Mineral Resource Accounting Measures in Africa

Louis Moussi Sopp and Anthony Leiman
Abstract

Prior to the end of the prolonged commodity boom that led up to the 2008 recession, much was made of the rapid growth in GDP demonstrated by many African countries. The continent’s rising GDPs were held to be heralding a new dawn: a turn in the evolutionary economic downturn cycles that had typified many of its economies since the end of the colonial era. The rapid fall in commodity prices as the global recession took hold showed the limitations of these high hopes, and the weak foundations on which some of them had been based. In this paper, we will begin by checking the veracity of this economic portrait, assessing the dependence of the income of eight mineral-resource-rich sub-Saharan African countries on their mineral commodities. The paper then compares the relationship between an economy’s fiscal deficit before borrowing and National Income as conventionally recorded, as opposed to that between the deficit and the National Income as calculated following the El Serafy method. It then discusses some of the challenges towards efficient resource management in low-income mineral-resource-rich sub-Saharan African countries.

This paper is the product of the Vice-Presidency for Economic Governance and Knowledge Management. It is part of a larger effort by the African Development Bank to promote knowledge and learning, share ideas, provide open access to its research, and make a contribution to development policy. The papers featured in the Working Paper Series (WPS) are those considered to have a bearing on the mission of AfDB, its strategic objectives of Inclusive and Green Growth, and its High-5 priority areas—Power Africa, Feed Africa, Industrialize Africa, Integrate Africa and Improve Living Conditions of Africans. The authors may be contacted at workingpaper@afdb.org.
Mineral Resource Accounting Measures in Africa¹

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**JEL Codes:** E01, Q32, Q56

**Keywords:** National income, ‘El Serafy’ method, accounting, mineral resources

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[N]atural resources are not purchased from mother nature who produced them so that their valuation must inevitably be artificial and controversial. ... the national accounts ought not to show the using up of assets whose creation has not first been recorded in the accounts.... Nature is not recognised as a factor of production by economists or national accountants and nature’s production of resources is not, and perhaps could never be, recorded in the accounts.

Derek Blades (1989, 215)

1. Introduction

Good policymaking needs good information. In the 1989 paper from the Organisation for Economic Co-operation and Development (OECD) cited above, Blades argued that the United Nation’s System of National Accounts then in place gave little aid to resource planners and decision makers. Four years later, the UN adopted satellite accounting to mitigate this deficiency. Despite their adoption by the United Nations, satellite accounts have not become universal, nor have the policy lessons they offer been fully recognised. Nowhere has this problem been clearer than in Africa’s recent growth surge, so much of which was mineral based.

Prior to the end of the prolonged commodity boom that led up to the 2008 recession, much was made of the rapid growth in gross domestic product (GDP) demonstrated by many African countries. The continent’s rising GDPs were held to be heralding a new dawn; an upturn that was reversing the downward economic trends that had typified so many of the continent’s economies since the end of the colonial era. Unfortunately, the rapid fall in commodity prices that ensued as the global recession took hold, showed the limitations of these high hopes and the weak foundations on which some of them had been based. Since then commodity prices have begun to recover, but the lessons of the price shocks have not necessarily been built into the fiscal policies of those economies most susceptible to such shocks.

In this paper, we will begin by checking the veracity of this economic portrait, assessing the dependence of the continent’s income on primary commodities, and the performance of its non-commodity sectors in the past decade. An index of risk is calculated for African economies. This is based on the contribution of major minerals to GDP and to Gross Exports, together with the historic variances in their prices (i.e. the amplitudes and frequencies of historic price fluctuations).
While many countries, following the lead of 1993 UN System of National Accounts, have begun compiling satellite accounts, and while the interpretation of these has been significantly improved (see United Nations et al., 2009, chapters 12 and 29), the real message of this data may have been missed by policy makers. A simple test can be used to reveal the extent to which policy makers have internalised the message of the satellite accounts. This would take the relationship between an economy’s fiscal deficit before borrowing and its nominal net domestic product (NDP) as conventionally recorded, significantly improved (see and compare it to the relationship between the country’s fiscal deficit and its National Income as calculated using the El Serafy method (which follows Hicks’s view of income as the time derivative of wealth). Such a comparison would provide a mechanism to test the fragility of economies (or the risk their fiscal policies entail in the face of commodity price fluctuations).

A more complete indicator of an economy’s exposure to fluctuating commodity prices would be relationship between national debt and NDP as computed in these two manners. Such tests will provide the remainder of the paper. The data to be used is taken from a sample of eight selected sub-Saharan African countries for the period 1990-2015. These countries are Angola, Botswana, Congo (Brazzaville), Gabon, Equatorial Guinea, Mauritania, Nigeria, and South Africa. The essential data comprises GDP, NDP, specific mineral rents, sector shares (minerals and mining as percentage of NDP or NY), budget deficit, and national debt.

