Fund).

Nelson, C.R., and H. Kang, 1984, "Pitfalls in the Use of Time as an Explanatory Variable in Regression," *Journal of Business and Economic Statistics,* Vol. 2, pp 73–82.

Nehru,V., and A. Dhareshwar, 1993, "A New Database on Physical Capital Stock: Sources, Methodology and Results." *Revista Análisis de Económico,* Vol. 8, pp 37–59.

Park, W.K, 1996, "Wagner's Law Versus Keynesian Paradigm: The Korean Experience," *Public Finance,* Vol. 51, pp. 71-91.

Porter, A.K, and M. McSweeney, 1974, "Comparison of Three Common Experimental Designs to Improve Statistical Power when Data Violate Parametric Assumptions", presented at the Meeting of the American Education Research Association.

Sinha, D., 1998, "Government Expenditure and Economic Growth in Malaysia," *Journal of Economic Development*, Vol. 23 (December), pp. 71–80.

III. The Equilibrium Real Exchange Rate in a Commodity Exporting Country: Algeria's Experience[49]

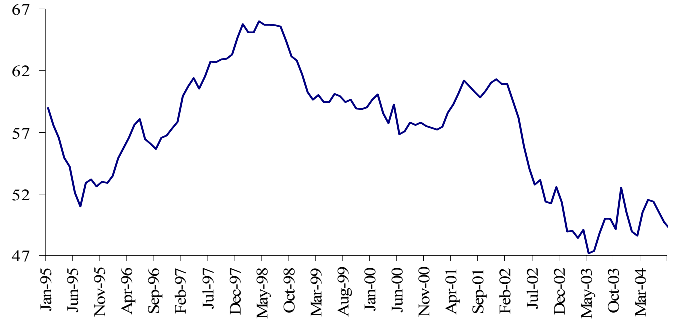
The real effective exchange rate (REER) varied significantly during the last decade. Moreover, in 2002-03, it depreciated by 17½ percent. By estimating an equilibrium path for Algeria's REER over the period from 1970 to 2003, this chapter assesses the existence of any current real exchange rate misalignment. It finds that the Balassa-Samuelson effect together with real oil prices explain the long-run evolution of the equilibrium REER and that the current REER is in line with equilibrium.

A. Introduction

1. **The rapid increase in hydrocarbon exports since 2000 raises questions on the evolution of the Algerian dinar's real exchange rate** and its effect on private sector development. Algeria's main challenge is to manage its volatile external inflows from hydrocarbon exports to strengthen the outlook for private sector-driven economic growth and employment. While fiscal and monetary policies have an important role in maintaining macroeconomic stability, management of the exchange rate is essential in order not to harm the competitiveness of the nonhydrocarbon tradable sector (Dutch disease). A prolonged departure from the equilibrium real exchange rate could generate major problems for the economy.

2. **The real effective exchange rate (REER) varied significantly during the last decade.** Algeria's exchange rate regime is a managed float with no pre-announced path for the exchange rate. Since 1995, the authorities aimed at maintaining a stable REER against a basket of currencies weighted on the basis of the trade shares of the country's main trading partners.[50] However, the REER has varied continuously over the last decade (Figure 1).[51] Moreover, in 2002–03, the REER of the Algerian dinar depreciated by 17½ percent.

Figure 1. Real Effective Exchange Rate (1990=100)
January 1995-September 2004



[49] Prepared by Taline Koranchelian.

[50] Algeria's main trading partners are: Austria, Belgium, Canada, China, France, Germany, Italy, Japan, the Netherlands, Spain, Switzerland, Sweden, Turkey, United Kingdom, and the United States.

[51] An increase in the REER is equivalent to a real appreciation.

3. **The literature emphasizes that equilibrium real exchange rates are determined by fundamental determinants.** A well-known problem with the purchasing power parity approach (constant real exchange rate rule) is that it fails to take into account that the equilibrium real exchange rate, defined as the price of tradable goods relative to nontradable goods that is consistent with both internal and external balance, is itself an endogenous variable that is likely to change through time in response to a variety of disturbances.[52] The literature shows that exogenous time-varying factors determine exchange rate dynamics and the equilibrium path of the exchange rate.

4. **The significant depreciation of the REER in 2002-03 raises questions** as to what extent the evolution of the Algerian dinar was consistent with the equilibrium real exchange rate over the last decade, in particular in 2002–03, and whether fundamentals can explain the exchange rate path in Algeria.

5. **This study addresses these questions by estimating an equilibrium path for Algeria's REER over the period from 1970 to 2003**. It examines the fundamental determinants of the Algerian dinar in real terms, and, based on these results, assesses the existence of any current real exchange rate misalignment.

6. The main findings of the study are:

- There are no signs of a current misalignment in the real exchange rate. Both the long-run equilibrium model and the behavior of macroeconomic variables show that the REER was close to its equilibrium level in 2002–03.

- Algeria's equilibrium real exchange rate varies over time. The Balassa-Samuelson effect together with real oil prices explain the long-run evolution of the equilibrium REER. The convergence speed towards equilibrium is 9 months, similar to the findings in other commodity-exporting countries. The poor productivity of the nonhydrocarbon sector has been the main factor behind the depreciation of the equilibrium real exchange rate over the last twenty years.

