WAVES TECHNICAL REPORTS

Preliminary Mineral Resource Accounts and Implications for Development in Botswana

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Global Partnership for Wealth Accounting and Valuation of Ecosystem Services (WAVES)

Wealth Accounting and Valuation of Ecosystem Services (WAVES) is a global partnership led by the World Bank that aims to promote sustainable development by mainstreaming natural capital in development planning and national economic accounting systems, based on the System of Environmental-Economic Accounting (SEEA). The WAVES global partnership (www.wavespartnership.org) brings together a broad coalition of governments, UN agencies, nongovernment organizations and academics for this purpose.

WAVES core implementing countries include developing countries—Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, the Philippines and Rwanda—all working to establish natural capital accounts. WAVES also partners with UN agencies—UNEP, UNDP, and the UN Statistical Commission—that are helping to implement natural capital accounting. WAVES is funded by a multi-donor trust fund and is overseen by a steering committee. WAVES donors include—Denmark, the European Commission, France, Germany, Japan, The Netherlands, Norway, Switzerland, and the United Kingdom.

Country work on natural capital accounting and their policy applications are reported in a publication series, WAVES Technical Reports.

These are preliminary mineral accounts compiled from publicly available data as of December 31 2013. The mineral accounts and associated macroeconomic indicators will be updated in future reports.

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Contents

List of Figures

List of Tables

Abbreviations

5yma	5-year moving average
BoB	Bank of Botswana
CBM	coal-bed methane
GIA	Government Investment Account
GoB	Government of Botswana
GOS	gross operating surplus
IIP	international investment position
mcts	million carats
mtpa	million metric tons per annum
MFDP	Ministry of Finance and Development Planning
MMEWR	Ministry of Minerals, Energy, and Water Resources
NRA	natural resource accounts
P	Pula
RoC	return on capital
SB	Statistics Botswana
SBI	sustainable budget index
WAVES	Wealth Accounting and the Valuation of Ecosystem Services

1. Introduction

This report is part of an ongoing project under the Wealth Accounting and Valuation of Ecosystem Services (WAVES, www.wavespartnership.org) global partnership, being carried out by the Government of Botswana (GoB) and the World Bank. The WAVES project has a number of components, including the preparation of water accounts, mineral accounts, and appropriate macroeconomic indicators. These elements were selected as the first components of the WAVES project following a scoping report prepared in February 2012.[1]

This report follows on from some earlier work conducted in the same field, in particular Lange and Wright (2004) and the set of mineral accounts prepared by the Department of Environmental Affairs and the Centre for Applied Research in May 2007.[2] In several respects, this report updates and builds up the earlier results, and is structured in a similar fashion.

The mining sector continues to be the backbone of Botswana's economy, despite efforts to diversify. Mining is still, by some measures, the largest contributor to gross domestic product (GDP), generates the majority of export earnings, and makes a major contribution to government revenues. The use of mineral revenues is, therefore, of critical importance for sustainable development. Botswana has received widespread praise for the way in which it has managed mineral revenues and invested them in education, health care, and other forms of assets. In some respects, it has managed to avoid what is commonly known in the literature as the "mineral curse" and "Dutch disease," through appropriate macroeconomic, exchange rate, and fiscal policies.

However, it is important that past success should not lead to complacency, and to recognize that policy changes may be required in response to changing circumstances, both domestically and internationally. As this report will show, the peak of the economic contribution of minerals appears to have passed, and the economic importance of minerals is likely to decline in future. At the same time, some Dutch Disease and resource curse characteristics can be observed, such as high unemployment, high income inequality, slow growth of non-mining exports, and questionable public spending decisions.

The decision to include the construction of mineral accounts in the WAVES project reflects the importance of the mining sector and the need to ensure that appropriate decisions are taken regarding the investment of mineral revenues to provide for future economic growth. This study has the following objectives:

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[1] *"The Global Partnership for Wealth Accounting and Valuation of Ecosystem Services (WAVES): Report of the Botswana Preparation Phase," prepared for World Bank/WAVES by the Centre for Applied Research and Econsult Botswana, February 2012*

[2] *"Towards Mineral Accounts for Botswana," prepared by the Department of Environmental Affairs and Centre for Applied Research, May 2007*

- Quantifying the major physical trends in resource stocks for major minerals;
- Quantifying the major monetary trends in resource stocks for major minerals;
- Exploring the extent to which the government has captured the resource rents from mineral extraction for the country's development and growth;
- Identifying the uses to which mineral revenues have been put;
- Producing estimates of national mineral wealth;
- Identifying any challenges with regard to the appropriation and use of resource rents; and
- Identifying challenges that need to be addressed for the future compilation of mineral accounts.

The report is structured as follows: Section two describes the role and importance of minerals in the economy of Botswana. Section three explains the concept of resource rent, the conditions necessary for nonrenewable resources such as minerals to contribute to sustainable development, and the methodology used to measure rent and the economic value of mineral assets. Section four presents physical assets accounts and provides an estimate of resource rent generated by mining during the period 1994 to 2012. Both physical and monetary accounts are constructed for diamonds, copper-nickel, and coal. The section concludes with a comparison of the relative importance to the Botswana economy of mineral assets and other forms of national wealth (produced assets and net foreign financial assets). Section five considers the public finance policy framework and the uses to which mineral revenues have been put, in particular for sustainable economic management. Sustainable management depends, in part, on the degree of caution exercised with regard to providing for the well-being of future generations from these exhaustible resources. Section six concludes and identifies areas of challenges from both policy and statistical perspectives.

2. Minerals, the Mining Sector, and the Economy of Botswana

2.1 Introduction

The mining sector has long been the dominant sector of the Botswana economy. For most of the past 35 years, it has been the largest contributor to GDP, the largest contributor to government revenues, and the source of the majority of export earnings. The importance of mineral production to the Botswana economy is summarized in Table 1 below.

Table 1: Economic Importance of Mining

Macroeconomic Indicator	Value (average 2003-2012)
Mining % of GDP	25%
Minerals % of government revenues	41%
Minerals % of merchandise export revenues	86%
Merchandise export revenues % GDP	41%

The main driver of mining sector growth and earnings has been diamonds, although there have been smaller contributions from base metals (copper, nickel, and cobalt), coal, soda ash, and gold. This situation has been changing in recent years, and is likely to continue evolving in the future. Government revenues from minerals appear to have peaked (relative to GDP and to overall revenues); and, in the past two years, minerals have no longer been the largest contributor to government revenues.[3] The share of GDP accounted for by the mining sector has been in decline, and—depending on the measure used—may no longer be the largest economic sector. In 2012, mining was the largest economic sector when measuring GDP/value added at current prices, but at constant (2006) prices, mining was the fourth largest economic sector, after trade, hotels and restaurants, finance and business services, and the government.

There are a variety of reasons for the declining economic role of mining in Botswana:

- The diamond mining industry, which is the largest contributor to mining, has reached maturity; production (in terms of carats) peaked in the mid-2000s and has since declined.
- The global financial crisis of 2007–9 and its aftermath led to a sharp reduction in demand for diamonds, lower prices for copper and nickel, and delays in some planned mining investments.
- Economic diversification policies have succeeded, as a result of which the non-mining sector of the economy has experienced rapid growth.[4]

While it is certain that minerals will remain important to the Botswana economy, the nature of the sector and its economic impact are likely to change.

2.2 Production Levels and Trends

As of 2013, Botswana's mineral sector comprises the production of the following major minerals: diamonds, copper, nickel, cobalt, soda ash, salt, coal, gold and silver. Of these, diamond production is by far the most important in terms of its significance, both domestically and globally. Diamonds account for the bulk of value added produced in the mining sector and of mineral export earnings. Globally, Botswana was for many years the world's largest producer of rough

[3] *The largest contributor was receipts from the Southern African Customs Union (SACU) revenue sharing arrangement.*

[4] *Over the period from 2002–12, the non-mining private sector grew by 104 percent, while the mining sector shrank by 37 percent.*

diamonds by value, although it was probably displaced from the top position in 2012 by the Russian state-controlled company Alrosa. For nickel and soda ash, Botswana accounts for 1.1 percent and 1.9 percent of global production, respectively, and is a moderately significant producer; while for all other minerals, Botswana produces less than 0.3 percent of global output (see Table 2).

Diamond production started in 1970 and increased over the years to reach a peak of 34 million carats (mcts) in 2006. Production was cut back significantly (to 18 mcts) in 2009 during the global financial crisis, but has since recovered somewhat and has varied between 21 and 23 mcts from 2010 to 2012. Diamonds are produced from two large mines (Jwaneng and Orapa) and three smaller mines (Letlhakane, Damtshaa and Karowe, all located in the Orapa area), all of which are open pit operations. All mines, except for Karowe, are operated by Debswana (a joint venture between the GoB and De Beers), while Karowe is operated by Lucara Diamond Corp. Two small mines (BK11 and Lerala) are mothballed. A new mine (Ghagoo) is due to open in mid-2014; this will be Botswana's first underground diamond mine.

For many years, all diamonds were exported in rough form, with sales and marketing largely taking place outside of the country. This situation is changing, however. Around 20 diamond cutting and polishing operations have been established, which in part use Botswana diamonds. As of 2013, De Beers's global sales operations have been relocated from the United Kingdom to Botswana, which means that diamonds from all of the De Beers group mines will be sold from Gaborone. There are also other diamond marketing platforms, including the GoB-owned Okavango Diamond Company, which will sell a share of Debswana's production outside of De Beers's channels, and Lucara Diamonds. All of these operations are helping to establish Botswana as a global diamond marketing hub.

Base Metals (copper-nickel) production also started in the early 1970s. There are four companies and five mines in operation: Selebi-Phikwe (operated by BCL), Phoenix (Tati Nickel), Mowana and Thakadu (African Copper), and Boseto (Discovery Metals). Selebi-Phikwe is an underground mine, while the other three are open pit operations. There also is a mothballed underground nickel mine at Selkirk (Tati Nickel). BCL also operates a smelter at Selebi-Phikwe, which processes concentrate from the mines and produces semi-refined copper-nickel matte; the matte is exported for final refining elsewhere. Nickel production has been declining in recent years, as reserves have been worked out, while copper mining has been increasing as new mines have opened. Small quantities of cobalt and silver also are produced (although the majority of the value is accounted for by the nickel content). Despite the decline in nickel production, it accounts for the majority of the value of Botswana's base metals output.

Soda ash and salt are produced from brine deposits located at the Makgadikgadi salt pans, through an evaporation process. During the past seven years, the production of soda ash averaged 250,000 metric tons a year, while salt averaged 280,000 metric tons a year; apart from small quantities of salt sold domestically, all of the production is exported. Botswana is the fourth largest

producer of natural soda ash in the world (after the United States, Turkey and Kenya), although it has the second-largest reserves.

Coal is produced in small quantities, mainly for domestic consumption, with the main usage being for power generation. Historical production has been just under 1 million metric tons per annum (mtpa), from a single mine at Morupule, although output has now risen to 2–3 mtpa to supply a new coal-fired power station. Nevertheless, output is very low compared to reserves that have been estimated at around 40 billion metric tons and total resources of more than 200 billion metric tons.

Gold has been mined in northeast Botswana intermittently for several hundred years, although at present there is only one mine in operation (Mupane), which commenced production in 2005. Production is relatively low, less than 2000 kilograms a year, and is declining as reserves are depleted.

Table 2: Botswana Mineral Production in Global Context

Mineral	Units	Annual Production [1]	Global Production [2]	Share of Global Production	Global Ranking [3]
Diamonds	mcts	23.2	132.4	17.5%	1
Copper	thousands of metric tons	23.4	17,000	0.1%	…
Nickel	thousands of metric tons	23.0	2,100	1.1%	12
Cobalt	metric tons	255.0	110,000	0.2%	…
Soda Ash (natural)	thousands of metric tons	244.5	13,000	1.9%	4
Coal	thousands of metric tons	975.5	7,700,000	0.0%	…
Gold	metric tons	1.9	2,700	0.1%	…

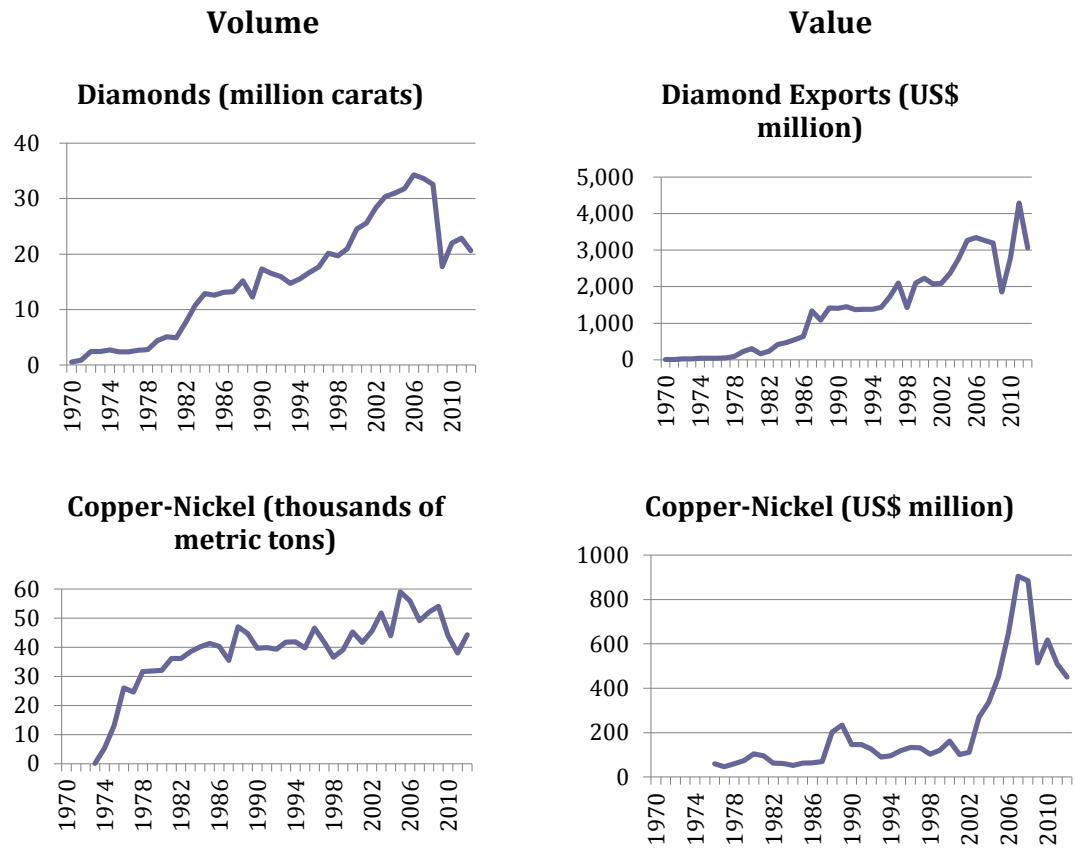
Notes: [1] annual average, 2008–2012; [2] Coal data is actual production in 2011, while data for the rest are 2012 estimates; [3] diamond ranking by value of production, others by volume; … = not available
Sources: U.S. Energy Information Administration; U.S. Geological Survey; Kimberly Process; Bank of Botswana (BoB); own calculation