2. Literature review
Macroeconomic analysis usually focuses on GDP growth as the principal measure of economic performance; however, as is now widely established, GDP gives an incomplete picture of an economy’s true situation and the welfare of its inhabitants. Other indicators, while harder to quantify, can provide valuable information on the state of an economy.

This is particularly true for countries with a large endowment of mineral resources, as is the case of many sub-Saharan African countries. GDP and comparable measures describe the value of total production in the economy without accounting for changes to the capital stock (which would be captured in NDP or in National Income if ideally calculated). Particularly important are the depreciation of capital assets, including the exhaustion of non-renewable resources, damages to the ecosystem, the accumulation of human and physical capital, and new mineral discoveries. In resource-rich economies, these subtleties have vital implications for the sustainability of long-term growth and the design of fiscal policies.

The relationship between natural resources and economic success has confounded economists for a long time now. In spite of being endowed with considerable natural resources,
many African countries are still considered among the poorest nations in the world and have neither been able to embark on sustainable long-run economic growth paths, nor implement stable fiscal policies necessary to sustain that growth. The role of natural resources in established theories of economic wealth ranges from highly beneficial for economic growth to deeply undermining. The empirical weak relationship between resources and economic performance has promoted an emphasis on country-context-specific factors that promote the success or failure in harnessing resource wealth. It is in this environment that wealth accounting can be used to measure the natural and intangible capital that contribute to economic growth.

The subsequent analysis attempts to identify patterns in natural capital depletion in Angola, Botswana, Congo (Brazzaville), Equatorial Guinea, Gabon, Mauritania, and Nigeria, and to discuss the implications for the long-term growth and development. This analysis uses the methodology developed by El Serafy to determine the value of mineral resources.

One of the most valuable indicators of changes in an economy’s underlying productive capital stock is the ratio of Adjusted Net Savings to Gross National Income. To derive Adjusted Net Savings we need five main components namely:

- Gross National Saving
- Current education expenditures
- Depreciation of produced capital
- Depreciation of natural resources
- Damage caused by CO₂ emissions

The main advantage of this measure is that it allows an assessment of the degree to which the investment of natural resource rents and consequent increases in the stock of produced and human capital compensate for the present depletion of natural resources. This has significant consequences for intergenerational equity in the exploitation of natural resources and welfare.

Numerous studies on Adjusted Net Savings rates have revealed a disturbing trend among natural resource-rich countries in sub-Saharan Africa, where high GDP growth rates often hide decreases in the underlying stock of natural capital. While a very few countries have been able to successfully transform their natural capital into human and produced capital, the vast majority have failed to do so. In several cases, the exploitation of natural resources has created an unsustainable surge in current consumption expenditure at the expense of long-term sustained economic growth. Furthermore, some studies have shown a strong correlation between negative adjusted savings rates and persistently low socioeconomic development.
indicators, such as literacy rate, infant mortality and access to water and electricity (Collier et al., 2010).

**Figure 1: Contribution of mining to GDP**

![Bar graph showing contribution of mining to GDP for various countries.](image-url)


As Figure 1 shows, mineral resources play an important role in the growth of the economies we shall be examining. It is for this reason therefore that the focus of this analysis is restricted to mineral resources. Natural resources also include elements like wildlife, forest, fisheries but these are excluded for the purpose of this analysis. In the remainder of this paper, any reference to natural resources should be taken to mean mineral resources alone.

Before starting the analysis, it is important to calculating resource rents for each category of mineral resource. Resource rents can be defined as grossly be defined as:

\[
\text{Unit Rents} \times \text{Production} \quad \text{where} \quad \text{Unit Rents} = \text{Unit Price} - \text{Unit Cost}
\]

In the 1990s, attempts to measure sustainability were popular and numerous studies attempted to provide a good measure of sustainability for single countries or a selection of countries. These included Repetto et al. (1989) for Indonesia, Repetto and Cruz (1991) for Costa Rica, van Tongeren et al. (1993) for Mexico, Bartelmus et al. (1993) for Papua New Guinea, Serôa
da Motta and Young (1995) for Brazil, Pearce and Atkinson (1993), and Hamilton and Atkinson (1996). In this analysis, the El Serafy method will be used to compute resource rents for the eight countries to ascertain which of them can be classified as weakly sustainable and formulate the appropriate policy recommendations.

