Mineral Accounting, National Wealth and Adjusted Net Savings Calculations in Botswana

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Botswana

- Landlocked country located in Southern Africa
- Large (560,000 km²) but with small population (2m), hence sparsely populated; mostly desert
- Important mining sector: the world’s largest producer of diamonds, also base metals (copper & nickel), gold, large coal deposits, and soda ash
- Major areas reserved as national parks, with important ecosystems (wetlands, desert) and wildlife populations
- Substantial population of livestock; cattle rearing the main activity in rural areas
- Upper middle income country (GDP/capita USD7,700)
System of Environmental-Economic Accounting (SEEA)

- Framework for understanding the interaction of environment and the economy
- Describes stocks and changes in stocks of environmental assets
- Complementary to economic national accounts (GDP, capital stock-produced assets, savings, investment etc.)
- Particular focus on trends in the availability and use of natural resources
- Includes both renewable and non-renewable assets

Examples of renewable and non-renewable environmental assets

<table>
<thead>
<tr>
<th>Renewable</th>
<th>Non-renewable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>Minerals</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Fuels (energy)</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Soil</td>
</tr>
</tbody>
</table>
Natural Capital

• Many components to natural capital in Botswana

• To date, natural capital accounting has focused on:
  • Minerals
  • Water

<table>
<thead>
<tr>
<th>Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals</td>
<td>Diamonds</td>
</tr>
<tr>
<td></td>
<td>Copper-nickel</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
</tr>
<tr>
<td></td>
<td>Gold</td>
</tr>
<tr>
<td></td>
<td>Soda ash</td>
</tr>
<tr>
<td>Land</td>
<td>Pasture</td>
</tr>
<tr>
<td></td>
<td>Arable</td>
</tr>
<tr>
<td></td>
<td>Protected areas (national parks)</td>
</tr>
<tr>
<td>Water</td>
<td>Rivers, dams, aquifers</td>
</tr>
<tr>
<td>Animals</td>
<td>Cattle</td>
</tr>
<tr>
<td></td>
<td>Wildlife</td>
</tr>
</tbody>
</table>
Mineral Accounts - Objectives

1. Tracking changes in the value of national mineral assets
   • A component of the national balance sheet

2. An input to the calculation of Adjusted National Savings (ANS)
   • Incorporating resource depletion into the national accounts

3. Assessing whether mineral exploitation is leading to asset depletion
   • Is resource depletion being matched by re-investment?

4. Tracking the various types of income earned from the exploitation of mineral assets
   • who earns income? what is done with the income?

5. How effective is fiscal policy with regard to mineral exploitation?
   • Taxation of mineral rents
   • Use of revenues from mineral taxation
Stages of Mineral Accounts

1. Physical accounts – extraction and stocks
2. Economic valuation
3. Link to national wealth/asset accounts
4. Wealth calculations & changes
5. Taxation of economic value – mineral revenue
6. Use of mineral revenue – public spending & investment
MINERAL RENT – THE PRINCIPLES
Mineral Rents

The concept of mineral rents is central to mineral accounts, the valuation of mineral assets & depletion

- Represents the surplus revenue derived from the sale of minerals over and above the costs of production (including costs of capital)
- Used to value “un-mined” minerals in the ground
- Optimal mining fiscal regime should aim to tax mineral rents as highly as possible
Mineral Accounting: the Process

Calculation of Mineral Rent

- Resource Depletion
- ANS
- National accounts

- Fiscal Analysis
- Public finance

- Valuation of Mineral Assets
- National Balance Sheet
- Financial Assets
- Produced Capital
Mineral Accounts - Components

1. **Physical Accounts**
   - The physical quantities of mineral assets held in the ground (measured in tonnes, barrels, carats etc.)
   - Cannot be aggregated across minerals

2. **Monetary accounts**
   - Based on the physical accounts, but with the addition of a monetary valuation
   - Can be aggregated across minerals
   - Can be integrated into national accounts

3. **Resource rent calculations**
   - Required for the valuation of physical assets to produce monetary accounts
Mineral Accounts - Components

STOCKS

Physical Stocks

FLOWS

Annual change (+/-)