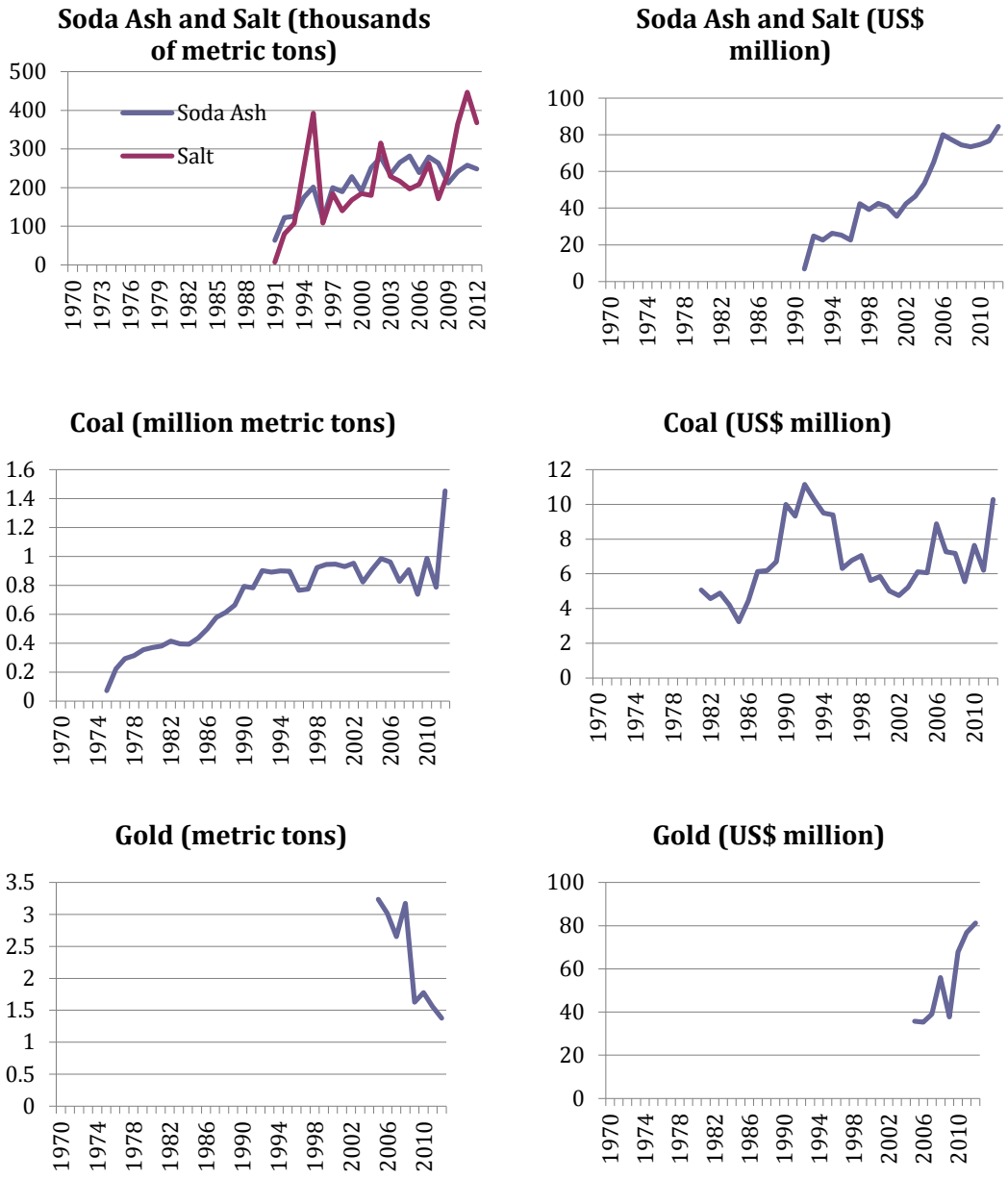
Table 3: Botswana Mines in Operation, 2013

Mineral	Name of Mine	Owner	Beneficial Owners
Diamonds	Jwaneng	Debswana	GoB (50%) / De Beers (50%)
	Orapa	*same*	*same*
	Letlhakane	*same*	*same*
	Damtshaa	*same*	*same*
	Karowe (AK6)	Boteti Mining	Lucara Diamond Corp. (listed on Toronto Stock Exchange & Botswana Stock Exchange)
Copper-nickel (& cobalt)	Selebi-Phikwe	BCL	GoB (100%)
	Phoenix	Tati Nickel Mining Co.	GoB (15%) / Norilsk Nickel (85%)
	Mowana	African Copper (Listed on AIM, London)	ZCI Ltd (Listed on JSE, Johannesburg)
	Thakadu	*same*	*same*
	Boseto	Discovery Metals (Listed on ASX and BSE)	
Coal	Morupule	Morupule Colliery Ltd	Debswana (100%)
Soda Ash (& salt)	Sua	Botswana Ash	GoB (50%) / Chlor-Alkali Holdings (50%)
Gold	Mupane	Galane Gold (Listed on Toronto Stock Exchange)	

Source: MMEWR, authors

Figure 1: Mineral Production by Volume and Value, 1970–2012





Source: Bank of Botswana

Note: volume figures are for production and value figures are for exports, except for coal, which is estimated value of production (EVP)

2.3 Export Revenues

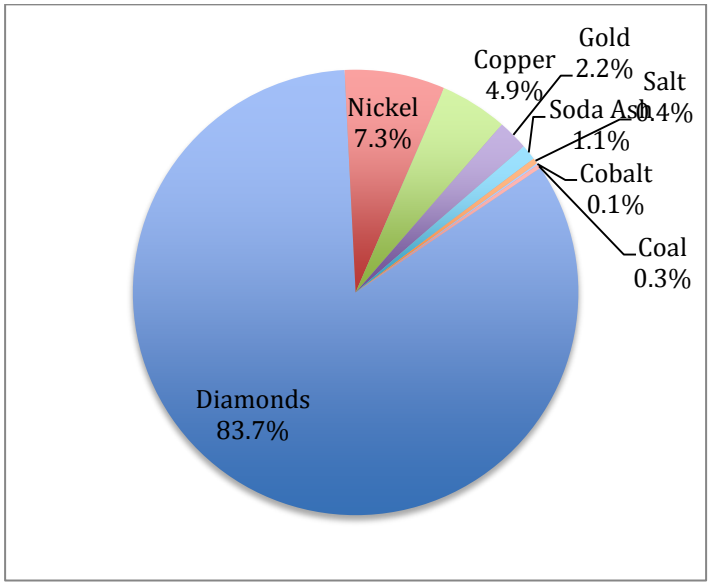
The value of mineral production—primarily earned through exports—is shown in Table 4 (for 2012) and Figure 2. As is clear, diamonds account for the majority of the value of Botswana's mineral production. Base metals (copper, nickel, and cobalt) also are important. The values of soda ash, salt, gold, and coal are relatively small, although coal may have significant value in the future.

Table 4: Value of Mineral Exports/Production, 2012

	US$ Million	% of Total
Diamonds	3,065.0	83.7%
Nickel	266.9	7.3%
Copper	179.9	4.9%
Gold	81.3	2.2%
Soda Ash	40.9	1.1%
Salt	15.0	0.4%
Coal	10.3	0.3%
Cobalt	4.6	0.1%
Total	**3,663.9**	

Source: Bank of Botswana; Statistics Botswana; author's calculations

Figure 2: Value of Mineral Exports/Production, 2012



2.4 Prospects for the Mining Industry

Botswana's mining sector is likely to become more diversified over the next two decades, as diamond production declines in relative terms and other minerals develop.

Diamonds: The mainstay of Botswana's diamond production, the large Debswana mines at Orapa and Jwaneng, can keep producing on the basis of current investments for another 10–15 years. However, there are reserves that can be exploited beyond this time, although this will require significant investments to deepen and broaden the pits, or to go underground. With an anticipated upward trend in real diamond prices over the next two decades, driven by emerging supply-demand imbalances as major deposits are worked out, such investments should be worthwhile. Nevertheless, production is likely to remain well below historical peaks of 30-plus mcts a year; and, as production costs rise, the rents generated and mineral revenues earned by the government are expected to decline as a proportion of gross output value. Although new mines have opened in recent years, these are much smaller than Orapa and

Jwaneng,[5] and are more marginal economically.[6] There is extensive prospecting taking place for diamonds, and although many kimberlites have been discovered, their economic viability is yet to be established.

Base metals: Botswana's base metals mines have had mixed fortunes in recent years and have been adversely affected by low prices (especially for nickel), declining reserves and ore quality (especially at Tati Nickel), production problems, and difficulties in achieving anticipated ore processing volumes (especially for African Copper and Discovery Metals). However, it has been established that there are substantial unexploited base metal deposits around Selebi-Phikwe and in northwest Botswana (the Ghanzi district and Ngamiland); the latter may contain an extension of the Zambian copperbelt. It is likely that further base metal mines will open in the coming years, although much depends on the availability of transport and power infrastructure, as well as price developments.

Uranium: A substantial uranium deposit exists in northeast Botswana, and—unlike some of the known base metals deposits—is well served by existing infrastructure. The deposit is relatively easy to mine, but depends on a recovery of global uranium prices.

Coal and coal-bed methane (CBM): Probably the main potential for large-scale development of mining development in Botswana lies with coal. Although there is no publicly available comprehensive and up-to-date survey of Botswana's coal resources, it is widely agreed that there are extensive deposits spread throughout much of eastern and central Botswana. A significant ramp-up in production requires an export market, whether for coal itself or for products derived from coal, such as electricity or chemicals. Developing a significant coal export market will, in turn, require the provision of dedicated rail infrastructure to either the east coast of Africa (via Zimbabwe, Mozambique, or South Africa), or the west coast (Namibia). These are large and expensive projects, and various options are under consideration. Government support will be vital for such a large-scale infrastructure investment, but so far, the GoB has not stated which, if any, of these projects it prefers. Mining of coal for export also has substantial water requirements, for washing, and the availability and cost of sufficient water is another factor to consider when developing large-scale coal production.

There are also substantial deposits of CBM(similar to shale gas), which could be exploited as an energy source (liquid petroleum gas), a fuel for power generation, or a chemical feedstock. The viability of exploiting CBM deposits is under investigation.

While there is nothing definitive regarding the likely development of coal or CBM production, the potential is large, and there should be more clarity over the next 2–3 years regarding development prospects.

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[5] *New mines (including the two mothballed mines) have production capacity in the range of 250,000–1 mcts a year (compared to +/- 10 mcts a year at Jwaneng and Orapa).*

[6] *As demonstrated by the closure/mothballing of the two smallest mines soon after opening.*

2.5 Downstream Processing

The majority of Botswana's minerals are exported in unprocessed or semi-processed form. However, there is a gradual move along the value chain, at least for diamonds. Rough diamonds have long been sorted and valued in Botswana. In recent years, some diamonds have been cut and polished locally. Since 2013, the entire production also has been marketed locally, since the relocation of De Beers Global Sightholder Services from London to Gaborone. In addition, the newly-established Okavango Diamond Company is marketing a portion of Debswana's output in Botswana (but outside De Beers' channels), and other diamond mining companies (e.g., Lucara) also have established marketing operations in Botswana. There is also some jewelry production.

Many of the transactions involved in the sale of rough diamonds are non-market transactions, and it is therefore possible that a portion of the mineral rent is transferred to these later stages (i.e., may not fully appear in the mining sector of the national accounts, but in the manufacturing or business services sectors). In the future, it would be helpful to include downstream processing sectors in the mineral accounts calculations, if possible.

Coal is already processed locally to produce electricity. Other possible downstream processing activities on the basis of current mineral products include copper-nickel refining, fabrication of metal products, and glass production from soda ash. Coal also may be used for much larger-scale electricity production for export, or for chemical or liquid fuel production. Future CBM production also can be used as the basis for a variety of downstream products.

3. The Framework for Mineral Accounts

3.1 Introduction

Section 2 showed that Botswana's mining industry is very important to the economy, and in the case of some minerals, is significant on a global scale. This suggests that minerals probably form a major component of Botswana's national wealth, where national wealth includes produced, human, natural and financial capital that can be used to generate income and livelihoods. From a sustainable development perspective, it is important to track changes in national wealth over time. This applies to all economies, but especially to mineral economies, as the extraction of minerals can easily lead to a diminution of national wealth, if declining mineral assets are not compensated by increasing assets of other forms (produced capital, intangible and human capital, and financial assets). If national wealth is not sustained or increased, in the long term, real incomes will decline.

Botswana does not produce any consolidated picture of national wealth in official statistics—i.e., there is no national balance sheet. Indeed, there is little information on the various individual components of national wealth, several of which are not yet calculated. The current assignment of preparing mineral accounts therefore represents a contribution to a broader assignment of

calculating the level of national wealth, changes in wealth, and genuine net savings.

The only component of national wealth that is regularly calculated and published vis-à-vis the rest of the world is net financial assets. This is published by the Bank of Botswana (BoB) as the international investment position (IIP) in the monthly publication "Botswana Financial Statistics." Annual data for the IIP are available going back to 1995. Statistics Botswana (formerly the Central Statistics Office) used to publish information on produced capital (capital stock), divided across different economic sectors, but this has not been done since 2006–7.

The construction of mineral asset accounts for Botswana is part of a broader international initiative to monitor the sustainable use of mineral wealth through the use of natural resource accounts (NRA). The UN System of National Accounts now proposes that NRA are incorporated in order to provide a more accurate picture of the extent to which the economy relies on natural capital and, with regard to minerals, the economic implications of the rate at which this capital is being depleted (or increased when new discoveries are made). In this way, policymakers can anticipate and plan for the eventual exhaustion of mineral assets. The NRA will therefore form part of the national balance sheet. Although most countries do not yet produce a national balance sheet, those that do generally include subsoil assets such as mineral deposits.

As with the 2007 exercise (Department of Environmental Affairs/Centre for Applied Research), this report focuses on asset accounts for minerals. Most minerals historically have been exported in unprocessed or semi-processed form, and there are few linkages to other economic activities in Botswana. However, this is gradually changing. An increasing proportion of diamonds are cut and polished locally rather than exported as rough. Even for rough diamonds, there is an increasing amount of sorting, valuing, and marketing being carried out in Botswana. Furthermore, there are plans to use much larger amounts of local coal for power generation, both domestically and in export markets. Other downstream uses of coal and CBM also are being considered. There also may be scope for further processing of base metals, extending the smelting already carried out at BCL through to refining and possible further downstream uses. In due course, therefore, it will be important to prepare use accounts for minerals as well as asset accounts.

3.2 Mineral Resources and Reserves

In constructing mineral stock accounts, one of the most important starting points is the classification of mineral deposits in the ground. Essentially, any mineral deposit can be classified according to the level of confidence regarding the geological structure of the deposit—this will depend on both the nature of the mineral and the type of prospecting and exploration that has been carried out. For a hard mineral, for instance, which typically would be explored using borehole drilling and core sample evaluation, the closer together the test drill holes, the more confidence regarding the geology of the deposit. The level of geological confidence will be fairly stable, although can be changed through more

intensive exploration (e.g., infill drilling) or new geochemical techniques for sample evaluation.

In addition to the level of geological confidence, a deposit can be classified according to the economic viability of the deposit. For instance, there may be a high level of geological confidence regarding a deposit, but it may be of low grade or difficult to extract, such that it is not economically viable to do so given existing mining and processing techniques and market prices. The level of economic viability of a deposit will be less stable than the level of geological confidence, given that prices and price expectations can change considerably.

Any mineral deposit can therefore be evaluated across these two dimensions, as shown in the "McKelvey" diagram below. Identified (i.e., discovered) resources can be divided into Measured, Indicated, and Inferred, with progressively lower degrees of confidence as to the geology of the deposit. In terms of economic classification, deposits are either economic (i.e., mineable) or sub-economic.

Figure 3: McKelvey Diagram for Classification of Mineral Deposits

<table>
<tr><td rowspan="4">----------Economic confidence--→</td><td></td><td colspan="3">IDENTIFIED RESOURCES</td><td>UNDISCOVERED RESOURCES</td></tr>
<tr><td></td><td>Measured</td><td>Indicated</td><td>Inferred</td><td>Hypothetical/ speculative</td></tr>
<tr><td>Economic</td><td colspan="2">Reserves
Proven Probable</td><td>Inferred resources</td><td rowspan="2"></td></tr>
<tr><td>Sub-economic</td><td colspan="2">Demonstrated sub-economic resources</td><td>Inferred sub-economic resources</td></tr>
<tr><td colspan="5"><----------Geological confidence------</td></tr>
</table>

Source: adapted from McKelvey (1972, 32–40)

Deposits that are both economic and identified with a reasonably high degree of geological confidence (measured or indicated) are classified as "reserves," which may be further subdivided into proven and probable categories. Other identified deposits that are either in the geological inferred category, or are subeconomic (or both) are classed as "resources." Mineral reserves are of primary economic interest, although mineral resources can be moved into the reserves category over time, due to either changing economic conditions (such as higher prices), or further geological assessment or exploration work. In the current exercise, we focus on reported reserves, except in the case of diamonds where—for reasons of differences in geology between diamonds and other minerals—we also include inferred resources.