7. **The remainder of the study is organized as follows.** After briefly describing the evolution of the Algerian exchange rate regime in Section B, Section C reviews the existing literature on the equilibrium real exchange rate. Section D uses different tools to determine the long-run equilibrium real exchange rate. First, it tests the purchasing power parity (PPP) theory for the market-determined REER. Then, it investigates the presence of a long-run cointegrating relationship between the real exchange rate and certain explanatory variables, estimates the speed at which the real exchange rate converges toward its equilibrium level, and assesses the gap between the actual and the equilibrium real exchange rate levels.

---

[52] A constant real exchange rate rule, based on the notion of purchasing power parity, aims at keeping the real exchange rate constant at a level that prevailed in some base period, when macroeconomic balance was thought to obtain (see Dornbusch (1982) and Montiel and Ostry (1991).

Section E discusses the equilibrium REER from a forward-looking perspective, and Section F concludes.

B. Developments in the Algerian Exchange Regime

8. **From January 1974, the exchange rate of the Algerian dinar was pegged to a basket of currencies**—in which the US dollar was assigned a relatively large weight due to its importance in oil export receipts and debt-service payments—with adjustments taking place from time to time. The substantial appreciation of the US dollar during the first half of the 1980s led to a strong rise in the real value of the Algerian dinar (of about 50 percent during 1980–85), thus undermining the competitiveness of nonhydrocarbon exports and stimulating imports.

9. **In 1986, Algeria's economy experienced the reverse oil shock**, and the government responded to the dramatic erosion of export revenue by borrowing abroad and intensifying import restrictions. In parallel, the Bank of Algeria adopted an active exchange rate policy, and the Algerian dinar depreciated against the basket by 31 percent between 1986 and 1988. However, the restrictions imposed on the allocation of foreign exchange increased demand for foreign exchange in the informal market, driving the premium in the parallel market rate to about 500 percent. This rigid system was replaced in 1988 by a system of foreign exchange allocation to the five public commercial banks within a framework of credit ceilings, which were consistent with balance of payments targets. The public banks in turn would allocate foreign exchange to their client public enterprises. Between 1989 and 1991, the Algerian dinar was allowed to depreciate (more than 200 percent in nominal terms) to counteract the terms of trade losses during this period.

10. **From 1991, the Council on Money and Credit was made responsible for setting foreign exchange and external debt policy**, and for approving foreign investments and joint ventures. The supplementary budget of August 1990 granted businesses and individuals the right to hold foreign currency accounts. In 1991, as part of an attempt to realign domestic relative prices and increase openness, the Algerian dinar was devalued by more than 100 percent to DA 22 per US dollar. During 1991-94, the rate of nominal depreciation averaged 4 percent annually, bringing the value of the Algerian dinar to about DA 24 per US dollar on the official market. This relative stability of the nominal rate did not correspond to economic fundamentals: adverse terms of trade shocks and expansionary fiscal and monetary policies led to inflation being persistently higher than in Algeria's trading partners. The Algerian dinar, therefore, appreciated by 50 percent in real terms between October 1991 and end 1993.

11. **In 1994, the authorities put in place an adjustment program with the objective of correcting the previous real appreciation of the Algerian dinar**. A two-step devaluation of the Algerian dinar (in total 70 percent) took place between April and September 1994. The spread between the parallel market and the official exchange rates fell to about 200 percent during this time.

12. **Since 1995, Algeria's foreign exchange policy has aimed at maintaining a stable real exchange rate** against a basket of currencies weighted according to the country's main trading partners and competitors. In 1995, the managed float regime was implemented through fixing sessions between the Bank of Algeria and commercial banks. An interbank foreign exchange market was established in 1996 to allow a free determination of the exchange rate. Between 1995 and 1998 the REER appreciated by more than 20 percent, followed by a depreciation of 13 percent between 1998 and 2001. Following 16 months of real depreciation since early 2002, due to the appreciation of the euro against the US dollar, the authorities intervened in the foreign exchange market in the second half of 2003 to realign the REER to its end-2002 level instead of its end-1995 level. Between June and November 2003, the Algerian dinar appreciated against the US dollar by 24½ percent and the REER increased by 11 percent.

13. **The central bank strongly influences the nominal exchange rate on the official market.** Through its intervention, the Bank of Algeria adjusts periodically the nominal exchange rate so as to achieve its real exchange rate target. In practice, the central bank holds the counterpart of the majority of the transactions on the foreign exchange market, as a result of the combination of three factors: (a) hydrocarbon exports account for more than 95 percent of total exports; (b) by law, the foreign exchange receipts from hydrocarbon exports have to be converted into dinars directly at the central bank outside the interbank market; and (c) capital account transactions are subject to strict controls.

14. With the advent of the external convertibility of the dinar for current account transactions in 1997, the authorities have indicated that the parallel market has shrunk. The exchange rate spread between the interbank market and the parallel market is currently about 25 percent.

C. Review of the Literature

15. **Purchasing power parity (PPP) implies that the real exchange rate will revert to its mean**, although it may deviate from its mean for several years at a time.[53] The concept of PPP is often the first port of call for economists and market analysts who wish to estimate exchange rate equilibrium. The most widely used methodology to confirm or reject the PPP is based on the analysis of the time series properties of the REER, which is assumed to measure changes in price level differences between a country and its trading partners (Rogoff, 1996). If the REER series is stationary and the speed of convergence of the REER towards its mean is fast enough, then the PPP can be considered to hold. Slow convergence is inconsistent with the PPP, which only allows for short-term deviations from equilibrium.