Reserve adjustments

Extraction (-)
# Minerals – Physical Accounts

<table>
<thead>
<tr>
<th>Item</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opening stock</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Additions to stock (+)</strong></td>
<td></td>
</tr>
<tr>
<td>Discoveries</td>
<td></td>
</tr>
<tr>
<td>Upwards re-appraisals</td>
<td>Depending on geological information, technology, resource prices</td>
</tr>
<tr>
<td>Reclassifications</td>
<td>Depending on legal/regulatory changes</td>
</tr>
<tr>
<td><strong>Total additions to stock</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Reductions in stock (-)</strong></td>
<td></td>
</tr>
<tr>
<td>Extractions</td>
<td></td>
</tr>
<tr>
<td>Downwards reappraisals</td>
<td></td>
</tr>
<tr>
<td>Reclassifications</td>
<td></td>
</tr>
<tr>
<td>Catastrophic losses</td>
<td>e.g. mine flooding, oil-well fires, disasters</td>
</tr>
<tr>
<td><strong>Total reductions</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Closing stock of mineral resources</strong></td>
<td></td>
</tr>
</tbody>
</table>
Valuation of physical mineral stocks

Market price

Derived from sales of “in situ” mineral resources
But, few transactions, hence not readily available

Indirect approach

A mineral deposit yields a regular flow of produced minerals
Calculate Net Present Value (NPV) of that future flow of minerals

Need information on:

• Anticipated future production
• Value of the mineral - determined by Resource Rent
Contributions to Value of Mineral Output

- Resource rent is a residual (hence depends on the accuracy of other valuations)
- If a mineral sells for a price that just reflects the costs of production, the surplus (i.e. resource rent) is zero
- Resource rent may be volatile from year-to-year, esp. if price of mineral fluctuates
- Use a moving average to reduce volatility

- Intermediate consumption (inputs)
- Labour
- Consumption of fixed capital
- Cost of capital (interest, normal profit)
- Resource rent
### Valuation of Mineral Deposits: Calculation of (annual) Mineral Rent

<table>
<thead>
<tr>
<th>Revenue from sale of mineral (Gross output)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: <strong>cost of intermediate consumption</strong></td>
<td></td>
</tr>
<tr>
<td>Intermediate consumption (inputs excluding labour and capital)</td>
<td></td>
</tr>
<tr>
<td><strong>Equals</strong>: Value Added (GDP)</td>
<td></td>
</tr>
<tr>
<td>Less: <strong>costs of labour and capital inputs</strong></td>
<td></td>
</tr>
<tr>
<td>Labour costs (wages &amp; salaries)</td>
<td></td>
</tr>
<tr>
<td><strong>Equals</strong>: <strong>gross operating surplus</strong></td>
<td></td>
</tr>
<tr>
<td>Less: Consumption of fixed (produced) capital (depreciation)</td>
<td></td>
</tr>
<tr>
<td>Less: Return to produced capital</td>
<td></td>
</tr>
<tr>
<td><strong>Equals</strong>: <strong>Resource rent</strong></td>
<td></td>
</tr>
</tbody>
</table>
Flow of rent calculations - 1

Gross output

• Less intermediate consumption

Value added

• Less labour and capital costs

Mineral rent
Flow of rent calculations - 2

Mineral rent ÷ Extraction = Per unit Rent

NB the value of mineral resource rent (per unit) is not constant, and may vary from year to year as mineral prices and costs of production change.
Mineral Accounts - Components

- **STOCKS**
- **FLOWS**

- Economic Output
- Mineral rent
- Cost of production

- Inputs (IC)
  - Labour
  - Capital (deprec)
  - Capital (cost)
Valuation of (Un-mined) Mineral Assets

We now have

Information on mineral stocks (un-mined reserves in ground)

A valuation of per-unit mineral rent

Hence we can put a value on mineral assets

However, it is not as straightforward as simply multiplying the volume of the resource stock by the per unit value

Why not?
Valuation of Mineral Assets

Mineral stocks will not/cannot all be sold today, at today’s price

Will be mined and sold over a period of time

Must take account of the fact that value will be realised at different points of time in the future

Simple assumptions:

- Reserves will be mined at a steady rate until depleted (life of mine = reserve/current production)
- Per unit value (rent) will not change (steady prices/costs)

Hence:

Discount returns occurring in future and calculate NPV of flow of future returns
Mineral Accounts - Components

STOCKS

Physical Stocks

Monetary Stocks

National Balance Sheet

Produced assets

Financial assets

FLOWS

Annual change (+/-)

Reserve adjustments

Extraction (-)

Per unit Rent

Economic Output

Annual change (+/-)

Mineral rent

Cost of production

Inputs (IC)
Labour
Capital (deprec)
Capital (cost)
MINERAL RENT – THE PRACTICE
Mineral Accounts - Data Requirements & Assumptions

Physical Accounts

- Reserves (in the ground)
- Production (extraction of minerals)
- New discoveries, other adjustments etc.