3.3 Measuring Resource Rent and Valuing Mineral Assets

The economic value of a mineral resource is measured by the *resource rent*. This is the economic return earned from the sale of a mineral over and above the

costs of extracting the mineral. Resource rent occurs because of the scarcity of a resource.

Unless there are specific policies to recover resource rent from mineral producers, it will accrue as "windfall" or "super-normal" profits to mining companies—i.e., a profit that is over and above that which would be normally required to reward the mining company for the capital employed in the mining operation and the risks incurred in mining investment and operation.

In many countries, relevant law prescribes that minerals belong to the state. Mining companies are then given licences entitling them to exploit (mine and sell) the mineral resource. However, as the owner of the resource, the government is entitled to a return on it.

From an economic perspective, sustainable and equitable resource management requires that the resource rent be recovered by the government through appropriate taxes and used for the benefit of all citizens. Nonrenewable resources like minerals eventually will be depleted, and the employment and incomes generated by this activity will come to an end. It is especially important that resource rents from minerals be invested in other kinds of economic activity, which can replace the employment and income from the mineral-based industries once they are exhausted. In this way, exploitation of minerals can be *economically* sustainable—because it creates a permanent source of income—even though nonrenewable resources are, by definition, not physically sustainable, and the revenues derived directly from minerals are consequently unsustainable.

Most countries, including Botswana, levy special taxes and royalties on minerals to capture resource rent. While the principle of capturing resource rent is well established and widely accepted, doing so in practice is quite difficult, for several reasons. First, there is room for disagreement between what is an acceptable return on capital (RoC) for the investor, including an allowance for risk. Second, the taxation regime should have a relatively low or normal rate of tax on profits when profits are low, but a higher rate of tax when profits are high, to capture any windfall gains—so a variable profits tax rate is required, which must be carefully designed. Third, there is a time inconsistency problem. Governments may agree to a tax regime that is favorable to mining companies prior to a mining investment, but once the capital (which is largely immovable) is committed, the government may impose a more draconian tax regime to the disadvantage of the investor, who is by then committed; hence mining investors often will seek legally enforceable precommitments from governments, such as through tax stability agreements. Fourth, there is scope for transfer pricing, because investors can transfer profits out of the mining jurisdiction (where taxes may be high) to tax havens or lower-tax jurisdictions. Fifth—partly to address the transfer-pricing issue—mineral royalties on the gross value of production are by far the simplest kind of tax to impose on mining companies, but have the disadvantage of making some mineral deposits subeconomic, by raising the costs of mining.

The value of natural capital is the present discounted value of the stream of income (rent) that it is expected to generate in the future, or what is called the present value. There are two steps in calculating the present value of mineral assets:

- calculating the rent per unit of output generated by current production, and
- calculating the economic value of the mineral deposit as the discounted value of future rents, usually based on assumptions relative to current rates of rent.

The calculations and assumptions required are described in more detail in Appendix 2.

3.4 Data Availability and Limitations

In conducting rent calculations for the present exercise, there have been major data limitations. This partly reflects the strategic importance of minerals and a desire to keep certain data confidential. This applies in particular to data on the size of mineral reserves and new discoveries, as well as some of the information required for economic rent calculations, such as the capital employed. The data issues and their handling are listed in Table 5.

Table 5: Data Availability and Approaches to Resolving Gaps

Variable	Data Availability	Comment
Physical Stock Calculations		
Reserves of minerals by type	Official government data generally not published for reserves or new discoveries. Data published at company level for listed companies, although not annually	
Diamonds	Data available for 1999 and 2012	Extrapolate based on historical figures and known production levels; assume increases spread evenly over relevant time period
Copper-nickel	Data available up to 1987 and for 2011	
Coal	Data available from 1970s for two coalfields only	Renewed exploration in other coalfields is improving data availability
Mineral extraction by type	Available from Statistics Botswana	Some delay in incorporating new mining operations
Economic Rent Calculations		
Gross operating surplus (GOS)	Not available from SB since 2001	Data on value added available at the level of individual minerals since 1994; approximation made on the ratio of value added/GOS based on pre-2001 data

	Mineral royalties classed as intermediate consumption, hence not included in GOS	Estimate royalty payments based on known royalty rates and value of production; add back to GOS for rent calculation
Capital stock	Not available from SB since 1997	Data available from company accounts for 2–3 recent years; used to extrapolate from 1997
Consumption of capital	Not available from SB since 1997	Assume same ratio of consumption of fixed capital to capital stock as prior to 1997
Return on capital	No agreed figure to use, especially for valuation of risk	Calculated using 10% and 20% (nominal), as in 2007 report. May not be appropriate—consider 15% and 25%
Calculation of Value of Mineral Resource Stocks		
Magnitude of deposits	Possible new discoveries	Ignore possible new discoveries (conservative)
	Proportion of reserves that is mineable—unknown	Assume 50%
Discount rate for present value calculation	No agreed figure	Used 10% (real)

4. Mineral Accounts and Resource Rent

4.1 Physical Accounts

The construction of physical accounts for minerals is an important step in constructing economic accounts, whereby the changes in the economic value of the country's natural capital can be tracked.

As Table 4 shows, diamonds dominate the economic value of Botswana's mineral production. Base metals (copper, nickel, and cobalt) are also economically important. Other minerals—gold, soda ash, salt, and coal—are relatively insignificant at present, although coal has the potential to become much more important in future. Mineral accounts are presented below for diamonds, copper-nickel and coal. They are not presented for soda ash or gold, due to both lack of data and the relatively small scale of production.[7]

4.1.1 Diamonds

Physical accounts for diamonds are presented in Table 6 for the period 1979 to 2012. Information on diamond extraction/production is compiled by the Department of Mines (DoM), although it does not publish the information.

[7] *Subject to data availability, gold and soda ash will be included in future revisions.*

However, the information is provided on request by the DoM, and by Statistics Botswana, and is also obtainable from Debswana and other mining companies.

Obtaining information on the stock of diamonds in the ground, or reserves, is much more problematic. Information on reserves for the Debswana mines was published by De Beers in its 1999 annual report. This included reserve figures for each of the mines then in operation—Jwaneng, Orapa, and Letlhakane—in the categories of probable, inferred, and indicated. However, De Beers did not publish similar reserve figures for subsequent years. Reserves could therefore be estimated by deducting annual production from this 1999 base for subsequent years, and by adding back annual production for prior years. However, this meant that reserves could not be updated by the addition of new resources identified through new discoveries, whether by Debswana or other diamond mining companies. Thus, the estimated physical stock is an underestimate.

However, the situation changed in 2012 following the acquisition by Anglo American plc of the 40 percent of De Beers held by the Oppenheimer family, through Central Holdings Ltd. This took the Anglo American shareholding in De Beers to 85 percent; the other 15 percent is held by the GoB. Given that Anglo American is listed on several major international stock exchanges, disclosure rules require that figures on mineral reserves be provided to investors and published as part of the annual accounts. Hence, the 2012 Anglo American annual report included figures on reserves for all four Debswana mines—the above three plus Damtshaa, which opened in 2000. Going forward, this figure and anticipated annual updates provide the basis for a more accurate calculation of Botswana's diamond reserves. The Debswana figures can be supplemented by similar information published by the smaller diamond miners, which also are publicly listed companies.

Table 6: Physical Production and Resource (Stock) Accounts for Diamonds (million carats), 1979–2012

	Opening Resources (Stocks)	Extraction	Closing Stocks	New Discoveries (est.)	Closing Stocks (adj. after 1999)
1979	1,057	4.4	1,053		
1980	1,053	5.1	1,048	NA	
1981	1,048	5.0	1,043	NA	
1982	1,043	7.8	1,035	NA	
1983	1,035	10.7	1,024	NA	
1984	1,024	12.9	1,012	NA	
1985	1,012	12.6	999	NA	
1986	999	13.1	986	NA	
1987	986	13.2	973	NA	
1988	973	15.2	957	NA	
1989	957	15.3	942	NA	
1990	942	17.4	925	NA	
1991	925	16.5	908	NA	

1992	908	15.9	892	NA	
1993	892	14.7	878	NA	
1994	878	15.6	862	NA	
1995	862	16.8	845	NA	
1996	845	17.7	828	NA	
1997	828	20.1	807	NA	
1998	807	19.8	788	NA	
1999	788	20.7	767	NA	
2000	767	24.6	742	27.4	770
2001	742	26.2	716	27.4	771
2002	716	28.4	688	27.4	770
2003	688	30.4	657	27.4	767
2004	657	31.0	626	27.4	763
2005	626	31.9	595	27.4	759
2006	595	34.3	560	27.4	752
2007	560	33.6	527	27.4	746
2008	527	32.6	494	27.4	741
2009	494	17.7	476	27.4	750
2010	476	22.0	454	27.4	756
2011	454	22.9	431	27.4	760
2012	431	20.6	411	27.4	767

NA: not available

Note: Figures for new discoveries were not available prior to 1999. During the period 1999–2012, new discoveries were evenly distributed on an annual basis, as explained in the text.

Source: author's calculations, based on data from Statistics Botswana, De Beers, Anglo American, Lucara Diamonds, and Gem Diamonds

In Table 6 above, the adjusted figure for 2012 closing stocks is based on Anglo American resource figures (747 mcts), as well as resource figures for the Karowe (15 mcts) and Ghagoo (5 mcts) mines. This total resource figure of 767 mcts is 356 mcts higher than the figure implied by the 1999 De Beers figures and subsequent extraction, and represents new discoveries or reclassification of deposits. In the absence of any other information as to when this took place, these additional resources are spread evenly as new discoveries over the 13 years between the 1999 De Beers report and the 2012 Anglo American report. The closing stocks (adjusted) column in Table 5 takes these new discoveries into account.

One of the interesting results is that the pace of new discoveries has more or less matched the pace of extraction, so that overall resources in 2012 were similar to the level in 1999.

This illustrates an important characteristic of mining projects, which is that there is no real need to prove up reserves far ahead of anticipated production. For most purposes, identification of reserves or resources sufficient for mining up to

15 years ahead is sufficient. Given that identifying resources is expensive, it is rational to delay this process until it is required. Hence, for mines that are not nearing exhaustion, identified resources are likely to underestimate true resources.

The AA 2012 annual report indicated that the anticipated life of mine for Orapa and Jwaneng was around 20 years.

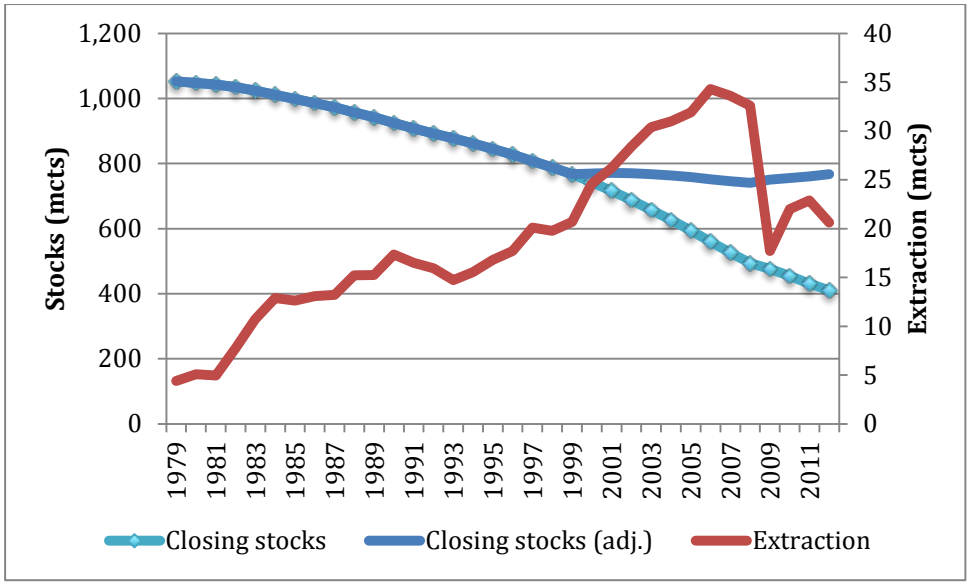
Table 7: De Beers 1999 and Anglo American 2012 Resource Estimates for Debswana Mines (million carats)

Type of reserve/resource	Mine	1999	2012
Probable	Orapa	169	86
	Letlhakane	3	1
	Jwaneng	49	88
	Damtshaa	..	4
	Total	**221**	**179**
Indicated	Orapa	32	119
	Letlhakane	2	8
	Jwaneng	4	84
	Damtshaa	..	6
	Total	**38**	**218**
Inferred	Orapa	121	254
	Letlhakane	12	2
	Jwaneng	375	269
	Damtshaa	..	5
	Total	**508**	**530**
Total	Orapa	322	373
	Letlhakane	17	10
	Jwaneng	428	353
	Damtshaa	..	11
	Total	**767**	**747**

Note: indicated resources include probable reserves in the 2012 figures, while they do not in 1999

Source: De Beers 1999 annual report (44–45) and AA 2012 annual report (219).

Figure 4: Diamond Extraction and Stocks (million carats)



Source: author's calculations, based on data from Statistics Botswana, De Beers, and AA

4.1.2 Copper-Nickel

Information on extraction, production, and reserves of copper-nickel was published in the Department of Mines annual report until 1987. Since that time, a much more limited range of information has been published, covering only the production of copper-nickel matte and its metal content. Estimates of resource stocks can be derived from the 1987 data by subtracting data on annual extraction; however, this is increasingly inaccurate as it does not contain information on new discoveries or identification of reserves. It also can be seen that on the basis of the 1987 figures, copper-nickel reserves would have been depleted by 2007.

Table 8: Physical Asset Accounts for Copper-Nickel, 1979–2012 (thousands of metric tons)

	Opening Stocks	Total Extraction	Final Production (metal content of matte)	Losses During Processing	Closing Stocks	New Disco-veries	Closing Stocks (adj. after 1987)
1979	912.1	39.5	30.7	8.8	872.6	NA	
1980	872.6	44.5	31.0	13.5	842.4	NA	
1981	842.4	41.9	36.1	5.8	761.6	NA	
1982	761.6	41.8	36.1	5.7	891.6	NA	
1983	891.6	48.4	38.5	9.9	937.8	NA	
1984	937.8	51.0	40.1	10.9	1,069.4	NA	
1985	1,069.4	53.6	41.3	12.3	937.8	NA	
1986	937.8	53.1	40.3	12.7	1,152.7	NA	
1987	1,152.7	53.5	35.5	18.0	1,115.0	NA	
1988	1,115.0	53.3	47.0	6.3	1,061.7	57.05	1,118.8
1989	1,061.7	51.0	41.5	9.6	1,010.7	57.05	1,124.8

1990	1,010.7	48.5	39.6	8.9	962.2	57.05	1,133.3
1991	962.2	48.3	39.9	8.4	913.9	57.05	1,142.1
1992	913.9	47.9	39.3	8.6	865.9	57.05	1,151.2
1993	865.9	50.9	41.8	9.2	815.0	57.05	1,157.3
1994	815.0	51.0	41.8	9.2	764.0	57.05	1,163.3
1995	764.0	47.0	39.7	8.5	716.9	57.05	1,173.4
1996	716.9	55.4	46.6	10.0	661.6	57.05	1,175.0
1997	661.6	48.8	41.8	8.8	612.8	57.05	1,183.3
1998	612.8	54.9	36.6	9.9	557.9	57.05	1,185.5
1999	557.9	47.6	39.0	8.6	510.3	57.05	1,195.0
2000	510.3	50.3	45.2	9.1	460.1	57.05	1,201.7
2001	460.1	50.7	41.6	9.2	409.3	57.05	1,208.1
2002	409.3	55.4	45.5	10.0	353.9	57.05	1,209.7
2003	353.9	63.0	51.7	11.4	291.0	57.05	1,203.8
2004	291.0	53.5	43.9	9.7	237.5	57.05	1,207.4
2005	237.5	71.9	59.0	13.0	165.6	57.05	1,192.6
2006	165.6	68.1	55.9	12.3	97.6	57.05	1,181.6
2007	97.6	59.8	49.1	10.8	37.7	57.05	1,178.8
2008	37.7	63.4	52.1	11.5	(25.7)	57.05	1,172.4
2009	(25.7)	65.1	53.4	11.9	(90.8)	57.05	1,164.4
2010	(90.8)	59.6	48.9	9.7	(150.4)	57.05	1,161.9
2011	(150.4)	38.7	31.8	6.2	(189.1)	57.05	1,180.2
2012	(189.1)	43.3	35.6	7.8	(232.4)	57.05	1,193.9
2012 adj.					1180.2		

NA = not available

Note: Figures for new discoveries were not available prior to 1988. During the period 1988–2012, new discoveries were evenly distributed on an annual basis, as explained in the text.