The El Serafy method for computing resource rents

In order to calculate the user costs for resource depletion according to the El Serafy method, we need to get four different terms:

- \( P - AC \) (net price of the resource)
- \( R \), Production (Resource Depletion)
- \( r \), the real discount rate (discount rate used in analysis is 4 percent p.a.)
- \( n \), the number of years of reserves remaining at current production rates and current extraction technologies (reserves to production ratio).

The El Serafy formula for user cost can be expressed as shown below:

\[
(P - AC) \cdot R \cdot \frac{1}{(1+r)^{n+1}}
\]

Source: Neumayer (2000)

It is an estimate of the total Hotelling Rent (only an estimate, since Hotelling used marginal rather than average extraction cost) that the resource could provide, but following Keynes’s terminology is called the ‘user cost’ of resource depletion as it indicates the share of resource receipts that should be considered as capital depreciation. With this method, an explicit correction term for resource discoveries is not needed because discoveries and new technologies that affect effective reserves enter the formula via changes to \( n \), and the formula is re-calculated again for each year.

The logic behind the formula for the El Serafy method is that, sustainability need not require that all resource rent be invested (as Hartwick, 1997 suggested) but that a portion can be consumed. While the earnings from the resource stock will end at some finite time, sustainable income by definition must persist. Therefore, a finite cash flow has to be converted into an infinite one. Sustainable income is that part of resource receipts which if received infinitely would have a present value just equal to the present value of the finite stream of
resource receipts over the lifetime of the resource; i.e. if each year’s resource rents were used to purchase an infinitely long lasting annuity, sustainable income (and the El Serafy user cost) would be the annual pay out from that annuity.

An advantage of using the El Serafy method is that it does not presume efficient resource pricing i.e. resource rent growing at the rate of interest according to Hotelling’s rule. This is because the El Serafy method does not depend on an optimisation model. It is an ‘after the fact’ approach thus making it more flexible than competing resource-rent calculation methods (World Bank, 2013). Consequently, future resource receipts have to be discounted and the El Serafy method requires the selection of a discount rate r. If either the remaining lifetime of the mineral resource, n, or the discount rate r are quite small, then user cost value will consequently be relatively large.

Computing resource rents according to the El Serafy method

In the following section, resource rents have been computed using the El Serafy method. Table 1 shows which resources we used for the analysis, and that for Angola, Congo (Brazzaville), Equatorial Guinea, Gabon, and Nigeria the dominating resources are oil and natural gas. For Mauritania, the dominating resource is iron ore and for Botswana it is diamonds. Figure 1 (above) indicates the share of mining (includes oil and natural gas) as a percentage of GDP.

Table 1: Share of single natural resources of total resource rents

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Angola</td>
<td>99.35</td>
<td>92.04</td>
<td>91.5</td>
</tr>
<tr>
<td>Congo (Brazzaville)</td>
<td>90.34</td>
<td>97.49</td>
<td>98.91</td>
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<tr>
<td>Equatorial Guinea</td>
<td>95.00</td>
<td>96.00</td>
<td>97.00</td>
</tr>
<tr>
<td>Gabon</td>
<td>86.30</td>
<td>85.00</td>
<td>85.41</td>
</tr>
<tr>
<td>Mauritania</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigeria</td>
<td>99.77</td>
<td>99.59</td>
<td>95.17</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Share of Iron Ore of Rents in percent</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mauritania</td>
<td>100.00</td>
<td>97.00</td>
<td>91.30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Share of Copper &amp; Nickel of Rents in percent</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>0.00</td>
<td>0.04</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Share of Diamonds of Rents in percent</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>0.00</td>
<td>0.04</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Figure 2: Mineral exports as a percentage of total exports


Figure 2 shows that the exports of these countries also tend to be very concentrated and dominated by mineral exports. This makes them very vulnerable in terms of trade shocks when the prices of the primary commodities suddenly fall.

Results

Figure 3: Angola adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1994-2012

Source: Author’s own calculation
Figure 4: Botswana adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1992-2014

Source: Author’s own calculation

Figure 5: Congo (Brazzaville) adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1994-2012

Source: Author’s own calculation
Figure 6: Equatorial Guinea adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1994-2012

Source: Author’s own calculation

Figure 7: Gabon adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1992-2005

Source: Author’s own calculation
Figure 8: Mauritania adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1992-1998

Source: Author’s own calculation

Figure 9: Nigeria adjusted net savings (percentage GNI) and gross national savings (percentage GNI) 1992-2014