*Usually obtained from mining companies, Government depts responsible for mines*

Monetary Accounts

- Gross output
- Value added
- Labour costs
- Consumption of fixed capital (depreciation)
- Capital stock (fixed assets)

*Usually obtained from Statistics Bureau, National Accounts*
PHYSICAL ACCOUNTS
Calculation of Diamond Rent 1979-2013

Physical accounts – requirements – 2 of:
  • End of year stocks
  • Annual production
  • Annual reserve adjustments/discoveries

In practice, data availability was limited; we had:
  • Annual diamond production
  • End of year stocks only for 1999, 2012, 2013
  • Little information on new discoveries
  • No information on reserve adjustments
    • i.e., not enough information
    • Had to make estimates of discoveries and reserve adjustments, based on reported information on new mines and extended production at existing mines
Diamond reserves and production

[Graph showing the trend of diamond reserves and production from 1979 to 2013. The x-axis represents years from 1979 to 2013, and the y-axis represents stocks (mcts) and production (mcts). The graph includes lines for estimated stock, known stock, and production.]
RENT CALCULATION
### Example of diamond rent calculation - 2010

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Value (P mn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross output</td>
<td>StB (NA)</td>
<td>23,349</td>
</tr>
<tr>
<td>- Intermediate consumption</td>
<td>StB (NA)</td>
<td>4,147</td>
</tr>
<tr>
<td>= Value added</td>
<td>StB (NA)</td>
<td>19,202</td>
</tr>
<tr>
<td>- Wages</td>
<td>StB (NA)</td>
<td>1,492</td>
</tr>
<tr>
<td>= Operating surplus</td>
<td>StB (NA)</td>
<td>17,710</td>
</tr>
<tr>
<td>- Consumption of fixed capital</td>
<td>StB (NA)</td>
<td>1,214</td>
</tr>
<tr>
<td>- Return on capital</td>
<td>Calculated</td>
<td>1,292</td>
</tr>
<tr>
<td><em>Capital stock</em></td>
<td>StB (NA)</td>
<td>6,461</td>
</tr>
<tr>
<td><em>Return on capital (nominal)</em></td>
<td>Assumed</td>
<td>20%</td>
</tr>
<tr>
<td>= Total rent</td>
<td>Calculated</td>
<td>15,204</td>
</tr>
</tbody>
</table>
Example of diamond rent calculation - 2010

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rent</td>
<td>Calculated</td>
<td>15,204</td>
</tr>
<tr>
<td>Extraction (mcts)</td>
<td>DoM</td>
<td>22.0</td>
</tr>
<tr>
<td>Per unit rent (P/ct)</td>
<td>Calculated</td>
<td>691</td>
</tr>
<tr>
<td>Per unit rent 5yma (P/ct)</td>
<td>Calculated</td>
<td>400</td>
</tr>
<tr>
<td>Reserves (mcts)</td>
<td>Calculated</td>
<td>811</td>
</tr>
<tr>
<td>Est. life of mine (years)</td>
<td>Calculated</td>
<td>37</td>
</tr>
<tr>
<td>Value of reserves (NPV rent) (P mn)</td>
<td>Calculated</td>
<td>85,275</td>
</tr>
<tr>
<td>Discount rate (real)</td>
<td>Assumption</td>
<td>10%</td>
</tr>
</tbody>
</table>
Valuation of Diamond Reserves 1994-2013
Resource rent – by mineral (in real terms)

- Overall resource rent dominated by diamonds
- Rent can be negative, if no scarcity value, or if costs of production are very high

Graph showing resource rent by mineral from 1982 to 2012:
- Diamonds
- Copper-nickel
- Coal
- Gold
- Soda Ash
# Mineral Accounts – rents generated by mineral, annual avg. 2009-2013