16. **PPP has proven to be a weak model of the long-run real exchange rate.** Most studies have failed to find cointegrating relationships that are consistent with PPP (or,

---

[53] See Dornbusch (1987).

equivalently, consistent with a stationary real exchange rate). Meese and Rogoff (1983) demonstrated that a variety of linear structural exchange rate models failed to forecast more accurately than a random walk model for both real and nominal exchange rates. Recent work has therefore emphasized the time-varying nature of the long-run real exchange rate. The equilibrium real exchange rate is not a single rate, but a path of real exchange rates over time that is affected by the current and expected values of variables that affect internal and external equilibrium. These variables are known as fundamentals. The multitude of potential fundamentals offered by researchers in their attempts to resolve the PPP puzzle include the Balassa-Samuelson effect,[54] government spending, cumulated current account imbalances, and real interest rate differentials as important drivers of long-run deviations from purchasing power parity (see Froot and Rogoff (1995) and Rogoff (1996)). Clark and MacDonald (2000) extended the approach to better differentiate between permanent and transitory components of the real exchange rate.

17. **Several models have been developed to determine the equilibrium real exchange rate in developing countries**. Edwards (1989, 1994) made a seminal attempt to build an equilibrium real exchange rate model specifically tailored to developing countries by exploring the long-run co-movements of the real exchange rate with variables such as the terms of trade, productivity, net foreign assets, the fiscal balance and measures of openness of the trade and exchange system. Khan and Ostry (1991) provided panel data estimates of the elasticity of the equilibrium real exchange rate with respect to terms of trade shocks and commercial policies in a static model.

18. **The connection between economic fundamentals and exchange rate behavior has also been controversial**. Many studies have failed to find a statistical link between real exchange rates and fundamentals. Edison and Melick (1999) failed to find cointegration between real exchange rates and real interest rate differentials, and Rogoff (1996) found a mixed empirical track record of the Balassa-Samuelson effect on real exchange rates. Recent efforts to confront these challenges have explored new approaches on both theoretical and empirical fronts, including incorporating non-linearity in modeling exchange rate dynamics.[55] Alternatively, it has also been recognized that if one could find a source of real shocks that is sufficiently volatile, one could potentially go a long way towards resolving these major empirical exchange rate puzzles. In this respect, Chen and Rogoff (2002) found for four commodity-exporting developed countries that the dollar price of commodity exports exhibits a strong influence on real exchange rates. Similarly, Cashin, Céspedes, and Sahay

---

[54] See Balassa (1964) and Samuelson (1964). The Balassa-Samuelson effect is described as follows: if a country experiences an increase in the productivity of the tradables sector (relative to its trading partners), its real exchange rate would tend to appreciate. For given prices of tradables, such stronger productivity would induce higher wages in the tradable sector; if wages are equalized across sectors, this would be reflected into higher prices of nontradables, and, hence an increase in the consumer price index relative to trading partners.

[55] Examples of recent papers that explore non-linear exchange rate responses to deviations from economic fundamentals include Taylor and Peel (2000) and Taylor (2001).

(2002) show that in many commodity-dependent low-income countries, the real price of commodity exports and real exchange rates move together in the long run.

D. Determination of the Equilibrium Real Exchange Rate in Algeria

Purchasing power parity

19. **PPP does not hold in Algeria, suggesting that the equilibrium real exchange rate may vary over time**. Figure 1 shows that the REER did not converge towards its mean between January 1995 and June 2004. Furthermore the augmented Dickey-Fuller and Phillips-Perron test statistics show that the REER is non-stationary (Table 1).[56] Finally, similarly to others' findings, 50 percent of a unit impulse (half-life speed (HLS)) dissipates in about 42 months or three and a half years, thus rejecting the hypothesis that deviations from PPP are short-lived.[57] This result suggests that the equilibrium real exchange rate of the Algerian dinar may depend on fundamental variables.

Table 1. Tests of Order of Integration, January 1995- June 2004

ADF	Level		First Difference	
	Lag	t-ADF	Lag	t-ADF
LREER 1/	12	-1.60	12	-2.93 *

Phillips-Perron	Level		First Difference	
	Bandwith	t-PP	Bandwith	t-PP
LREER 1/	6	-1.18	6	-9.01 **

* and ** denote rejection at 5 percent and 1 percent critical values.
1/ LREER is the real effective exchange rate expressed in log.

The Equilibrium Real Exchange Rate and Fundamentals

20. **Given that Algeria is a commodity exporting country, the model used is that developed by Cashin et al. (2002) for commodity-dependent countries** (see Appendix). It is a commodity-price- and relative productivity-augmented PPP model. The REER is defined as a function of relative productivities between tradables and nontradables sectors, as well as the terms of trade:

$$EP/P^* = f(a_x/a^*_i \;\; a^*_n/a_n \;\; P^*_x/P^*_i)$$

where :

[56] The used data is the logarithm of the INS monthly REER for the period 1995:01-2004:06

[57] See Cashin et al., 2002; Chen and Rogoff, 2002. The estimated coefficient α of the AR(1) OLS regression is equal to 0.984, thus the HLS=abs(log(1/2)/log(α))=42 months.

- EP/P^* = the real exchange rate defined as the domestic price of the domestic basket of consumption goods relative to the price of the foreign basket of consumption goods expressed in foreign currency.
- a_x/a^*_i = productivity differential between exports and import (foreign) sectors; or between domestic and foreign tradables sectors.
- a^*_n/a_n = productivity differential between the foreign and domestic nontradables sectors; and
- P^*_x/P^*_i = commodity terms of trade (or the price of the primary commodity with respect to the intermediate foreign good) measured in foreign prices.