Source: Author’s own calculation
The figures above are illuminating. Much has recently been made of who should be appointed to head the Angolan sovereign wealth fund, a body whose objective is to accumulate assets that parallel the hypothetical ones in the El Serafy calculation. The persistence of negative Adjusted Net Savings for Angola and Congo (Brazzaville) certainly highlights the need for better resource management in the future. As the figures show, there are large discrepancies between Gross Savings and Adjusted Net Savings (El Serafy) for Angola, Congo (Brazzaville), and Equatorial Guinea. These discrepancies suggest that these countries have not been able to capitalise on the considerable opportunities given to them through their natural resource endowments to build up and maintain their physical and human stock of capital in exchange for the exhaustion of their stock of natural capital. Botswana consistently experienced positive Adjusted Net Savings and, with very high reserves to production ratios, there seems to be no indication of weak sustainability. Although it is true that the El Serafy method allows for some of the resource rents to be consumed, the widening of the gap in recent years between Gross Savings and Adjusted Net Savings (El Serafy) suggests that some amount of the national wealth that is consumed is in excess of what should be the case under efficient resource-rent management.

It is a stylised fact that commodity prices are more volatile than manufactured goods. It is also well documented that many resource-dependent countries experience more
generalised macroeconomic volatility and have a strong tendency towards procyclicality (Hausmann and Rigobon, 2003; Van der Ploeg and Poelhekke, 2009). Lastly, it has been shown repeatedly that such volatility is not good for sustainable long-term economic growth and welfare (Ramey and Ramey, 1995).

Table 2: Sustainability risk index

<table>
<thead>
<tr>
<th>Country</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>3.3</td>
</tr>
<tr>
<td>Botswana</td>
<td>4.1</td>
</tr>
<tr>
<td>Congo (Brazzaville)</td>
<td>3.2</td>
</tr>
<tr>
<td>Equatorial Guinea</td>
<td>4.3</td>
</tr>
<tr>
<td>Gabon</td>
<td>2.7</td>
</tr>
<tr>
<td>Mauritania</td>
<td>1.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1.9</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.8</td>
</tr>
</tbody>
</table>

We then construct a sustainability index (Table 2) that indicates how at-risk an economy is to shocks or fluctuations in the price of the dominant natural resource. The higher the index value, the more at risk the economy is to fluctuations in the price of the dominant natural resource. According to this index, we see that Equatorial Guinea is the most at risk followed by Botswana and then Angola. South Africa is the least at risk followed by Mauritania and then Nigeria. It should not be surprising that South Africa is the least exposed given that its economy is more diversified relative to the other countries.

5. Discussion and policy implications

Robinson et al. (2006) produced one of the most comprehensive studies on the relationship between abundance of resource revenues, political accountability and the quality of institutions in the economy. Their argument and empirical evidence suggest that governments that do not have to introduce socially tolerable and consistent systems of taxation, but can rather finance themselves through resource revenues, have reduced incentives to be accountable and responsive to their citizens. Consequently, they do not have a stake in the development of a thriving market-based, non-resource economy that is otherwise required to establish a taxable economic base and secure the fiscal sustainability of the state. In contrast, governments in non-resource countries have an incentive to promote the development of such a market-based economy as it generates a multitude of corporate and individual taxpayers, providing a steady and stable source of revenue for the state.
In the Robinson et al. (2006) model, the existence of resources and the associated rents increases the utility of holding political power for too long. As a result, political horizons across a range of policy issues are short sighted and sub-optimal from a social welfare perspective. Most of the resource revenues are directed towards the single purpose of keeping political power. One manifestation of this is a bloated public sector that establishes a stake in keeping the status quo and is paid off through the rents emanating from the resource sector. Unsurprisingly, a number of prominent studies have found strong evidence that resource abundance is associated with higher levels of corruption.

The rent-seeking and broader political economy literature on the resource curse helps explain the prevalence of poor public investments financed by resource related public revenue windfalls. Torvik (2009) suggests that one of the biggest issues concerning resource-rich countries is why massive domestic investments in some of them have not resulted in greater growth gains. Gelb (1988) estimated that more than half of the bonus gains from the rise in oil prices in the 1970s were invested in domestic projects. Any of the leading growth models would have predicted that, following such significant public investments, strong and sustainable economic growth will have occurred, but this was not the case for most if not all of the countries in this study.

There are a number of reasonable arguments that may be brought forward to explain why the expected growth failed to happen. In a study of the response by the Nigerian government to positive terms of trade shocks during the oil boom, Gavin (1993) found that the government largely invested in projects with high prestige and political gains but which made little economic sense. Nigeria is not the only country with this issue. The tendency of investing in projects with negative social surplus is typical of many resource-rich African governments.