Source: author's calculations, based on data from Statistics Botswana, BCL, Norilsk Nickel, African Copper, and Discovery Metals

Although the DoM no longer publishes reserve figures, some information can be obtained directly from the mining companies involved. All of the four companies involved in copper-nickel mining—BCL, Tati Nickel, African Copper and Discovery Metals—have published reserve and resource estimates on their websites, although at different dates. The reserves and resources detailed by these companies are summarized below:

Table 9: Base Metals (Copper-Nickel) Resources and Reserves

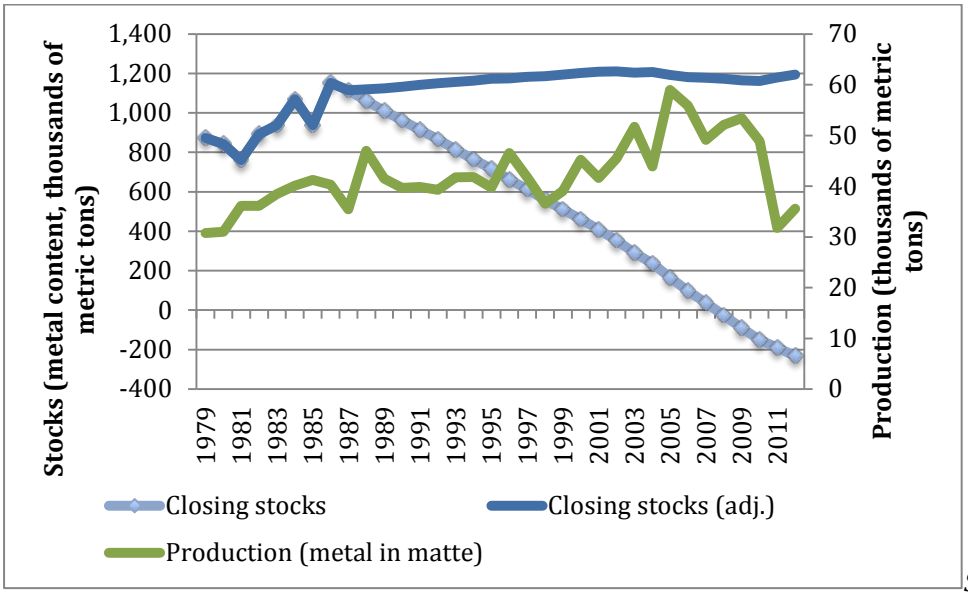
Company	Date	Reserves (thousands of metric tons)	Resources (thousands of metric tons)
BCL	30/06/2011	704	1,368
Tati Nickel	31/12/2009	556	1,446
African Copper	26/11/2007	164	622
Discovery Metals	22/07/2013	195	1,413
Total	**Various**	**1,619**	**4,849**

Sources: www.africancopper.com; www.bcl.bw; www.nornik.ru/en/our_products/MineralReservesResourcesStatement; www.discoverymetals.com/mineral-resources-ore-reserves; accessed November 4, 2013

Adding these figures to the implied resources in Table 8 above, we get a revised stock figure for 2011 of 1.18 million metric tons, or an increase of 1.37 million metric tons over the implied reserves based on the 1987 figures. As with diamonds, we spread this increase over the 24 years between 1987 and 2011, or 57,050 metric tons a year. This approximately matches the rate of extraction, so that over the period as a whole, the level of reserves remains roughly constant, matching the result found with diamonds.

In principle, the 2011 reserve figures would cover some 15–20 years of extraction at current rates. However, this may not in fact be the case, as some of the reserves (especially those at Tati Nickel) are very low grade, and continued mining may not be viable—obviously depending on copper and nickel prices.

Figure 5: Copper-Nickel Stocks and Production (thousands of metric tons)



Source: author's calculations

4.1.3 Coal

Eleven coalfields have been identified in Botswana. However, only one of them is being mined (Morupule), and only two (Morupule and Mmamabula) have been explored to a significant degree. Reserves for these two coalfields were originally

measured during the 1970s, and totaled 7.2 billion metric tons. In addition, there were 28.8 billion metric tons of indicated reserves in other coalfields, and 176 billion metric tons of inferred resources.

Clearly, these coal reserves are very large in relation to current production, which has averaged just under 1 mtpa in recent years. The Morupule coal mine is expanding to meet the needs of the new Morupule B power station, but this is expected to reach only 2.5 mtpa.

Little exploration of Botswana's coalfields took place between the 1970s and the mid-2000s, due to the large size of the then-identified reserves relative to extraction levels, and the lack of apparent channels for monetizing the remaining resources. Since then, there has been a revival of interest, prompted by regional energy shortages and the potential for export-oriented large-scale coal-fired power stations, and also the possibility of direct coal exports using planned new rail routes. Hence, there has been widespread prospecting and firming up of resource estimates.

A more recent presentation provided the following information on Botswana's coal resources:

Table 10: Coal Reserves (millions of metric tons)

	Measured Reserves	Indicated Reserves	Inferred Resources	Total
Morupule	2,864	2706	15,574	21,144
Mmamabula	494	20,215	5,005	25,714
Eastern		339	17,809	18,148
SE		9,283	132,810	142,093
Total	**3,358**	**32,543**	**171,198**	**207,099**

Source: Paya (2012)

The increased figure for measured and indicated reserves is included in the 2012 adjusted figure in Figure 6 below.

The Coal Roadmap (Wood Mackenzie 2011), commissioned by the GoB, indicated the following potential uses of Botswana's coal:

Table 11: Potential Uses of Botswana's Coal Resources (million metric tons per annum)

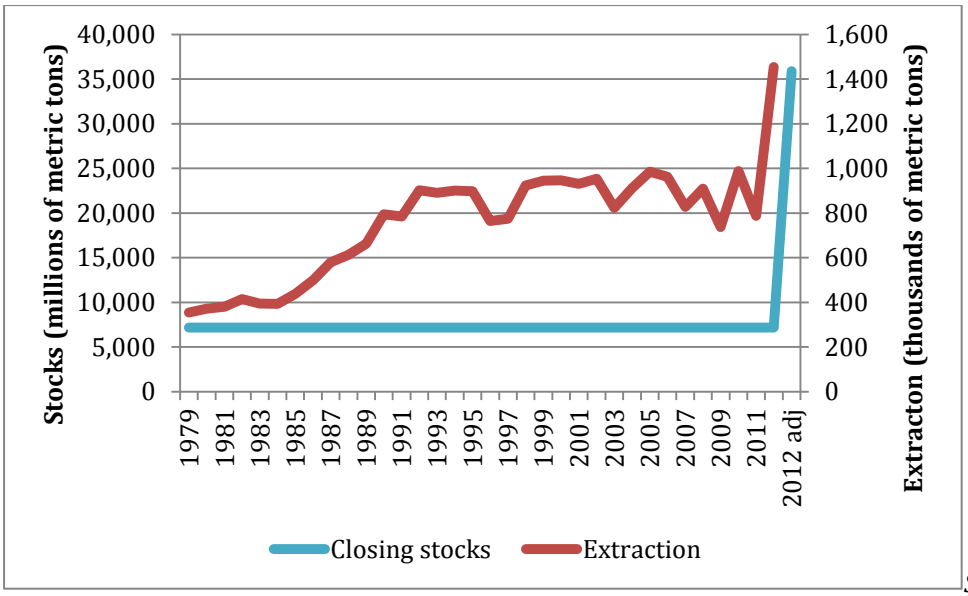
Potential Use	Potential Annual Volume (mtpa)
Coal exports	90
Export power generation	30
Domestic power generation	3.0
Coal-to-liquid	3.5
Cement	0.05

Source: Wood Mackenzie Coal Consulting (2011)

Even if all of these projects came to fruition, total coal reserves (measured and indicated) shown above would be sufficient to supply coal for nearly 300 years,

even before further exploration moves some of the identified deposits from the inferred category to the measured or indicated categories.

Figure 6: Coal Stocks (millions of metric tons) and Production (thousands of metric tons)



Source: author's calculations, based on data from Statistics Botswana and MMEWR

4.2 Resource Rent and Monetary Accounts

Resource rent has been calculated for the three major minerals—diamonds, copper-nickel, and coal—for the period 1994–2012—i.e., the period for which updated and rebased national accounts data are available. The methodology used is as described in Section 3 above and in Appendix 2. The results are shown in Table 12 and Figure 7 below.

One of the uncertainties in resource rent calculations is the level of RoC that should be assumed. Calculations carried out here used both a 10 percent and 20 percent RoC, in line with previous exercises. However, given that all figures are presented in nominal (current price) terms, a RoC of 10 percent equates to a very low real return after taking into account inflation, which averaged 8.6 percent a year during the period 1994–2012, as measured by the GDP deflator. Hence, the main figures below use a 20 percent RoC, although even this would probably be considered too low for a risky mining projects by private investors. The appropriate RoC needs further consideration, and it may be appropriate to use different RoCs for different companies or minerals.[8]

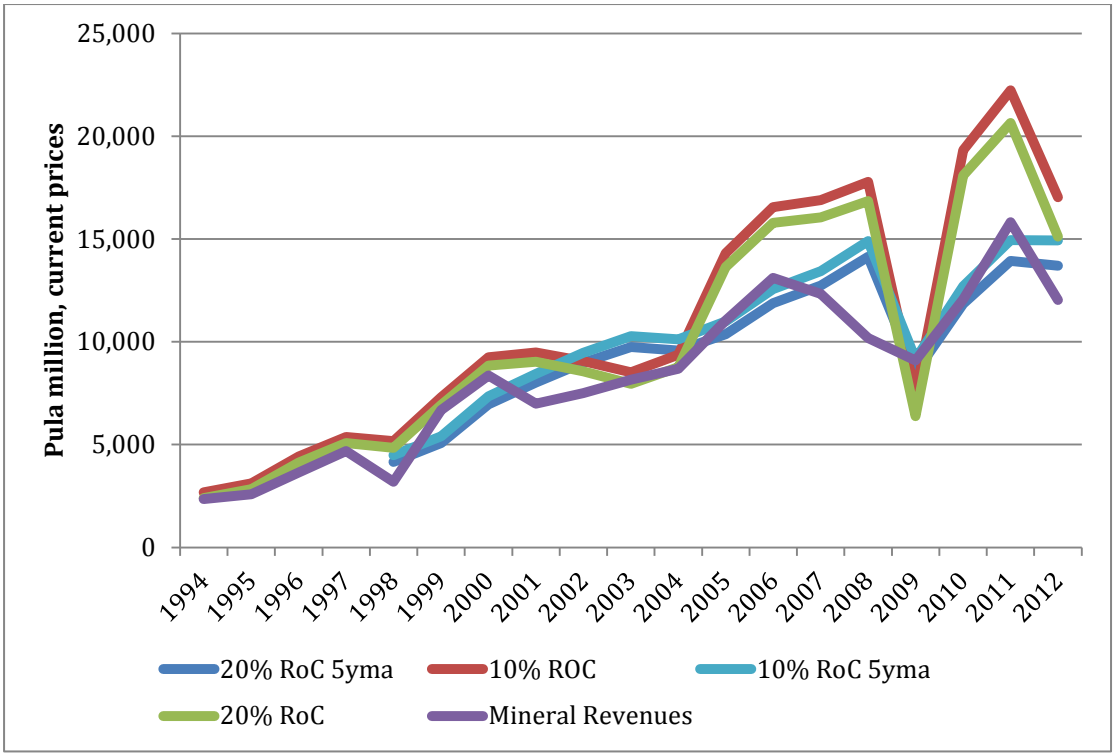
[8] *For example, a coal mine selling to a power station under a long-term contract faces lower risks than a copper mine selling into the global spot market.*

Table 12: Calculation of Total Resource Rent, All Mining Activities, 1994–2012 (Pula million)

	Operating Surplus	Consumption of Capital	Capital Stock	Return on Capital (20%)	Total Resource Rent
1994	3,187	246	2,729	546	2,459
1995	3,660	267	2,851	570	2,894
1996	4,992	277	2,992	598	4,197
1997	5,932	273	2,991	598	5,140
1998	5,787	299	3,335	667	4,915
1999	7,979	333	3,720	744	7,017
2000	10,002	371	4,148	830	8,942
2001	10,327	413	4,627	925	9,149
2002	10,000	461	5,161	1,032	8,699
2003	9,542	514	5,758	1,152	8,107
2004	10,514	572	6,425	1,285	8,928
2005	15,533	638	7,170	1,434	13,822
2006	17,864	712	8,002	1,600	16,009
2007	18,312	794	8,931	1,786	16,299
2008	19,386	885	9,970	1,994	17,129
2009	9,262	916	10,357	2,071	6,701
2010	21,529	1,098	12,337	2,467	18,413
2011	25,150	1,399	15,441	3,088	21,079
2012	20,588	1,773	19,537	3,907	15,381

Source: author's calculations

Figure 7: Total Resource Rent, 10% and 20% Return on Capital



Source: author's calculations

These results support a number of conclusions:

- Annual resource rents have been quite volatile, depending on mineral prices and production volumes—indicating that a 5-year moving average of rents gives a more representative long-term trend;[9]
- The impact of the global financial crisis of 2008–9 was very large, causing a sharp fall in resource rents; and
- There is little difference in the level of resource rents calculated at a 10 percent assumed RoC compared to a 20 percent RoC.

Overall resource rents are dominated by rents received from diamonds—an average of 94 percent of the total. Rents from copper-nickel have been much smaller, but positive in each year. Rents from coal have been consistently negative, although generally small until the last two years, when a large investment program at Morupule sharply increased the level of capital employed.