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Rent (P million)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamonds</td>
<td>12,132</td>
<td>99.6%</td>
</tr>
<tr>
<td>Copper-nickel</td>
<td>-243</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Coal</td>
<td>-128</td>
<td>-1.1%</td>
</tr>
<tr>
<td>Gold</td>
<td>166</td>
<td>1.4%</td>
</tr>
<tr>
<td>Soda Ash</td>
<td>255</td>
<td>2.1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>12,182</td>
<td></td>
</tr>
</tbody>
</table>
VALUATION OF MINERAL ASSETS
Valuation of Mineral Assets

Mineral stocks will not/cannot all be sold today, at today’s price
Will be mined and sold over a period of time
Must take account of the fact that value will be realised at different points of time in the future

Simple assumptions:
- Reserves will be mined at a steady rate until depleted (life of mine = reserve/current production)
- Per unit value (rent) will not change (steady prices/costs)

Hence:
- Discount returns occurring in future and calculate NPV of flow of future returns
Valuation of mineral assets

Assumptions:
• Life of mine = $t$
• Constant annual rent per unit of output = $R$
• Constant annual output (units) = $X$
• Discount rate (real) = $d$

Formula for NPV of mineral reserve:

$$NPV = R \cdot X \cdot \left( \frac{(1 + d)^t - 1}{d (1 + d)^t} \right)$$
Valuation of Botswana’s mineral assets, 2013

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Reserves (units)</th>
<th>Valuation (P/unit)</th>
<th>Life of mine (years)</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamonds</td>
<td>754.1 mcts</td>
<td>554.2</td>
<td>33</td>
<td>120,861</td>
</tr>
<tr>
<td>Copper-nickel</td>
<td>1.2 mt</td>
<td>-8001.1</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Coal</td>
<td>3,340 mt</td>
<td>-128.1</td>
<td>2,233</td>
<td>0</td>
</tr>
<tr>
<td>Gold</td>
<td>14,129 kg</td>
<td>111,158</td>
<td>12</td>
<td>902</td>
</tr>
<tr>
<td>Soda ash</td>
<td>5.9 mt</td>
<td>1,080</td>
<td>26</td>
<td>1,945</td>
</tr>
</tbody>
</table>

Total value: 123,707
What is the trend in mineral assets?

Value of (unmined) mineral assets grew over the years as prices rose and more deposits were discovered.

Peaked in the early 2000s and has since declined due to depletion, rising production costs and lower prices.
NATIONAL BALANCE SHEET

Using information on key assets on the national balance sheet, we can trace the level, composition of and changes in national assets over time, and assess sustainability.
## Description of Asset Classes

<table>
<thead>
<tr>
<th>Asset class</th>
<th>Comments / Data</th>
</tr>
</thead>
</table>
| Produced capital                  | • Prepared specifically for the WAVES project  
• Distinguishes between public (govt.) assets and private sector assets (firms and households)                                                                                                       |
| Mineral assets (non-produced capital) | • Prepared under mineral accounting component of WAVES project  
• Value of (unexploited) deposits major minerals (diamonds, copper-nickel, coal, soda ash, gold)                                                                                                         |
| (Net) Financial assets            | • Assets held abroad by Botswana residents (govt., firms, individuals)  
• Mainly BoB foreign exchange reserves and external pension fund assets  
• Net of liabilities to non-residents  
• Mainly inward FDI and govt. borrowing abroad                                                                 |
## National Balance Sheet

<table>
<thead>
<tr>
<th>Produced assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus: Mineral assets</td>
</tr>
<tr>
<td>Plus: Financial Assets</td>
</tr>
<tr>
<td>Equals: Total Assets</td>
</tr>
<tr>
<td>Less: Financial Liabilities</td>
</tr>
<tr>
<td>Equals: Net Worth</td>
</tr>
</tbody>
</table>

We will consider:
- The composition of total net worth (division between types of assets)
- Trends in total and individual assets (in real terms and relative to GDP)
- Changes in total assets
Real Assets – Mineral assets

- Mineral assets peaked in early 2000s, sharp drop with GFC, partial recovery since
- But no higher in 2013 than in 1999
Real assets – Produced Capital

- Steady upward trend in produced assets, now with private sector assets now the largest share
Financial Assets

- NFA – sharp decline after GFC due to both lower assets and greater liabilities
- No higher in real terms in 2013 than 15 years earlier
# Stock of National Assets, 2013