21. The first two terms in equation (1) capture the Balassa-Samuelson effect –a productivity improvement in the commodity sector will tend to raise wages throughout the economy– which translates into a price increase in the non-tradables sector, which, in turn, leads to an appreciation of the real exchange rate. The third term reflects the impact of the terms of trade. An increase in export prices leads to higher wages, and translates into an increase in non-tradable goods prices as well.

22. **The variables used in Algeria's model are the following**:

- LREER = the real effective exchange rate using INS data (2001=100); in logarithmic terms.
- LRGDPC = Real GDP per capita relative to trading partners. Normalized for each country to 1 in 2001; in logarithmic terms. Given the absence of data on unit labor costs, and as often done in estimation of equilibrium exchange rates, this variable is used as a proxy for the productivity differentials (Balassa-Samuelson effect).
- LROIL= real price of oil calculated, as in Cashin et al. (2002), by deflating the UK Brent spot price index by the manufactured exports unit price index for developed countries (2001=100); in logarithmic terms. This is a proxy for the commodity terms of trade (P^*_x/P^*_i).

23. The visual observation of the movements in the three variables in Figure 2 suggests that movements in the REER largely reflect developments in Algeria's productivity relative to its trading partners (a deterioration over almost the entire period), and, to a lesser extent, changes in real oil prices.

24. **The dataset consists of annual data from 1970 to 2003**. The ADF test indicates that the nonstationarity hypothesis cannot be rejected at the 5 percent confidence level in all three variables. However, for the first difference of the same variables, the hypothesis of nonstationarity is rejected at 5 and 1 percent confidence, suggesting that these variables are integrated of order one, I(1) (Table 2).