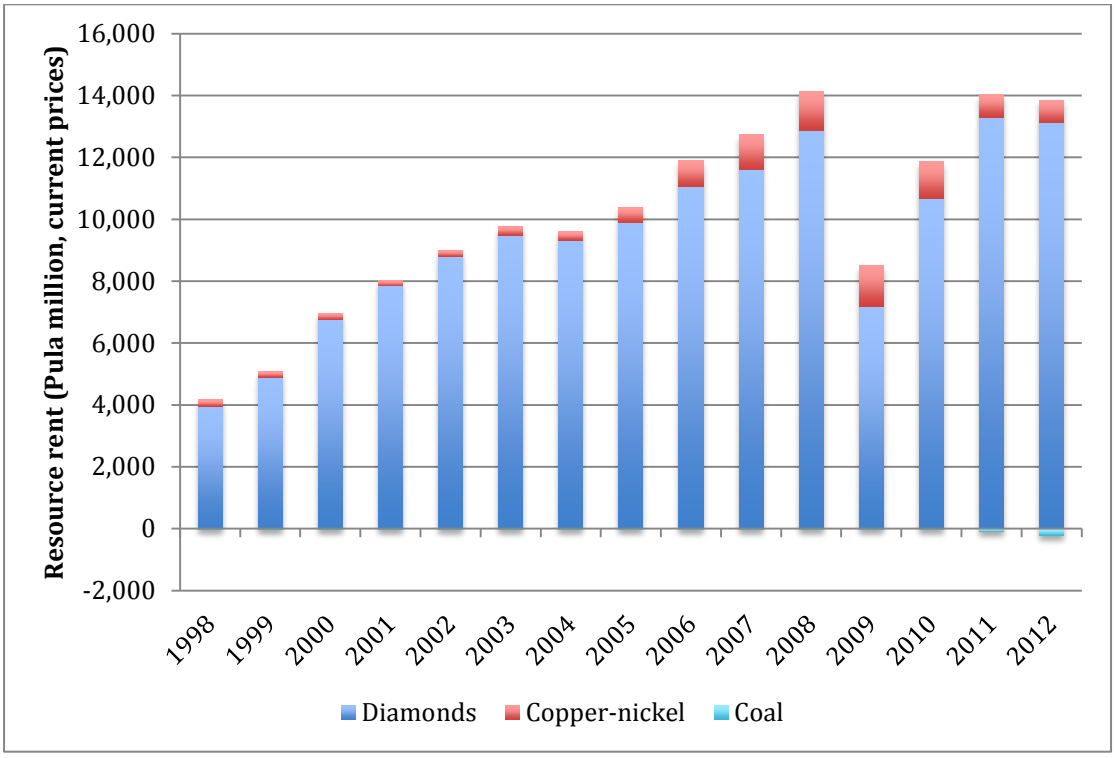
[9] *Most countries valuing subsoil assets use the moving average approach. These calculations use a lagged 5-year moving average (hence no figures are available for the first four years of the series).*

Table 13: Resource Rents from Major Minerals (P million, current prices)

	Diamonds	Copper-nickel	Coal
1994	2,240.9	224.0	(5.7)
1995	2,609.6	291.2	(7.1)
1996	3,850.4	353.2	(6.8)
1997	4,910.4	233.0	(3.8)
1998	4,756.8	163.4	(4.8)
1999	6,738.9	285.2	(6.6)
2000	8,530.8	419.5	(8.0)
2001	8,946.7	211.7	(9.9)
2002	8,378.0	332.2	(11.6)
2003	7,652.2	467.3	(12.6)
2004	8,339.7	599.2	(11.4)
2005	12,577.7	1,253.2	(9.4)
2006	13,757.3	2,260.6	(8.7)
2007	13,789.1	2,510.5	(0.2)
2008	16,251.5	874.9	3.1
2009	5,802.1	907.2	(8.3)
2010	17,303.6	1,124.0	(14.5)
2011	20,164.5	1,336.5	(421.9)
2012	14,151.5	1,530.1	(300.9)

Source: author's calculations

Figure 8: Resource Rent, by Mineral (current prices)

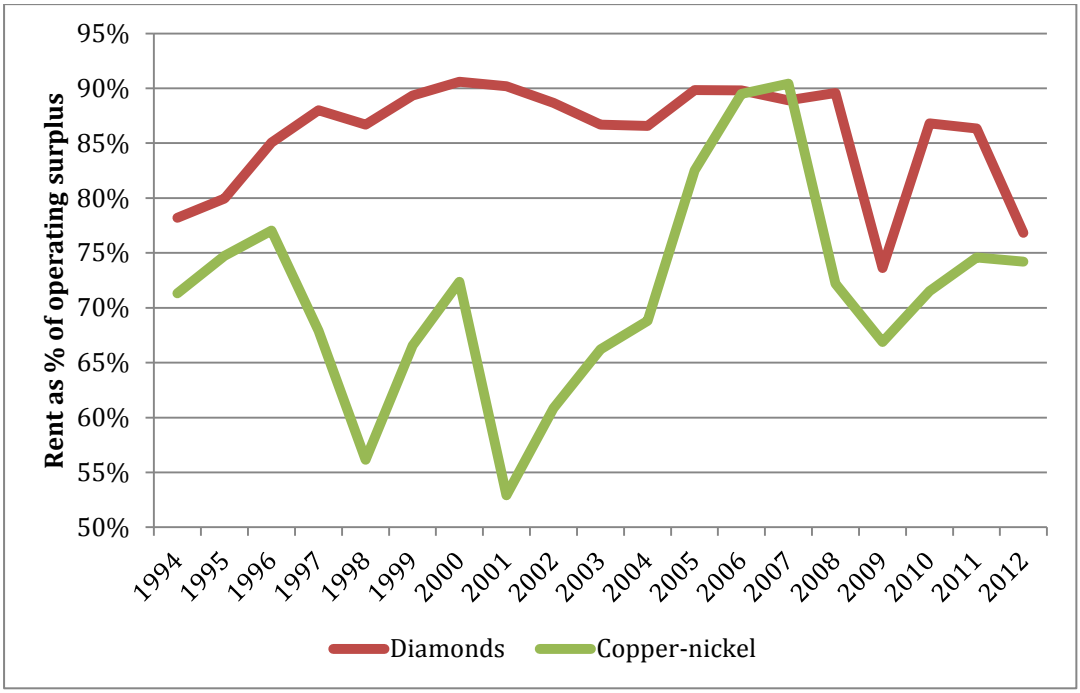


Source: author's calculations

Besides being by far the largest contributor to rents, diamond rents were also much more stable over the period as a whole than those from other minerals, despite the disruption caused by the global financial crisis.

As Figure 9 shows, mineral rents account for a large proportion of the operating surplus for both diamonds and copper-nickel (but not for coal, where the rent is generally negative). This is one reason for the rent calculations generally being insensitive to the rate of RoC used.

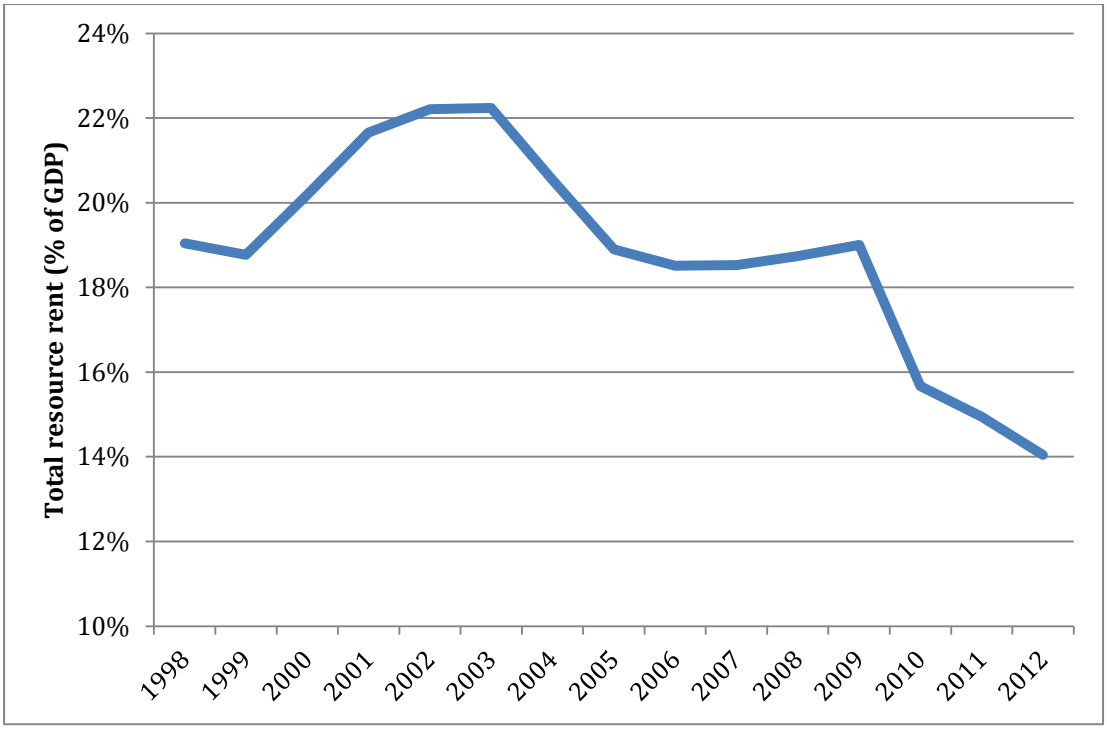
Figure 9: Rents as % of Gross Operating Surplus, by Mineral



Source: author's calculations

Resource rents have been extremely important to the Botswana economy, and contributed on average 20 percent of GDP during the period 1994–2012. However, it is evident that the relative contribution of resource rents has been in decline over the past decade. This is due to the decline in mineral production, particularly diamond production, as a share of GDP, as well as to rising costs of production.

Figure 10: Resource Rent (5-year moving average) as a Percentage of GDP

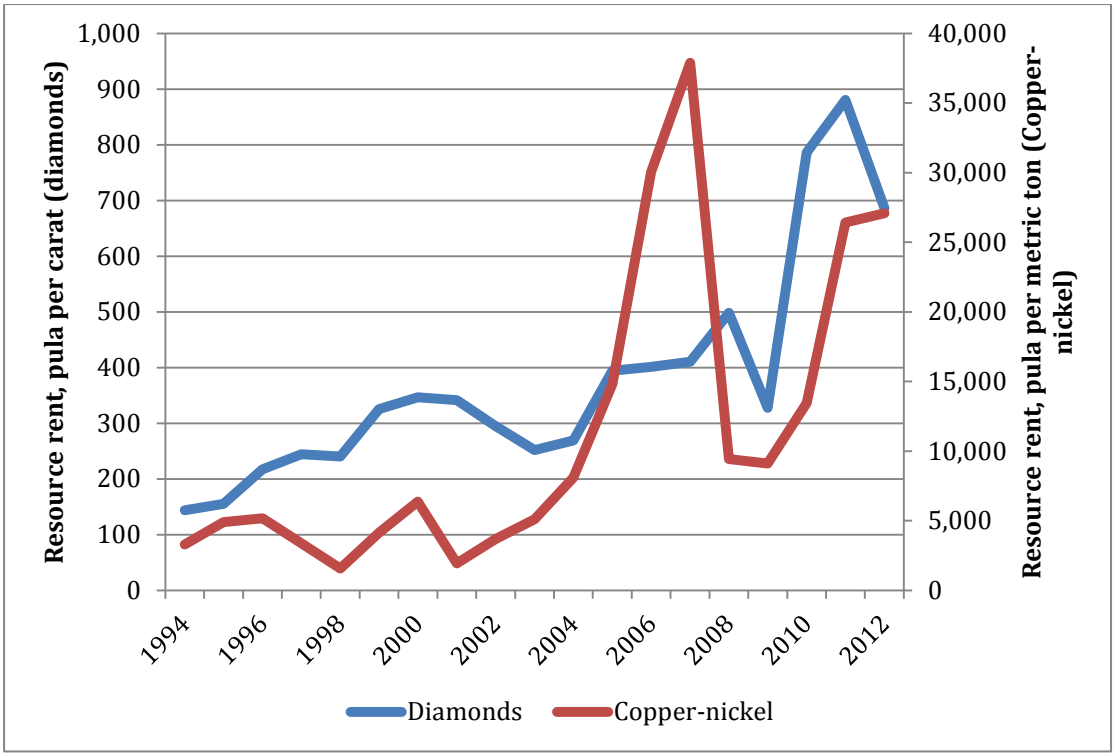


Source: author's calculations

Calculated resource rents per unit of production are shown in Figure 11. While per-unit rents for both diamonds and copper-nickel have been generally increasing, it has been more volatile for copper-nickel, most likely because of the greater price volatility in the base metals market than in the diamond market. Historically, De Beers controlled the majority of the global diamond market and, among other objectives, aimed to keep prices stable and generally increasing, through management of global diamond supplies. In recent years, diamond prices have become more volatile, in part because De Beers' influence over global diamond supplies has fallen as new producers have emerged. It remains to be seen whether price and rent volatility for diamonds becomes more like that for other commodities.

The negative resource rent for coal is of some concern, given that it has been a consistent outcome over the period. While there is some uncertainty over the data used—which has a number of estimates and approximations—this nevertheless suggests that the price at which coal has been sold has not reflected its true economic value (cost). This may have been a deliberate policy to help keep the price of electricity down. It would not be expected that there would be very large economic rent from coal—given the magnitude of Botswana's coal deposits, it is not a scarce resource—but nevertheless, the rent should not be negative.

Figure 11: Resource Rent, per Unit of Production, by Commodity



Source: author's calculations

On the basis of the calculated values for resource rent per unit, and assumptions about the future costs and prices, the pace of future exploitation, and the proportion of saleable reserves, current known reserves can be valued. Assuming that: (1) resource rents stay constant in real terms; (2) known reserves are exploited at the current (constant) rate until exhaustion; (3) 50 percent of known reserves are saleable (see Table 5); (4) there are no new discoveries or additions to reserves; and (5) the applicable discount rate for the purposes of present value calculation is 10 percent, as the calculation is in real terms, the following resource valuations are derived:

Table 14: Present Value of Mineral Reserves, 2012

Mineral	Present Value of Reserves (pula million)
Diamonds	127,343
Copper-nickel	6,872

Source: author's calculations

Coal reserves are valued at zero because of the negative calculated resource rent. However, the coal industry may undergo significant expansion and transformation, which would change the economics of the industry and the resource rent calculations. A rough estimate can be made of the value of coal reserves based on such a future trajectory. Based on estimated reserves of 40 billion metric tons, production of 50 mtpa, and resource rent of 40 pula per

metric ton,[10], the present value of Botswana's coal resource rents would be 20,000 million pula, i.e., substantially more than the copper-nickel deposits, but much less than diamonds. This illustrates the point that the management of a mineral asset is important in determining its value.

We have not attempted to calculate the changing value of mineral reserves over time, because of the lack of reliable information regarding the value of the stock of reserves/resources for years prior to 2012.

4.3 Mineral Wealth and National Wealth

The value of a country's capital assets constitute its national wealth. Various different types of capital can be distinguished: natural capital, produced physical capital, financial capital, and intangible capital (skills and institutions). Intangible capital tends to be very important in developed countries, and indeed is perhaps the main driver of economic growth over a long period of time. A rising supply of produced capital is also important in driving growth. Natural capital is particularly important in mineral-rich countries, and, therefore, a major development challenge for these countries is to convert natural capital (mineral wealth) into physical and intangible capital. Financial capital is important as a means of saving the proceeds of natural capital before converting them to produced and intangible capital, which may occur over a long period of time.

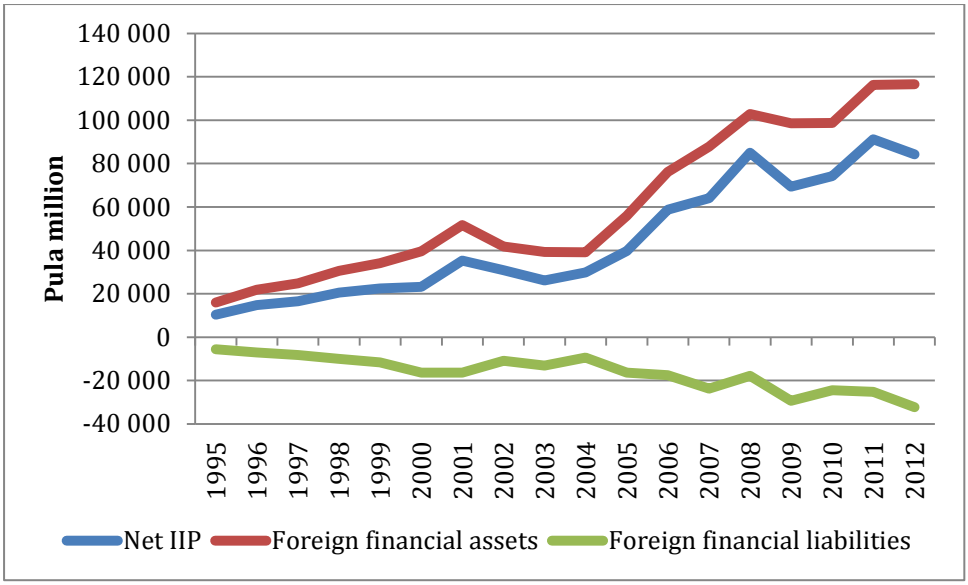
Data on some of these types of capital are poor in Botswana, and indeed in other countries as well. There are no readily available data on intangible capital,[11] nor is there an updated series on the capital stock (produced capital).

Financial capital can be considered as the country's net financial claims on non-residents (the rest of the world). Such data are published as the country's IIP, which has been calculated and published by the BoB since 1995.

[10] *Based on an estimated mine-mouth value of $35 per metric ton, of which $5 is assumed to be resource rent. This may well be an overestimate.*

[11] *An initial attempt to estimate intangible capital across a wide range of countries was contained in World Bank (2011).*

Figure 12: International Investment Position



Source: BoB (Botswana Financial Statistics, Table 6.8)

An estimate of the value of produced capital by the public sector can be derived from government budget figures. The details are discussed further below, but the estimates give a valuation of 120.7 billion pula for public-sector produced capital for 2012.