Several studies have also highlighted the strong relationship between resource abundance and conflict and war. Collier and Hoeffler (1998 and 2004) argue that resource-rich countries face conflict for two main reasons. Firstly, the resource rents are used to buy weapons and pay the soldiers. Secondly, because resources often have a winner-takes-all quality with big payoffs for the winner, and limited need for cooperation with losers in the future to extract rents, resources trigger fierce struggles over control.

The Brundtland report’s approach to sustainable growth (WCED, 1987) is broad: ‘growth that meets the needs of the present without compromising the ability of future generations to meet their own needs and the management of human, natural and financial assets
to increase long term economic wellbeing’. An economy that experiences rapid expenditure growth funded by extraction of mineral resources, and does so without increasing its overall stock of wealth by investing in physical and human capital, will not be able to sustain its economic growth in the long run and risks sacrificing the wealth of the future generations to finance current consumption; i.e. it fails even the Brundtland definition of sustainability.

A growth strategy that is sustainable needs to account for the temporal and intergenerational dimensions of resource wealth by ensuring that current growth does not come at the expense of future growth. It is important to acknowledge that a new discovery of mineral resources, or an increase in the stock of reserves of existing mineral resources can also play a positive role.

Adopting and implementing policies that increase savings and maximise rents from mineral resources, sustaining human capital investment, putting in place transparent and consistent fiscal policies will be vital to building the government’s policy credibility and expanding the available space for public investment or to free up resources to build fiscal reserves. It is also important for sustainable economic growth to be achieved that the revenues from mineral resources are reinvested into different types of productive capital. This requires a strong policy framework grounded by clear policy commitments. According to the World Bank (2013) such policy commitments should include

(i) efforts to promote efficient resource extraction with a view to maximizing resource rents;
(ii) a fiscal regime for the resource sector that enables the government to recover an equitable share of resource rents;
(iii) well-designed investment policies that use resource rents to generate sustainable returns over the long term.

6. **Challenges in efficiently managing resource rents**

The first issue is the availability of information to estimate the stock of mineral resources and total wealth. With the exception of Botswana, there is no comprehensive data or statistics on wealth accounting, nor a facade by the governments of Angola, Congo (Brazzaville), Equatorial Guinea, Gabon, Nigeria, and Mauritania to even create and regularly update this accounting to show the evolution of the stock of mineral resources. The full or even partial implementation of the United Nations SEEA System by these countries would be an important
first step towards preserving, protecting, and enhancing their national wealth, thus building the foundation for the prosperity of all generations.

Another difficulty with efficiently managing resource rents in order to achieve sustained economic growth involves determining the right amount of the resource rents to invest and consume. A key element in this trade-off is the marginal returns offered by different types of public investment. Mauritania for example suffers from a considerable lack of infrastructure in the form of reliable roads, like many African countries. This deficiency may suggest that increased investment in physical infrastructure will generate strong economic returns. Even though shortages of physical capital certainly constrain development, on the other hand and in the medium term especially, the absorptive capacity of Mauritania is likely to be low and an overemphasis on these forms of capital may result in unproductive investments. Therefore, the time path for the use of revenues needs to be carefully thought out. One possibility could be to keep at least some part of the revenues in a sovereign wealth fund in the short term, as is the case with many of the oil-rich middle-eastern Arab countries. The quality of institutions as well as the roles they play in the management of resource revenues forms an important part of this discussion.

References


APPENDIX 1 Data sources

Angola
Oil and natural gas production figures source: OPEC Database. Diamond production estimates from the Kimberley Process Website.

Botswana

Congo (Brazzaville)
Oil and natural gas production data source: OPEC Database.

Equatorial Guinea
Oil and natural gas production figures data source: OPEC Database.

Gabon
Oil and natural gas production figures data source: OPEC Database. Another major mineral is manganese but production figures were unavailable.

Mauritania

Nigeria
Oil and natural gas production figures data source: the OPEC Database. Other minerals such as lead, zinc, and tin are also present in Nigeria but data on production and reserve levels for these minerals were unavailable.

South Africa
Data on coal, gold, platinum and diamond production data sources: Statistics South Africa, the South African Department of Trade & Industry and the Kimberley Process Website.
APPENDIX 2

Figure A1: Platinum $/Oz price fluctuations

Source: International Monetary Fund: World Economic Outlook

Figure A2: Gold $/Oz price fluctuations

Source: International Monetary Fund: World Economic Outlook
Figure A3: Volatility crude oil

Source: International Monetary Fund: World Economic Outlook

Figure A4a: Mineral exports as a percentage of total exports (countries A-Le)

Source: International Monetary Fund: World Economic Outlook

Figure A4b: Mineral exports as a percentage of total exports (countries Li-Z)
Source: International Monetary Fund: World Economic Outlook