Figure 2. Determinants of the Real Effective Exchange Rate, 1970-2003

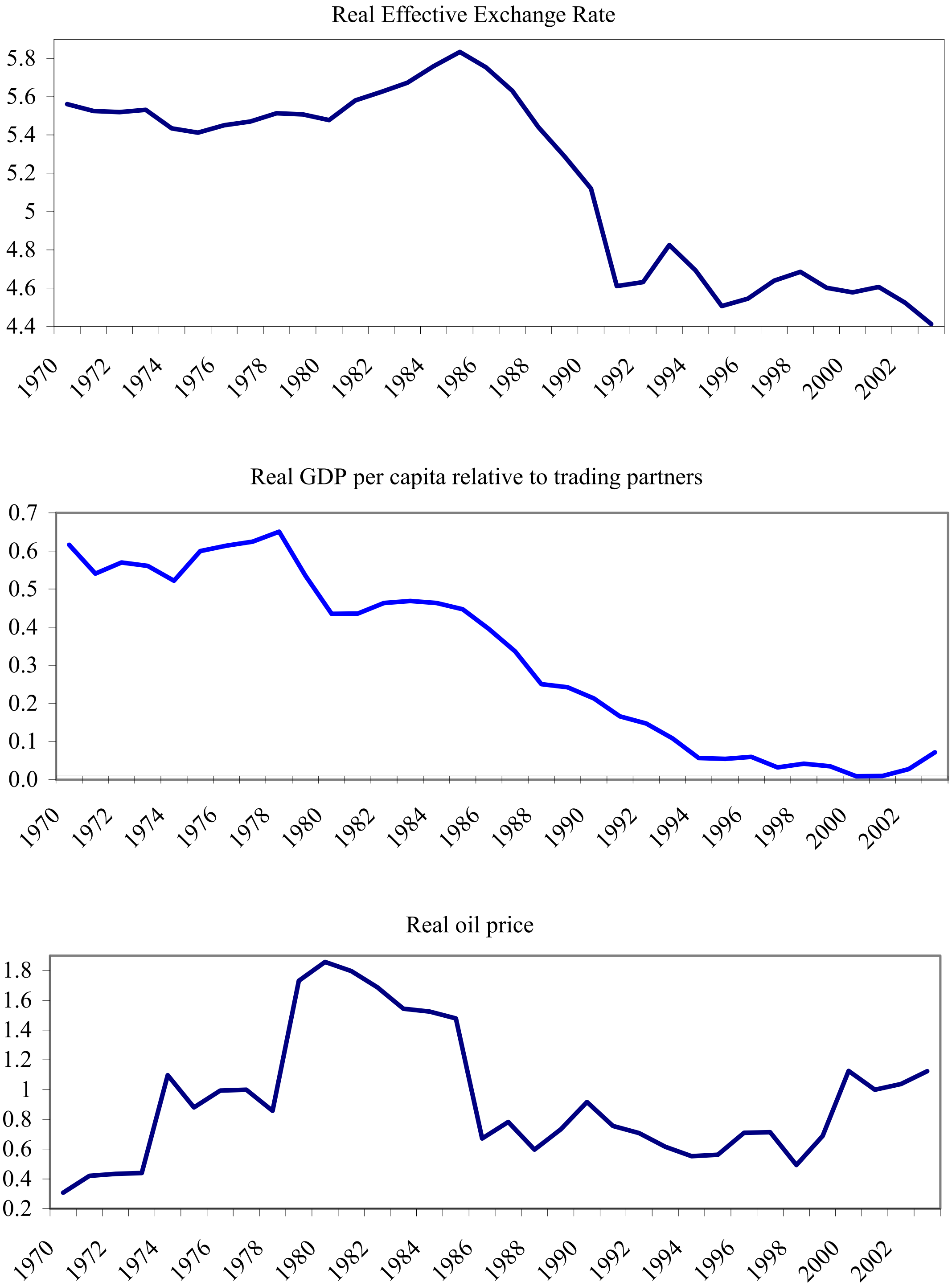


Table 2. Statistics for ADF(2) Unit Root Tests

Variables	Level		First Difference	
	Lag	t-ADF	Lag	t-ADF
LREER	9	-0.08	9	-4.03 **
LRGDPC	9	-0.84	9	-4.36 **
LROIL	9	-2.67	9	-6.52 **

Notes: Variables are as defined in the text. * and ** denote rejection at 5 percent and 1 percent critical values.

25. **The econometric analysis confirms the existence of a cointegration relationship between REER, real oil prices, and Algeria's productivity differential relative to its trading partners**. Table 3 shows the estimation of the vector error-correction model (VECM) using four lags for the changes in each variable (the lag structure is supported by appropriate tests). The Engle-Granger (1987) and Johansen (1995) maximum likelihood procedures are used to determine the number of cointegrating vectors among the variables.[58] Both procedures indicate that there is at most one co-integrating vector (at the 5 percent confidence level). The coefficients of the cointegration vector are plausible, significant, and of the correct sign. The cointegration analysis is appropriate (all variables are non stationary) and meaningful (not driven by the stationarity of one variable). Furthermore, the exclusion test suggests that none of the variables can be excluded from the long-run relationship (Table 4). The hypothesis that the residuals have a normal distribution is rejected due to excess kurtosis. The lag structure appears to be correct: if a fifth lag is introduced, the tests accept the hypothesis that the additional lag is jointly insignificant across equations.

Table 3. Selected Results of the VECM

Number of cointegrating vectors			
Trace statistic		Max Eigenvalue statistic	
5%	1%	5%	1%
1	1	1	1
Estimates of the cointegrating relationship with the real exchange rate			
LREER(-1)	LRGDPC(-1)	LROIL(-1)	C
1	-1.88	-0.24	-4.64
	[-16.42]	[-2.66]	
Speed of adjustment of the real exchange rate			
Cointeq1	-0.60		
	[-3.87]		
Half lifetime of the deviation from equilibrium exchange rate			
in years	0.75	in months	9

58 These procedures will provide better results for higher numbers of observations.

Table 4. VEC Tests

		Exclusion test 1/		
LREER	LRGDPC	LROIL	CHI-SQ	
21.89	21.93	16.34	3.94	
		Normality test		
	df		Probability	
Skeweness	3		0.74	
Kurtosis	3		0.00	
Jarque-Bera	3		0.00	

VEC Lag Exclusion Wald Tests 2/
(Chi-squared test statistics)

DLag 1	DLag 2	DLag 3	DLag 4	df
37.7	34.7	22.1	32.2	9
[0.00]	[0.00]	[0.00]	[0.00]	

1/ Significance level at 5%. Ho: Variable can be excluded.
2/ Numbers in [ ] are probability values

26. **The estimated long-run real exchange rate equilibrium equation takes the following form**:

$$\underset{}{LREER} = 4.64 + \underset{\substack{(0.11)\\ [16.42]}}{1.88}\ LRGDPC + \underset{\substack{(0.08)\\ [2.66]}}{0.24}\ LROIL$$

- An increase in real GDP per capita relative to trading partner countries of 1 percent is associated with an appreciation of the REER of almost 2 percent.

- An increase in real oil prices of 1 percent is associated with an appreciation of the REER of about 0.2 percent.

27. **Whenever the real exchange rate deviates from its equilibrium level due to a specific shock, it reverts to its equilibrium level fairly quickly in the absence of further shocks**. Depending on the cause of the gap, the adjustment requires that the real exchange rate either moves progressively toward a new equilibrium level, or returns from its temporary deviation to the initial equilibrium value. The parameter of the cointegration vector of 0.6 implies that the half life speed (HLS) of dissipation of a unit impulse is 0.75 years.[59] In other words, the model estimates that 50 percent of such a gap would be eliminated within 9 months. This adjustment speed is comparable to the 8 months found by Cashin et al. (2002), and much shorter than Rogoff's (1996) estimate of three to five years.

[59] The implied half-life of the shock to commodity-price- and productivity-augmented PPP is calculated as follows: the time (T) required to dissipate x percent (in this case, 50 percent) of a shock is determined according to $(1-\Theta)^T = (1-x)$, where Θ is the coefficient of the error-correction term and T is the required number of periods (years).

28. **Figures 3 and 4 show that there are no current signs of misalignment of the Algerian dinar.**[60] The actual REER appears to have been close to its estimated equilibrium in 2002-03. Following the appreciation of the euro against the US dollar in 2002-03, the gap between the actual and the smoothed equilibrium REER declined from +9 percent in 2001 to +2 percent in 2002 and to -6 percent on average in 2003. This depreciation was a little more than what was required by the fundamentals. However, the correction made by the authorities in the second half of 2003 (by appreciating the nominal exchange rate) brought the REER back to close to its equilibrium level. By year-end, the REER was 3 percent higher than its annual average level.[61] Figure 3 also shows the 1986-88 depreciation in response to the reverse oil shock, which brought the 1985 overvalued exchange rate back to its equilibrium. However, the 1994–95 perceived overvaluation is barely illustrated by the model.