This gives a total valuation of the various components of Botswana's national wealth as follows:

Table 15: Estimates of National Wealth, 2012

Type of wealth		Value (Pula billion)
Mineral wealth	Diamonds	127.3
	Copper-nickel	6.9
	Coal	n/a
	Other	n/a
Produced capital	Public sector	120.7
	Private sector	n/a
Intangible capital		n/a
Financial capital (IIP)		84.3

Source: author's calculations

5. Mineral Revenues and Development Policies

5.1 Introduction

This chapter reviews the appropriation of resource rents by the government through taxation and related policies, and the use of mineral revenues by the government. As discussed earlier, sustainable development requires that the rents derived from the exploitation of mineral deposits are used for investment

purposes and used to accumulate other forms of capital that can generate future economic activity and incomes while mineral resources are depleted.

The policy framework for the taxation of mineral revenues has been to maximize the economic benefits for the nation, while enabling investors to earn competitive returns, including a reward for risk. The revenue framework has, therefore, been focused on capturing the lion's share of mineral rents. Section 5.2 examines the extent to which this objective has been achieved. Section 5.3 examines the uses to which mineral revenues have been put.

5.2 Appropriation of Resource Rents

In common with many other countries, Botswana uses a variety of mechanisms to appropriate mineral rents. These include:

Royalties. They are laid out in the Mines and Minerals Act (paragraph 66.2), and are levied as follows on the gross market value of production:

Mineral	Royalty Rate
Precious stones (e.g., diamonds)	10%
Precious metals (e.g., gold)	5%
Other minerals (e.g., copper, nickel, coal)	3%

Taxation. Mining companies that hold a mining licence are subjected to a special taxation regime, laid out in the 12th Schedule of the Income Tax Act. In contrast to normal corporate taxation, which is levied at a rate of 22 percent of taxable profits, mining companies are subject to a variable-rate income tax, whereby the rate of tax is determined by the profitability of the mining enterprise. The aim of this approach is to ensure that a portion of any super-normal or windfall profits accrues to the government as tax revenue. Hence, the rate of tax rises with the profitability of the mining company. The specific formula applied is:

$$\text{Annual tax rate} = 70 - (1{,}500/X)$$

where X is the profitability ratio, given by taxable income as a percentage of gross income.

This formula is fixed for all mining operations except diamonds, where the tax arrangements are subject to negotiation between the mining company and the government.

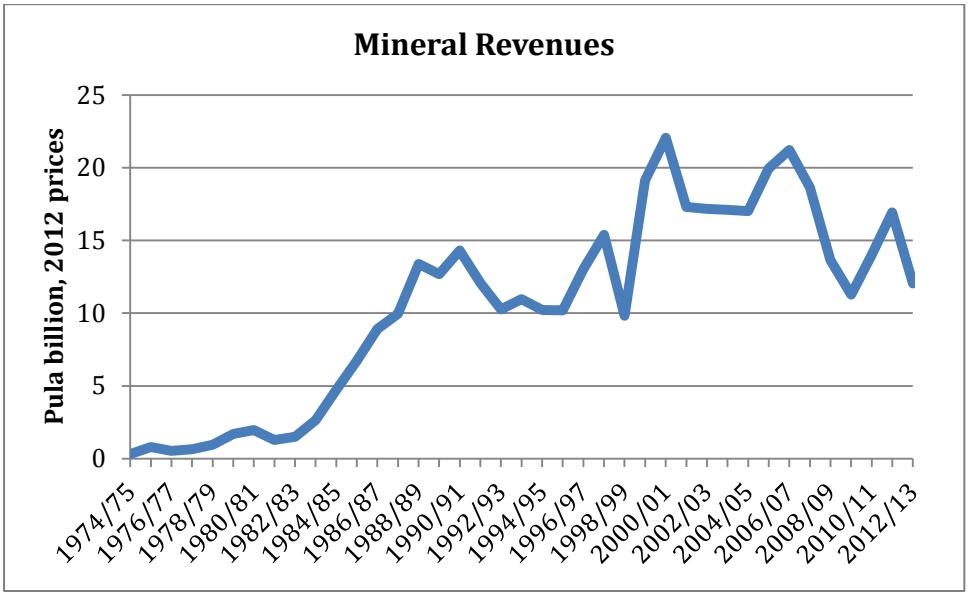
Dividends. Under the Mines and Minerals Act, the government is entitled to acquire a shareholding of up to 15 percent in mining companies at the time that a mining licence is granted. Again, diamond mining is an exception, and the proportionate government shareholding is a matter for negotiation. The government shareholding is paid for, with the government paying the relevant share of expenses incurred up to the stage of granting the mining licence, as well as being liable for a future share of investment costs, in line with its role as a shareholder. As a shareholder, the government is entitled to receive its proportionate share of any dividends declared by profitable mining companies.

The government directly owns shares in four Botswana mining companies: Debswana, BCL, Tati Nickel, and Botswana Ash.[12]

High-level mineral revenue figures are published in the general government accounts. Overall mineral revenues are divided into two portions: tax revenues and non-tax revenues, the latter including dividends and royalties. The government does not publish information on dividends and royalties separately, nor on the revenues received from different companies or different types of minerals.

Mineral revenues have been extremely important as a source of revenues for the government, increasing rapidly from the mid-1970s onwards and peaking in real terms in the early 2000s.

Figure 13: Government of Botswana Mineral Revenues (Pula billion, real, 2012 prices)[13]



Source: author's calculations

At their peak, mineral revenues contributed 60 percent of total government revenues, but they have since declined and account for around 30 percent of the total. As a share of GDP, however, mineral revenues reached their peak as far back as the late 1980s, and have declined from 30 percent then to around 10 percent now.

To illustrate the declining importance of mineral revenues, in the 2012/13 and 2013/14 budgets, mineral revenues are no longer the largest single source of government revenues—this position is held by Southern African Customs Union revenues. Apart from the past two years, minerals have been the largest single revenue source since 1983/4.

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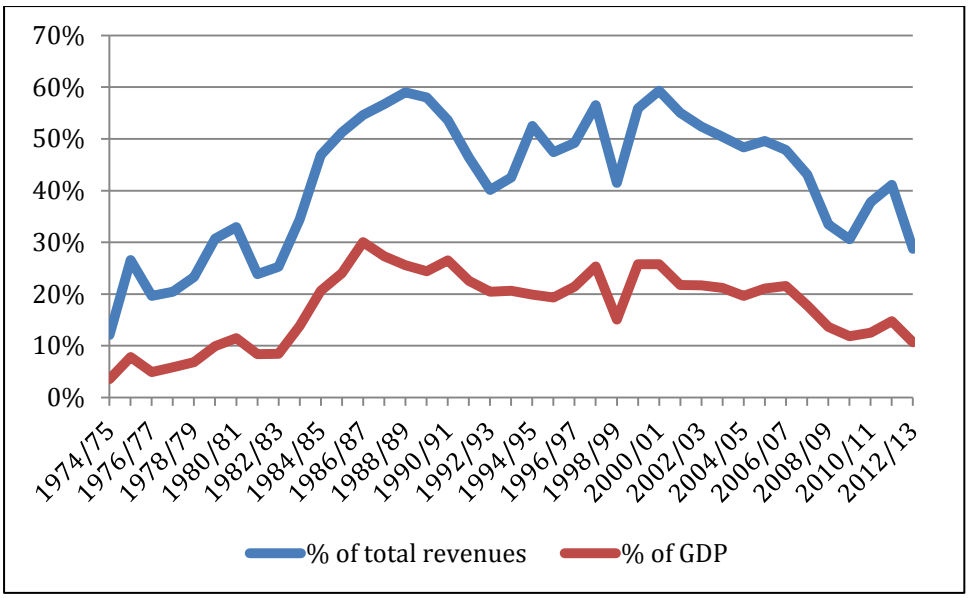
[12] *The GoB also indirectly owns shares in Morupule Colliery, through Debswana. It also owns 15 percent of De Beers (the other 85 percent is owned by Anglo American plc).*

[13] *Deflated using the consumer price index*

Figure 14: Government of Botswana Mineral Revenues as a Share of Total Revenues and GDP



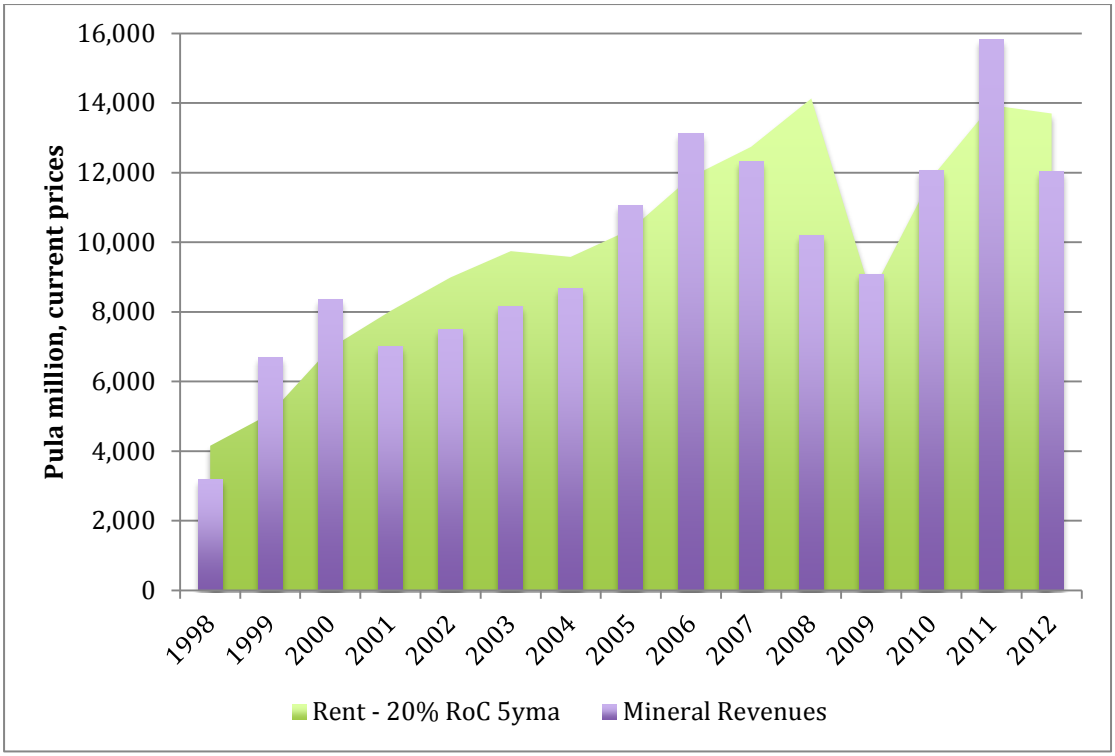
Source: author's calculations

For present purposes, we are interested in the effectiveness of revenue policy in appropriating mineral rents as government revenues. In this assessment, we concentrate on the period 1994–2012, as in the previous chapter.

At a high level, it may be concluded that mineral taxation policy has been quite successful at appropriating rents. Over the period in question, total mineral rents, using the 20 percent RoC definition, were 336.5 billion pula (measured in real terms, at 2012 prices). Total government mineral revenues over the same period were 280.4 billion pula. By this measure, mineral revenues were equal to 83 percent of mineral rents.

On an annual basis, revenues were less than rents in some years and more than rents in others. This is not surprising, given the nature of the taxation formula, which allows capital expenditure to be offset against tax liability in the year in which it is incurred; however, such spending would only be offset against rents over a longer period as the capital investment is consumed.

Figure 15: Mineral Revenues and Rents (current prices)



Source: author's calculations

5.3 Uses of Mineral Revenues

5.3.1 Budget Sustainability

It is generally accepted that for development to be sustainable in a mineral economy, the revenues derived from the exploitation of nonrenewable resources need to be reinvested in other assets that will generate future income when the nonrenewable resource is exhausted. Following Hartwick (1977) and Solow (1974, 1986), the Hartwick Rule (or Hartwick-Solow Rule) offers a rule of thumb for sustainability in mineral economies: a constant level of consumption can be sustained if the value of investment equals the value of rents on extracted resources at each point in time (World Bank 2006). In other words, depletion of natural capital requires a compensating increase in other forms of capital (Lange and Wright 2004).

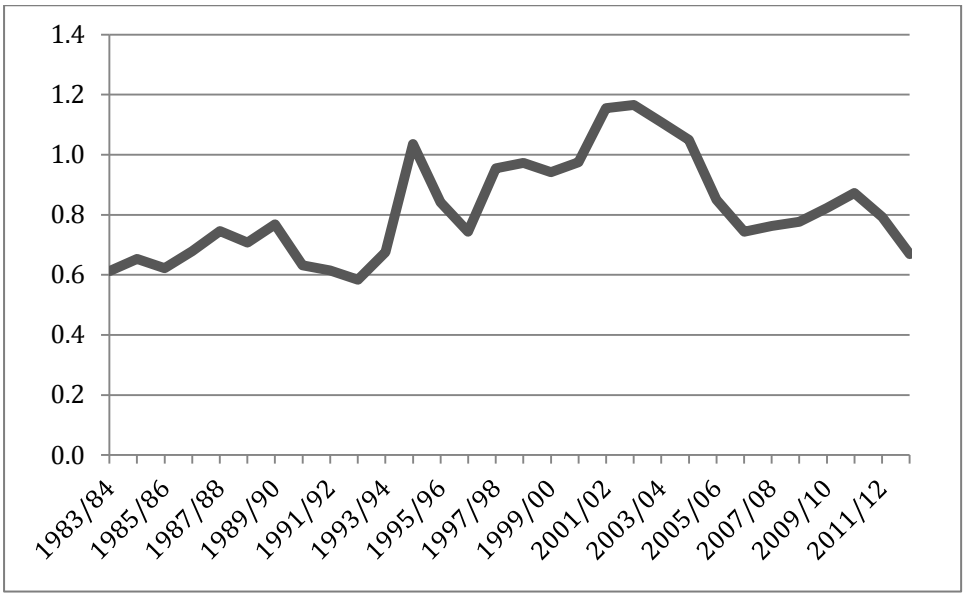
The policy adopted towards mineral revenues in Botswana broadly follows this approach. The public finance policy framework specifies that, broadly speaking, revenues derived from minerals, being derived from the sale of an asset, should be used to finance investment in other assets. The intention is twofold: first, to preserve the country's overall asset base, and second, to provide the basis for the generation of income that can replace mineral income when it eventually declines. The corollary to the asset replacement principle is that recurrent (non-investment) spending must be financed from recurrent (non-mineral) sources.

Mineral revenues are not institutionally segregated, but are paid into the general revenue pool.

The implementation of the asset-preservation principle was historically monitored through the Sustainable Budget Index (SBI), defined as the ratio of non-investment spending to recurrent revenues. An SBI value of more than 1 means that non-investment spending is being financed in part from mineral (non-recurrent) revenues; a value of less than 1 means that mineral revenue is either being saved or spent on public investment, while recurrent spending is being financed from non-mineral (recurrent) sources, which is interpreted as being sustainable. In calculating the SBI, the normal budget classification of expenditure is adjusted slightly so that recurrent spending on education and health is classified as investment in human capital.

For most of the period since 1983/84 (the start of the current data series on public spending), the SBI has been less than 1 and the budget has, therefore, been "sustainable"; however, it remained above 1 between 2001 and 2005, after having been on an upward trend for many years, indicating that part of recurrent spending was being financed by mineral revenues. Since 2006, the SBI has been well below 1, as the share of spending on development and health and education in the budget rose sharply.

Figure 16: Sustainable Budget Index



Source: author's calculations, based on data from the Ministry of Finance and Development Planning (MFDP)

However, the SBI has no statutory basis, nor is it even firmly entrenched in policy—for instance, neither the SBI or the principle underlying it are mentioned in the current National Development Plan 10.

5.3.2 Expenditure: Trends in Public Sector Asset Accumulation

Although the SBI suggests that mineral revenues should be devoted to asset accumulation, i.e., investment, it does not provide any guidance regarding the composition of public investment expenditure, i.e., how public investment should

be divided between different types of assets—human capital, physical capital, and financial assets. Nevertheless, expenditures on the different classes of assets can be traced easily, reflecting ex-post policy priorities as laid out in the National Development Plan and other policy documents.

Total mineral revenues during the period 1983/84 to 2012/13, at 2012 prices, were 402 billion pula. If the SBI constraint had not been observed, these could, in principle, be apportioned between spending on the different types of assets, or on recurrent spending.