<table>
<thead>
<tr>
<th>Asset type</th>
<th>Value, 2013 (P mn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced capital</td>
<td>239,011</td>
</tr>
<tr>
<td>Public</td>
<td>100,367</td>
</tr>
<tr>
<td>Private</td>
<td>121,071</td>
</tr>
<tr>
<td>Residential buildings</td>
<td>17,573</td>
</tr>
<tr>
<td>Mineral deposits</td>
<td>123,707</td>
</tr>
<tr>
<td>Financial assets</td>
<td>121,350</td>
</tr>
<tr>
<td>Total assets</td>
<td>484,069</td>
</tr>
<tr>
<td>Financial liabilities</td>
<td>55,933</td>
</tr>
<tr>
<td>Net financial assets</td>
<td>65,417</td>
</tr>
<tr>
<td>Net worth</td>
<td>428,135</td>
</tr>
</tbody>
</table>
• Mineral assets used to make up the largest share of national assets
• Now smaller than produced assets
• Share of NFA also declining
• Shift away from mineral assets to be expected as mineral economy develops
• As mineral resources are depleted, they should be offset by other productive assets
National balance sheet trends (net worth, real)

- An upward trend, but a sharp decline after the GFC
Change in total assets (real)

P million, real (2006 prices)

-50,000 -40,000 -30,000 -20,000 -10,000 0 10,000 20,000 30,000

Real Asset Trends – All

Produced - Public  Produced - Private  Mineral  Net FA
National Wealth – in relation to GDP

- National assets have been rising in real terms, but have not risen as fast as GDP
- Hence national assets have fallen in relation to GDP
National wealth by asset class
National wealth by asset type

- Main driver of lower national assets has been declining mineral assets
- Net financial assets have also fallen
- Produced assets (private) has risen fastest
- But not enough to offset decline in other asset classes
Real national net worth per capita

- Steady increase in real net worth per capita to 2008, but now below peak
Concluding Comments

• Some success in transforming mineral assets into other assets (mainly produced capital, less so financial assets)
• GFC was a major shock to national wealth, not just GDP
• National wealth has not kept up with GDP growth
• Could indicate lower future growth – unless productivity (of asset use) is increasing
• Supports argument for saving more of mineral revenues (e.g. proposed new fund for future generations).
ADJUSTED NET SAVINGS
Calculation of Genuine National Savings (Adjusted net savings) - Ideal

**Gross National Savings**
- Deduct: consumption of fixed capital

**Net National Savings**
- Add: expenditure on education (investment in human K)
- Deduct: natural resource depletion (minerals, energy, forests etc.)
- Deduct: pollution damage

**Genuine National Savings (adjusted net savings)**
- Monitoring changes in wealth each year
Sub-Saharan Africa generally has had low ANS – due to mineral depletion and lack of investment

Adjusted Net Saving: Sub-Saharan Africa, 2008

- Depreciation of Fixed Capital
- Net Saving
+ Educational Expenditures
- Depletion of Natural Resources
- Pollution Damages
- Depletion Adjusted Saving
Adj Net Saving

% of GNI
Calculation of Genuine National Savings (Adjusted net savings) – Botswana practice

Gross National Savings
• Deduct: consumption of fixed capital

Net National Savings
• Add: expenditure on education (investment in human K)
• Deduct: natural resource depletion (minerals)

Genuine National Savings (adjusted net savings)
• Monitoring changes in wealth each year
Adjusted net savings - components

-30,000 -20,000 -10,000 0 10,000 20,000 30,000 40,000 50,000

P million, current prices

GNS
Depreciation
Education exp.
Mineral depletion

Adjusted net savings - components

P million, current prices

GNS
Depreciation
Education exp.
Mineral depletion
Gross National and Adjusted Net Savings

Percent of GDP


GNS
ANS
Adjusted net savings, 2013

- Depreciation of fixed capital

+ Educational expenditures

- Depletion of minerals
Adjusted net savings: conclusions

- ANS is significantly lower than GNS, due mainly to consumption of fixed capital (depreciation) in recent years, and depletion of minerals in earlier years.
- Investment in human capital has made an important contribution to boosting ANS.
- Overall, ANS has remained positive, indicating that assets have been accumulated rather than depleted.
THANK YOU!

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