Figure 3. Actual and Equilibrium REER

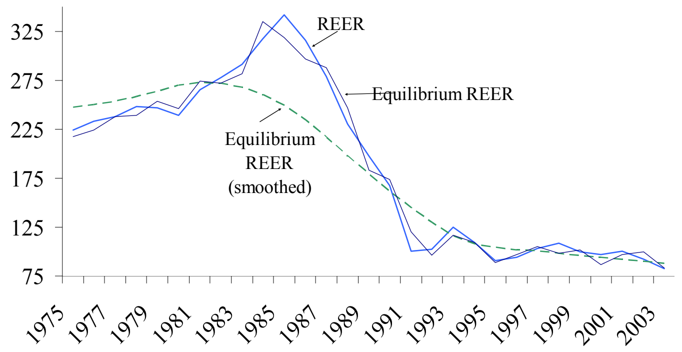
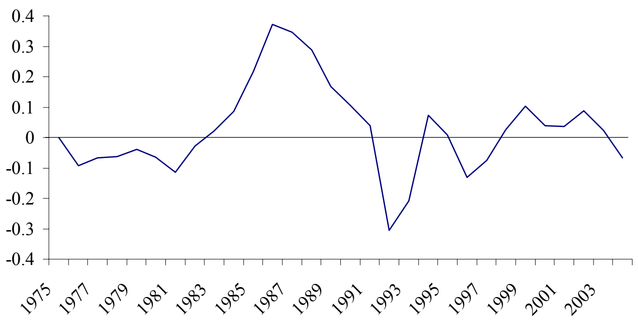


Figure 4. Gap: Actual Minus Equilibrium REER
(in percent of equilibrium level)



29. **The behavior of other macroeconomic variables also supports the assessment that the REER was not misaligned in 2003**. The high import growth in 2002–04 together with the decline in nonhydrocarbon exports in 2003 are not consistent with a real undervaluation. Furthermore, the low inflation in 2002–03 also does not fit well with the existence of a misalignment in the REER. If the exchange rate was significantly below its equilibrium value, inflationary pressures would have materialized.

[60] The smoothed equilibrium real exchange rate in Figure 3 is derived by applying to the explanatory variables a Hodrick-Prescott filter with a smoothing factor of 100. This smoothing technique neutralizes the impact of temporary fluctuations in explanatory variables on the evaluation of the equilibrium real exchange rate by deriving a proxy for the long run equilibrium values of these variables. This measure can therefore be defined as the level of the REER that is consistent in the long run with the equilibrium values of the explanatory variables.

[61] The small gap of -3 percent between the equilibrium and the actual level of the REER at end-2003 could be due to temporary shocks not captured by the long-run equilibrium model. In addition, the assessment of the equilibrium level using the Hodrick-Prescott filter is not very accurate for end-point data.

E. Forward-Looking Perspective

30. **The future path of the equilibrium real exchange rate beyond the short term is uncertain.** The authorities' prospective policies include two new aspects that will have an important impact on the equilibrium REER: further trade liberalization and fiscal consolidation. While the projected increase in real oil prices in 2005 will be associated with an appreciation of the equilibrium real exchange rate, the impact of these policies on the equilibrium real exchange rate is not straightforward.[62] In addition, whereas the impact of trade liberalization on the long-run equilibrium would be captured by movements in Algeria's real productivity relative to its trading partners, the relation between fiscal consolidation and fundamentals is ambiguous.

Further trade liberalization

31. **External trade liberalization is associated with a tendency for the equilibrium real exchange rate to depreciate.** Trade liberalization would have an impact on the equilibrium real exchange rate through both substitution and income effects: (i) a reduction in tariffs would increase demand for tradables relative to nontradables. This substitution effect would, in turn, tend to reduce the price of home goods, and hence favor a real depreciation; (ii) trade liberalization would also raise real income in the economy, which in turn would affect aggregate demand for all goods, including nontradables and hence the response of the equilibrium real exchange rate. However, the income effect is expected to be smaller than the substitution effect. Therefore, if trade liberalization is not accompanied by structural reforms, the equilibrium real exchange rate would tend to depreciate.

32. **However, if trade liberalization is accompanied by reform-driven productivity gains, this would limit the depreciation of the equilibrium REER.** Structural reforms would tend to increase productivity, leading to an appreciation of the equilibrium real exchange rate, thus offsetting the initial tendency for depreciation. Close monitoring of Algeria's real productivity relative to its trading partners would help to determine the likely path of the equilibrium real exchange rate.

Fiscal Consolidation

33. **Fiscal policy is the main transmission channel of oil price fluctuations into the Algerian economy.** This occurs because the majority of hydrocarbon receipts go to the government, and, thus far, there has been a strong correlation between government spending and hydrocarbon revenue. Therefore, the real oil price has been an important factor in determining the equilibrium real exchange rate. However, if the authorities delink government spending from hydrocarbon revenue, it is not clear if real oil prices alone would provide enough information on the equilibrium real exchange rate path. Thus, even in an

---

[62] Based on World Economic Outlook projections.

environment of increasing oil prices, if government spending declines in oil price equivalent terms, it will be important to closely monitor the impact of future fiscal policy on the economy together with the already identified fundamentals.