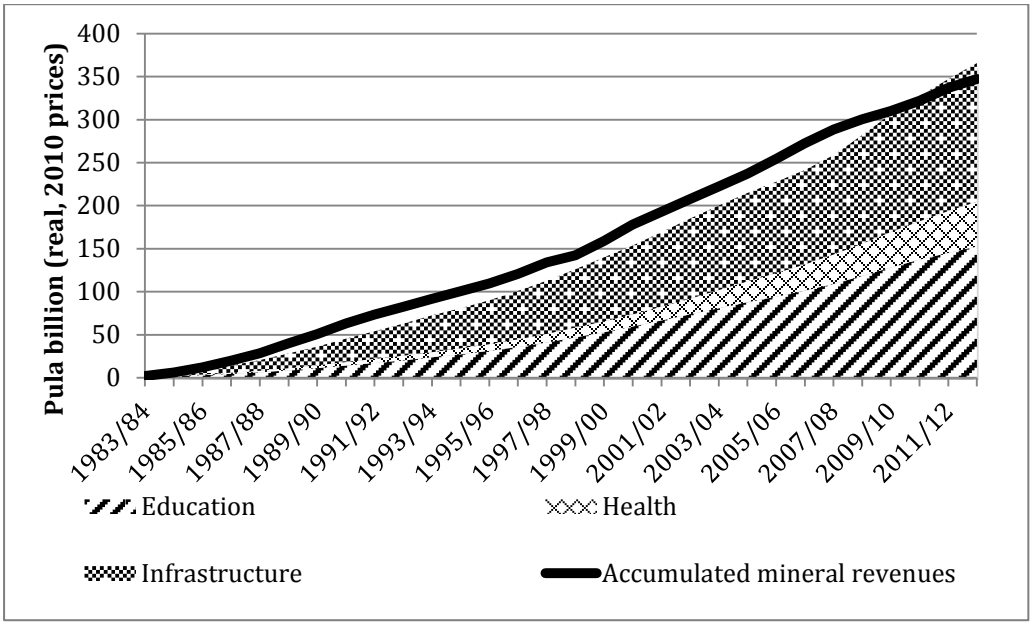
Table 16: Total Revenues and Spending, 1983/84–2012/13 (real, 2012 prices)

Category	**Pula** Billion
Mineral revenues	402.8
Total investment (physical and human capital)	424.3
of which: Education spending	176.9
Health spending	60.8
Other development (investment) spending	186.7
Net financial savings (December 2012, nominal)	20.1
Recurrent revenues, excluding grants and sale of property	440.4
Recurrent spending, excluding health and education	365.2
Recurrent budget balance	75.6

Sources: authors' calculations, based on data from MFDP

The data in Table 16 and Figure 17 show that, during the period as a whole, mineral revenues have been entirely devoted to investment in physical and human capital assets, and have not been used to finance recurrent spending, which has been financed by recurrent revenues over the period as a whole, if not in individual years. Public investment spending has been divided between physical assets (44 percent), education and training (42 percent), and health spending (14 percent).

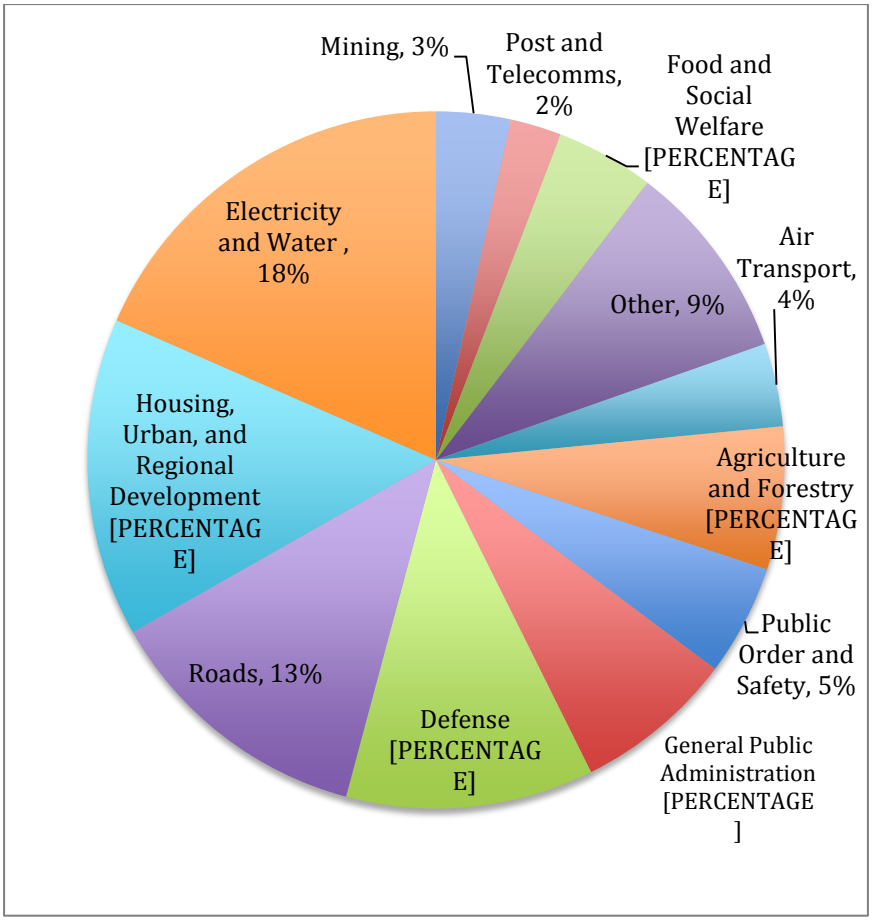
Figure 17: Accumulated Mineral Revenues and Public Investment (real)



Source: author's calculations, based on data from MFDP

Physical investment—excluding health and education facilities—has been across a range of assets, with the three largest areas of investment being electricity and water (18 percent); housing and urban infrastructure (15 percent), and roads (13 percent) (see Figure 18).

Figure 18: Allocation of Development Spending, Excluding Education and Health, 1983/4–2012/13



Source: author's calculations, based on data from MFDP

5.3.3 Investment in Financial Assets

Despite the fact that there has been rapid growth in public spending, during most of the review period, the budget has been in surplus, resulting in the accumulation of financial assets. Public finance decision making has generally been cognizant of the limits imposed by absorptive capacity constraints, and the government has felt under no obligation to spend all mineral revenues when there were concerns about overheating of the economy, or when suitable investment opportunities could not be found. As a result, there were 15 consecutive years of budget surpluses from 1983 to 1997. The situation has changed in recent years, as the earlier public finance discipline has arguably been eroded and as mineral revenues have declined, and as a result there have been budget deficits in eight of the 15 years since 1998/9.

The result of budget surpluses over many years is that initially, significant financial assets were accumulated. It is important to note that these assets are accumulated as a fiscal residual rather than through any process of targeting specific amounts of financial savings. However, as noted below, these assets have been largely depleted.

There are two specific pools of financial assets/savings that are relevant:

1. From a public finance perspective, budget surpluses are accumulated as government savings balances at the BoB, into the Government Investment Account (GIA). The GIA appears on the liabilities side of the central bank's balance sheet.
2. From a macroeconomic perspective, balance of payments surpluses are accumulated as foreign exchange reserves, which are, in turn, divided into a Liquidity Portfolio tranche and the Pula Fund tranche, which appear on the assets side of the BoB balance sheet.

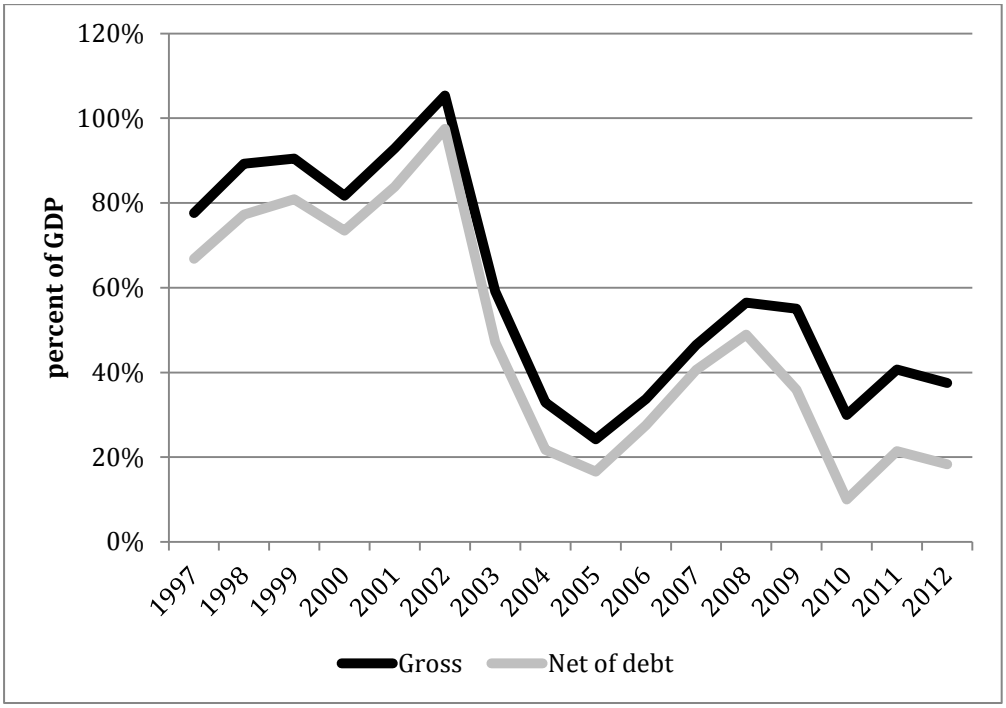
The proceeds of accumulated budget surpluses—the government's gross financial savings—therefore primarily appear in the form of the GIA. Due to the nature of the accounting arrangements between the GoB and the BoB, some of the savings also appear in the form of the BoB's currency revaluation reserves, which also are balance sheet liabilities for the BoB (like the GIA). Furthermore, as the sole shareholder of the BoB, the revaluation reserves are rightly part of the GoB's financial assets. Offset against these financial assets are the government's debt liabilities, including domestic debt (bonds and T-Bills) and foreign borrowing. Therefore, the government's net financial savings position is the balance of its financial savings at the BoB (the GIA plus revaluation reserves) and its domestic and foreign borrowing.[14]

Historically, the government has accumulated significant financial savings and undertaken very little borrowing. As Figure 19 shows, the GoB's net financial savings reached 98 percent of GDP in the early 2000s. The savings then were partially depleted by the decision to establish a new pension fund for government employees, which involved financing the contingent liabilities accumulated under the previous, unfunded government pension plan. Net financial savings were partially rebuilt in the mid-2000s, although only recovering to around 50 percent of GDP in 2008, but then were substantively depleted following the global financial crisis and several years of large budget deficits (which were financed by a mixture of draw-downs of savings and new borrowing). After reaching a low point of 10 percent of GDP in 2010, the GoB's net financial savings have since risen slightly, to reach 18.3 percent of GDP by the end of 2012.

[14] *The figures reported here also include some relatively small additional amounts in calculating the overall net financial position, including lending to parastatals; central and local government deposits in commercial banks; and local government borrowing from banks. It does not include the value of GoB's shareholding in De Beers, Debswana and other mining companies, or parastatals (state-owned enterprises),*

It is striking that during nearly 40 years of mineral exploitation, the government effectively has decided not to accumulate mineral revenues in the form of financial savings to any significant extent; the government's idea is that investment in physical assets and human capital will provide future income, rather than living off income from financial assets. The net financial savings that the government still holds amount to approximately 5 percent of mineral revenues received over the years. While this may not have been an explicit strategy, the net effect of various policy decisions has been to invest almost all of the mineral revenues received in investment in physical and human capital, rather than in financial assets.

Figure 19: Government Financial Savings (% of GDP)



Source: author's calculations, based on data from MFDP and BoB

It is important to note that while the government accumulated financial savings during part of the mineral development period, this was not pursued as an active policy. As noted earlier, financial assets were accumulated as a residual, from the budget surpluses that resulted once spending decisions had been made and implemented. Importantly, there were no rules regarding the payment of any mineral revenues into the GIA, nor any rules regarding withdrawals. As a result, the GIA could be depleted quite quickly, as the experience of recent years has shown.

5.3.4 Outstanding Issues

While there have been many achievements in Botswana's management of mineral revenues and their accumulation as assets, and the country is often used as an example of how newly emerging mineral producing countries should manage their resources, the record, nevertheless, has a few shortcomings.

Although the SBI—and its corollary, the maintenance of assets—is a convenient rule of thumb, it is questionable whether a budget meeting the SBI is sustainable, for a variety of reasons.

First, investing in public assets is not, in itself, sufficient to ensure that the investment is productive and will generate future income once minerals are depleted. Some categories of investment spending are clearly economically unproductive (such as defense spending), and others are more appropriately considered to be maintenance of human capital (such as large portions of health expenditure and spending on welfare programs) that may be justified for social reasons, but do not add to the stock of capital in economic terms—any more than the maintenance of roads, while essential, can be considered to be net investment.

Concerns have been expressed regarding the productivity and economic impact of many public investment projects. For compliance with the SBI rule to be effective in meeting its objectives, it needs to be supplemented with effective project appraisal analysis, appropriate project selection and prioritization systems, and effective monitoring and evaluation. While these skills and processes may have been in place in earlier years, it is widely agreed that these disciplines have dissipated over the years—in part because it is extremely difficult to maintain such discipline in an environment of prolonged fiscal surpluses and a "soft" budget constraint. As the World Bank's Botswana Public Expenditure Review Public Expenditure Review noted:[15]

> Botswana has in the past been seen as a best-practice leader in terms of its programming of public investment, but discipline appears to have been lost gradually over time. The historic abundance of resources appears to have weakened the attention paid to cost-benefit analysis of projects. This is apparent in the emergence over the years of project delays and increasing costs. Problems that should be identified at the screening and appraisal stages of projects are not. Deterioration in project performance has ensued. With poor *ex ante* scrutiny of economic benefits, *ex post* returns from public investment have fallen, even if this has not been accurately measured. Poor planning, including poor financial management and procurement planning, is evidenced by constant delays in project implementation. Close to 50 percent of all projects suffer implementation delays in one form or another (p. xiii).

Furthermore, while in the earlier years of mineral-financed spending, economic and social needs largely coincided, in the later years, many of the most important economic investment needs have been met and spending has been increasingly driven by social and political needs, often with minimal economic benefits.

The above concern relates largely to investment in physical assets, but there are similar concerns regarding the quality of much of the investment in human capital through education and training. Despite a very high level of investment in

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[15] *World Bank (2010)*

human capital, widespread skills shortages persist in the private sector, and unemployment is high among educated young adults.

A second concern with the SBI is that it considers investment in the aggregate—whether in physical, financial, or human capital—but does not provide any useful guidance as to the distribution of public investment and assets across these different types of capital. In particular, it does not have any way of ensuring that public investment will be effective at generating future income when minerals are depleted, and therefore contrasts with alternative approaches that focus on the accumulation of sufficient financial assets (for instance, in a sovereign wealth fund) that would be capable of yielding an annuity income to replace mineral income[16].

Third, the SBI does not address the fact that, due to the very high economic rents generated from diamond mining and the very high share of these rents accruing to the government, the level of fiscal revenues and spending in Botswana relative to GDP has been very high, leading to a very large government sector in the economy. Once diamonds are depleted, even if economic diversification is successful and new sources of growth are found, fiscal revenues will inevitably decline as a share of GDP and it will be necessary for the government to shrink in relative terms. From this perspective, simply adhering to the SBI does not mean that the government is of a sustainable size.

A fourth concern relates to the conceptual underpinning of the SBI. While the Hartwick Rule (reinvest all mineral revenues in other productive assets) is a useful rule of thumb, it is not necessarily optimal for developing countries. The analysis in Collier, van der Ploeg, and Venables (2008) and Collier (2012) shows that an optimal savings/investment path involves devoting some portion of resource revenues to consumption, especially in the early years of the exploitation of a mineral resource, and that savings/investment should asymptotically approach 100 percent of resource revenues as the resource nears depletion. While it is beyond the scope of this paper to go into the details of the different approaches, it is important to note that the Hartwick Rule principle of investing all resource rents may not be optimal.