34. **The authorities' planned fiscal consolidation for 2005 and beyond would have an ambiguous effect on the real exchange rate.** An improvement in the fiscal balance induced by a control of spending will tend to increase total savings and reduce aggregate demand.[63] As part of the decline in spending falls on nontradables, this would bring about a depreciation of the real exchange rate. However, the improvement in the external position generated by fiscal consolidation would be associated with a real appreciation.

F. Conclusions

35. **Drawing on the existing literature, this study estimates the long-run equilibrium real exchange rate path for Algeria. The main conclusions are:**

- **REER movements in Algeria can be explained by fundamental variables**. The long-run real exchange rate of Algeria is time-varying, and dependent on movements in relative productivity and real oil prices. Deviations of the real exchange rate from its equilibrium value are adjusted fairly rapidly (HLS=9 months), confirming that Balassa-Samuelson- and commodity-price-augmented PPP determines the real exchange rate in Algeria.

- **The REER was not misaligned in 2002-03.** Model-derived estimates of the long-run equilibrium real exchange rate replicate most recognized periods of currency overvaluation in Algeria. The estimates support the conclusion that the 2002-03 depreciation of the REER followed by an appreciation in the second half of 2003 were consistent with developments in its fundamental determinants.

36. **The results of this study have important implications for Algeria's exchange rate policy.** Although Algeria should continue with a managed float, targeting a constant REER is not warranted as such a policy does not accommodate real shocks by allowing the nominal exchange rate and/or relative prices to move. Exchange rate policy should be directed to align the real exchange rate with its fundamental determinants, namely relative productivity and real oil prices. However, since the impact of the planned fiscal consolidation is not captured by current fundamentals, exchange rate management in the period ahead faces the challenge of taking into account the impact of such consolidation on aggregate demand.

---

[63] Assuming that Ricardian equivalence does not hold in line with most empirical findings.

Theoretical Framework[64]

The model is based on a small open economy that produces two different types of goods: a nontradable good and an exportable good. The production of this exportable good is associated with the production of a primary commodity. Factors are mobile and both goods are produced domestically.

A. Domestic production

There are two different sectors in the domestic economy: one sector produces an exportable called "primary commodity"; the other sector consists of a continuum of firms producing a nontradable good. For simplicity, it is assumed that the production of these two different types of goods requires labor as the only factor. The production functions are:

Primary commodity sector: $Y_x = a_x L_x$ (1)
Nontradable good sector: $Y_n = a_n L_n$ (2)

Where x represents the primary commodity sector, n the nontradable good sector, L the amount of the labor input demanded by each sector, and a, the productivity of labor in each sector. The model assumes that labor can move freely across sectors in such a way that the labor wage w must be the same across sectors. The price equations are as follows:

$$P_x = w/a_x \qquad and \qquad P_n = w/a_n \tag{3}$$

In equilibrium, the marginal productivity of labor must equal the real wage in each sector. It is assumed that the price of the primary commodity is exogenous, and that there is perfect competition in the nontradables sector. These assumptions yield:

$$P_n = a_x/a_n P_x \tag{4}$$

Thus, the relative price of the nontradable good P_n with respect to the primary commodity P_x is completely determined by technological factors and is independent of demand conditions.

B. Domestic Consumers

The economy is inhabited by a continuum of identical individuals that supply labor inelastically (with $L = L_x + L_n$) and consume a nontradable good and a tradable good. This tradable good is imported from the rest of the world and is not produced domestically. The assumptions on preferences imply that the primary commodity is also not consumed domestically. Each individual chooses the consumption of the nontradable and tradable good

[64] Cashin et al (2002).

to maximize utility, which is assumed to be increasing in the level of aggregate consumption given by:

$$C = \kappa\, C^{\gamma}_{n}\, C^{1-\gamma}_{t} \tag{5}$$

where C_n represents purchases of the nontradable good, C_t purchases of the imported good and $\kappa = 1/[\gamma^{\gamma}(1-\gamma)^{(1-\gamma)}]$ is a constant. The minimum cost of one unit of consumption C is given by:

$$P = (P_n)^{\gamma}(P_t)^{1-\gamma} \tag{6}$$

Where P_t is the price in local currency of one unit of the tradable good. As usual, P is defined as the consumer price index. Now, the law of one price is assumed to hold for the imported good:

$$P_t = P^{*}_{t} / E \tag{7}$$

Where E is the nominal exchange rate, defined as the amount of foreign currency per local currency, and P^{*}_{t} is the price of the tradable (imported) good in terms of foreign currency.

C. Foreign Production and Consumption

So far it was assumed that the primary commodity is not consumed by domestic agents and is therefore completely exported. In addition, the domestic economy also imports a good that is produced only by foreign firms.[65] The foreign region consists of three different sectors: a nontradable sector; an intermediate sector; and a final goods sector. The nontradable sector produces a good that is consumed only by foreigners using labor as the only factor. The technology available for the production of this good is given by:

$$Y^{*}_{n} = a^{*}_{n} L^{*}_{n} \tag{8}$$

The foreign economy also produces an intermediate good that is used in the production of the final good. This intermediate good is produced using labor as the only factor. In particular, the production function available to firms in this sector is represented by:

$$Y^{*}_{i} = a^{*}_{i} L^{*}_{i} \tag{9}$$

Labor mobility across (foreign) sectors ensures that the foreign wage is equated across sectors.[66] The price of the foreign nontradable good as a function of relative productivities and the price of the foreign intermediate good is:

---

[65] The foreign economy is different than the rest of the world. The latter also includes other countries producing the primary commodity.

[66] It is assumed that labor can freely move across sectors within each region (domestic and foreign) but cannot move across regions.

$$P_n^* = a_i^*/a_n^* P_i^* \qquad (10)$$

The production of the final good involves two intermediate inputs. The first is the primary commodity (produced by several countries, among them the domestic economy). The second is an intermediate good produced in the rest of the world. Producers of this final good, also called the tradable good, produce it by assembling the foreign intermediate input Y_i^* and the foreign primary commodity Y_x^* through the following technology:

$$Y^*_\tau = v\,(Y^*_i)^\beta\,(Y^*_x)^{1-\beta} \qquad (11)$$

Now, it is straightforward to show that the cost of one unit of the tradable good in terms of the foreign currency is given by:

$$P^*_t = (P^*_i)^\beta\,(P^*_x)^{1-\beta} \qquad (12)$$

Foreign consumers are assumed to consume the foreign nontradable good and this final good in the same fashion as the domestic consumers. They also supply labor inelastically to the different sectors. Therefore, the consumer price index for the foreign economy can be represented by:

$$P^* = (P^*_n)^\gamma\,(P^*_t)^{1-\gamma} \qquad (13)$$

The real exchange rate in the domestic economy is determined by equations (6) and (13):

$$EP/P^* = (a_x/a^*_i\;a^*_n/a_n\;P^*_x/P^*_i)^\gamma \qquad (14)$$

References

Balassa, Bela 1964, "The Purchasing-Power Parity Doctrine: A Reappraisal", *Journal of Political Economy*, Vol. 72.

Cashin, Paul, Luis Cespedes, and Ratna Sahay, 2002, "Keynes, Cocoa, and Copper: In Search of Commodity Currencies," Working Paper WP/02/223 (International Monetary Fund: Washington DC).

Clark, P., and R. MacDonald, 1999, "Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs" in *Equilibrium real exchange Rates*, ed. by R. MacDonald, and J. Stein (Boston, Massachusetts: Kluwer Academic Publishers).

Clark, P., and R. MacDonald, 2000, "Filtering the BEER: A Permanent and Transitory Decomposition", *IMF Working Paper* 00/144 (Washington: International Monetary Fund).

Dickey, D. and W. Fuller, 1981, "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica*, Vol. 49.

Dornbusch, R., 1982, "PPP Exchange-Rate Rules and Macroeconomic Stability", *Journal of Political Economy*, Vol. 90. No. 1.

Dornbusch, Rudiger, 1987, "Purchasing Power Parity", in *The New Palgrave: A Dictionary of Economics*. Eds.: John Eatwell, Murray Milgate, and Peter Newman (London: MacMillan; New York: Stockton Press).

Edison, H., and W. Melick, 1999, "Alternative Approaches to Real Exchange Rates and Real Interest Rates: Three Up and Three Down", *International Journal of Finance and Economics*, Vol. 4.

Edwards, S., 1989, *Real Exchange Rates, Devaluation and Adjustment: Exchange Rate Policies in Developing Countries* (Cambridge, Massachusetts: MIT Press).

Edwards, S., 1994, "Real and Monetary Determinants of Real Exchange Rate Behavior: Theory and Evidence from Developing Countries" published in Williamson, John ed, Ch. 4.

Elbadawy, I., 1994, "Estimating Long-run Equilibrium Real Exchange Rates", published in Williamson, John ed, Ch. 5.

Engle, R.F and C. Granger, 1987, "Co-integration and Error Correction: Representation, Estimation and Testing," *Econometrica*, Vol. 55.

Froot, K. and K. Rogoff, 1995, “Empirical Research on Nominal Exchange Rates” in *Handbook of International Economics* Vol. 3, ed. by G. Grossman, and K. Rogoff (Elsevier Amsterdam).

International Monetary Fund, 1998, “Algeria: Stabilization and Transition to the Market,” Occasional Paper, No.165.

Johansen, S., 1995, *Likelihood-based Inference in Cointegrated Vector Autoregressive Models* (Oxford, United Kingdom, Oxford University Press).

Khan, M., and J. Ostry, 1991, “Response of the Equilibrium Real Exchange Rate to Real Disturbances in Developing Countries”, *IMF Working Paper* No. 91/3.

Meese, R., and K. Rogoff, 1983, “Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?”, *Journal of International Economics*, Vol. 14.

Montiel, P., and J. Ostry, 1991 “Macroeconomic Implications of Real Exchange Rate Targeting in Developing Countries”, *IMF Staff Papers*, Vol. 38, No. 4.

Rogoff, K., 1996, “The Purchasing Power Parity Puzzle”, *Journal of Economic Literature*, Vol. 34.

Samuelson, Paul, 1964, “Theoretical Notes and Trade Problems”, *Review of Economics and Statistics*, Vol. 46 (May).

Taylor, Alan, 2001, “Potential Pitfalls for the Purchasing Power Parity Puzzle?” Sampling and Specification Biases in Mean-Reversion Tests of the Law of One Price, *Econometrica*, Vol 69, No. 2.

Taylor, Mark, and David Peel, 2000, “Nonlinear Adjustment, Long Run Equilibrium and Exchange Rate Fundamentals”, *Journal of International Money and Finance*, Vol. 19, No. 1.