Taking into account some of these concerns, we have recalculated the allocation of spending of mineral revenues over the period 1983/4–2012/13, making the following adjustments to the definition of investment:

- excluding recurrent health spending
- excluding development spending on defense and food and social welfare

[16] *Of course financial assets can also be badly invested, mismanaged or misappropriated, so a return is not guaranteed.*

Table 17: Total Revenues and Spending, 1983/84–2012/13 (real, 2012 prices)

Category	Pula Billion	% of Mineral Revenues
Mineral revenues	402.8	100%
Total investment (physical and human capital)	353.1	88%
Of which: Education spending	176.9	44%
Other development (investment) spending	176.3	44%
Net financial savings (December 2012, nominal)	20.1	5%

These figures show that, even with the adjustments made, 93 percent of Botswana's mineral revenues have been devoted to asset accumulation. Of this, only 5 percent has been devoted to financial assets, with the remaining 88 percent split almost equally between physical infrastructure and human capital (skills and education).

6. Summary and Conclusions

The above discussion leads to the following conclusions:

- Mineral (resource) rents have made a major contribution to Botswana's economic growth; however, rents are declining in real terms and in relation to GDP.
- The vast majority of resource rents have been derived from diamond mining, with a small contribution from copper-nickel mining; the resource rent from coal has been negative, which suggests that it has been underpriced relative to its economic cost.
- The declining contribution of resource rents to GDP means that new sources of growth will be needed, emphasising the importance of diversification.
- Mining taxation policy has focused on appropriating resource rents and has been generally successful at doing so. During the period 1994–2012, 83 percent of calculated rents received by the GoB have been mineral revenues.
- Public finance policy has aimed to convert mineral revenues into other assets—including produced (physical) capital, human capital, and financial assets—and not to use mineral revenues to finance recurrent spending; this objective has largely been achieved, with recurrent spending financed from recurrent revenues and mineral revenues used to accumulate other assets.
- Public sector asset accumulation has largely resulted from investment in physical capital and human capital. Accumulation of net financial assets by the GoB has been limited, with only 5 percent of mineral revenues used to accumulate net financial assets.
- There are concerns about the quality of some public sector investment decisions, and whether the resulting assets—in terms of both human capital

and physical capital—will generate sufficient future income to replace income from mineral assets.

- Official data is not sufficient to calculate resource rent and to value mineral assets reliably and regularly. Many aspects of the calculations are dependent on data sources that are only available intermittently and from non-official sources.

The Way Forward

- A key requirement is to improve the availability of official data that will enable calculations of resource rent and mineral wealth to be carried out more frequently and reliably. This requires the following:
    - For Statistics Botswana
        - Providing data on GOS on an annual basis, for individual minerals;
        - Providing data on capital stock, at the levels of the economy as a whole, the main economic sectors, and mining subsectors for individual minerals;
        - Providing data on gold production as a separate mining activity, rather than being included in "other mining" as it is now; and
        - Providing data on downstream activities—particularly diamond processing—by separating out diamond cutting and polishing and diamond sorting, valuation, and marketing/trading as separate subindustries in the national accounts (within the manufacturing and business services sectors, respectively).
    - For MMEWR
        - Providing data on mineral reserves, new discoveries, and other changes, on an annual basis;
        - Providing more detailed data on extraction, e.g., losses during production, as well as final output; and
        - If necessary, revising the returns submitted by mining companies to obtain the data required.
- Appropriate discount rates and RoC must be considered:
    - This report and the previous exercise (Department of Environmental Affairs and Centre for Applied Research 2007) used 10 percent and 20 percent rates for RoC in the calculation of resource rents. Further consideration is required of appropriate rates to reflect the cost of capital, including reward for risk, which it may be appropriate to vary across companies/minerals; and
    - Similarly, further consideration is needed of the appropriate discount rate to use in the calculation of present value of mineral stocks.

- The public finance investment framework needs further refinement to consider the following:
    - The appropriate balance of investment of mineral revenues between broad categories (physical assets, human capital, and financial assets); and
    - An effective framework for ensuring that public sector investment is focused on high-return projects that will generate future income when mineral deposits are depleted, through appropriate project appraisal, selection, and monitoring.
- The following must happen with national accounts:
    - Establish the framework for regular annual production of mineral accounts by Statistics Botswana and MMEWR, including valuation of mineral resources;
    - Combine the mineral accounts with regular calculations of the value of produced assets;
    - Develop the capacity to produce valuation of intangible assets/human capital;
    - Use as the basis for producing national balance sheets; and
    - Start producing estimates of genuine net savings.

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Appendix 1—Mining Sector Tables

Table 18: Mineral Sector Output (pula million)

Year	Diamonds	Copper	Coal	Soda Ash	Other Mining [1]	Adjustment	Total Mining [2]	Total GDP	Mining %
1994	2,651.9	484.2	14.9	113.6	41.3	73.5	3,369.7	11,434.6	29%
1995	3,047.8	600.6	13.6	168.8	68.4	85.9	3,975.1	13,114.2	30%
1996	4,255.7	706.6	13.7	87.3	36.7	86.4	5,175.6	16,114.9	32%
1997	5,120.1	529.0	17.6	92.3	52.9	118.0	5,923.3	18,327.8	32%
1998	5,193.5	448.7	17.9	111.2	51.9	120.9	5,932.2	20,244.0	29%
1999	6,980.3	660.6	17.0	131.1	74.7	143.0	7,986.7	25,361.4	31%
2000	8,803.3	893.4	17.0	133.5	70.6	152.2	10,024.1	29,530.9	34%
2001	9,354.1	616.8	16.4	167.5	113.9	177.2	10,418.2	32,065.9	32%
2002	8,722.9	841.3	16.4	184.3	182.7	193.2	10,090.3	34,416.0	29%
2003	8,145.6	1,087.6	18.1	146.8	157.4	194.0	9,725.8	37,181.6	26%
2004	8,867.7	1,342.5	24.3	167.9	202.1	214.4	10,801.5	42,036.5	26%
2005	13,116.6	2,341.0	32.1	225.3	188.7	219.7	16,105.1	50,752.1	32%
2006	14,243.3	3,893.6	38.2	277.7	371.1	220.5	19,019.0	59,106.9	32%
2007	14,373.1	4,280.0	59.1	341.9	319.2	237.2	19,567.7	67,152.7	29%
2008	17,079.9	1,868.1	70.8	348.9	330.1	279.0	19,789.8	75,867.1	26%
2009	7,004.1	2,090.3	55.4	367.4	430.5	313.9	10,063.2	72,315.8	14%
2010	19,201.7	2,422.0	50.2	338.9	624.3	353.2	22,868.2	93,390.0	24%
2011	21,773.6	2,762.2	11.1	387.6	686.8	397.3	25,840.9	104,573.2	25%
2012	17,118.7	3,177.9	236.8	480.4	597.5	524.1	22,048.8	110,510.6	20%

Notes: *[1] includes gold, industrial minerals; [2] total includes informal sector, which is not included in subsector totals*
Source: *Statistics Botswana*

Table 19: Mineral Exports (pula million)

Year	Diamonds	Copper-Nickel	Soda Ash	Gold	Rough Diamonds	Total Mining	Total Exports	Mining %
1994	3,718	259	37		3,727	4,013	4,965	80.8%
1995	3,984	328	22		3,994	4,334	5,941	72.9%
1996	5,722	445	69		5,272	6,236	8,133	76.7%
1997	7,670	481	110		7,675	8,260	10,391	79.5%
1998	6,040	436	98		6,061	6,575	8,697	75.6%
1999	9,706	558	107		9,813	10,371	12,228	84.8%
2000	11,384	830	98		11,398	12,312	14,260	86.3%
2001	12,086	597	128		11,259	12,811	14,658	87.4%
2002	13,223	710	79		12,474	14,013	16,109	87.0%
2003	10,681	1,337	84		11,707	12,103	13,910	87.0%
2004	12,435	1,578	107		12,964	14,119	16,490	85.6%
2005	16,864	2,315	198	130	16,692	19,507	22,507	86.7%
2006	19,432	3,957	182	212	19,313	23,783	26,436	90.0%
2007	20,043	6,771	151	305	19,967	27,270	31,563	86.4%
2008	20,793	5,924	221	387	20,859	27,325	32,301	84.6%
2009	15,234	3,620	312	532	12,959	19,698	24,318	81.0%
2010	21,780	4,231	624	535	18,846	27,170	32,040	84.8%
2011	30,248	2,940	461	546	28,851	34,195	40,077	85.3%
2012	36,143	3,312	452	642	23,237	40,548	45,566	89.0%

Sources: Statistics Botswana, except data on rough diamonds, which are from Bank of Botswana

Table 20: Mineral Rent Calculations, Diamonds (pula million)

	Operating Surplus	Consumption of Capital	Capital Stock	Return on Capital (20%)	Total Rent	Total Rent (5-year moving average)	Rent/Operating Surplus	Rent per Unit (pula per carat)
1994	2,865.6	199.3	2,126.6	425.3	2,240.9		78%	144.1
1995	3,264.3	214.7	2,200.1	440.0	2,609.6		80%	155.3
1996	4,527.6	221.5	2,278.3	455.7	3,850.4		85%	217.5
1997	5,580.5	216.2	2,269.2	453.8	4,910.4		88%	244.2
1998	5,487.9	232.1	2,495.2	499.0	4,756.8	3,673.6	87%	240.6
1999	7,542.8	255.2	2,743.8	548.8	6,738.9	4,573.2	89%	325.5
2000	9,414.8	280.6	3,017.0	603.4	8,530.8	5,757.5	91%	346.8
2001	9,918.8	308.5	3,317.6	663.5	8,946.7	6,776.7	90%	341.5
2002	9,446.8	339.3	3,648.0	729.6	8,378.0	7,470.2	89%	295.0
2003	8,827.6	373.1	4,011.3	802.3	7,652.2	8,049.3	87%	251.7
2004	9,632.1	410.2	4,410.9	882.2	8,339.7	8,369.5	87%	269.0
2005	13,998.8	451.1	4,850.2	970.0	12,577.7	9,178.9	90%	394.3
2006	15,320.0	496.0	5,333.3	1,066.7	13,757.3	10,141.0	90%	401.1
2007	15,507.4	545.4	5,864.6	1,172.9	13,789.1	11,223.2	89%	410.4
2008	18,141.0	599.7	6,448.7	1,289.7	16,251.5	12,943.1	90%	498.5
2009	7,879.8	659.5	7,091.0	1,418.2	5,802.1	12,435.6	74%	327.8
2010	19,934.2	835.0	8,978.0	1,795.6	17,303.6	13,380.7	87%	786.5
2011	23,352.3	1,011.8	10,879.9	2,176.0	20,164.5	14,662.2	86%	880.5
2012	18,415.4	1,353.4	14,552.3	2,910.5	14,151.5	14,734.7	77%	686.3

Source: author's calculations

Table 21: Mineral Rent Calculations, Copper-Nickel (pula million)

Year	Operating Surplus	Consumption of Capital	Capital Stock	Return on Capital (20%)	Total Rent	Total Rent (5-year moving average)	Rent/ Operating Surplus	Rent per Unit (pula per metric ton)
1994	322.1	42.6	555.0	111.0	224.0		70%	3,302.5
1995	398.9	47.3	604.2	120.8	291.2		73%	4,907.5
1996	470.8	50.9	667.1	133.4	353.2		75%	5,172.5
1997	353.5	52.6	678.7	135.7	233.0		66%	3,386.5
1998	300.3	59.8	771.1	154.2	163.4	187.5	54%	1,573.4
1999	440.7	67.9	876.1	175.2	285.2	193.3	65%	4,152.5
2000	596.2	77.1	995.5	199.1	419.5	211.1	70%	6,365.8
2001	412.5	87.7	1,131.0	226.2	211.7	173.5	51%	1,944.3
2002	560.3	99.6	1,285.1	257.0	332.2	181.2	59%	3,675.7
2003	726.4	113.2	1,460.1	292.0	467.3	228.2	64%	5,102.4
2004	893.7	128.6	1,658.9	331.8	599.2	275.4	67%	8,101.5
2005	1,587.8	146.1	1,884.8	377.0	1,253.2	424.3	79%	14,816.4
2006	2,640.8	166.0	2,141.5	428.3	2,260.6	813.9	86%	30,062.0
2007	2,942.4	188.6	2,433.2	486.6	2,510.5	1,226.6	85%	37,892.4
2008	1,365.6	214.3	2,764.6	552.9	874.9	1,282.0	64%	9,431.9
2009	1,464.7	243.4	3,141.1	628.2	907.2	1,314.0	62%	9,114.0
2010	1,695.9	249.7	3,222.2	644.4	1,124.0	1,261.4	66%	13,463.3
2011	1,894.0	243.4	3,141.1	628.2	1,336.5	1,056.6	71%	26,410.5
2012	2,163.6	276.6	3,568.8	713.8	1,530.1	837.8	71%	27,084.5

Source: author's calculations

Table 22: Mineral Rent Calculations, Coal (pula million)

Year	Operating Surplus	Consumption of Capital	Capital Stock	Return on Capital (20%)	Total Rent	Total Rent (5-year moving average)	Rent/ Operating Surplus	Rent per Unit (pula per metric ton)
1994	7.9	4.1	47.7	9.5	-5.7		-72%	-6.4
1995	7.2	4.9	47.1	9.4	-7.1		-99%	-7.9
1996	7.3	4.8	46.5	9.3	-6.8		-94%	-8.9
1997	9.3	4.4	43.5	8.7	-3.8		-40%	-4.8
1998	9.5	4.8	47.5	9.5	-4.8	-5.7	-51%	-5.2
1999	9.0	5.2	51.9	10.4	-6.6	-5.8	-73%	-7.0
2000	9.0	5.7	56.6	11.3	-8.0	-6.0	-89%	-8.5
2001	8.7	6.3	61.8	12.4	-9.9	-6.6	-114%	-10.6
2002	8.7	6.8	67.5	13.5	-11.6	-8.2	-134%	-12.2
2003	9.6	7.5	73.7	14.7	-12.6	-9.8	-131%	-15.3
2004	12.9	8.1	80.5	16.1	-11.4	-10.7	-88%	-12.5
2005	17.0	8.9	87.9	17.6	-9.4	-11.0	-55%	-9.6
2006	20.2	9.7	96.0	19.2	-8.7	-10.7	-43%	-9.0
2007	31.3	10.6	104.8	21.0	-0.2	-8.5	-1%	-0.3
2008	37.5	11.6	114.5	22.9	3.1	-5.3	8%	3.4
2009	29.4	12.6	125.0	25.0	-8.3	-4.7	-28%	-11.2
2010	26.6	13.8	136.5	27.3	-14.5	-5.7	-54%	-14.7
2011	5.9	143.7	1,420.5	284.1	-421.9	-88.4	-7184%	-535.7
2012	125.5	143.2	1,416.1	283.2	-300.9	-148.5	-240%	-206.9

Source: author's calculations

Appendix 2—Mineral Rent Calculations

Introduction

Mineral or resource rent can be defined as the value of production minus the costs of production, or equivalently, as the share of the GOS not attributable to the fixed assets used in production. It can be calculated as follows:

Income from sale of resource = value of output

minus	intermediate consumption
equals	**gross value added**
minus	compensation of employees
minus	net taxes on production
equals	**gross operating surplus**
minus	consumption of fixed capital
equals	**net operating surplus**
minus	normal return to capital
equals	**net resource rent**

Cost of Capital

This calculation requires an assumption about the normal return to capital, or the opportunity cost of capital. The idea of opportunity cost in this instance is that an investor always has at least several alternative investment opportunities. To convince the investor to put their money in any one business, the profit on the investment must be at least as great as the average, or "normal," opportunity for profit from other economic activities that they could invest in, adjusted for the degree of risk relative to other economic activities.

Choosing an appropriate "normal" rate of return to use in the calculation is difficult. Possible reference points are the average RoC in an economy, or the average cost of borrowing, i.e., the long-term bond rate. The main problem with this is that any average will not reflect the level of risk involved in mining investments, which is an important omission because mining is an inherently risky activity. The reference cost of capital also has to appropriately take into account inflation and currency/exchange rate issues. The cost of capital also depends on the nature of the company, with a large mining multinational facing a lower cost of capital than a small, junior explorer.

For AA (a large mining multinational), the cost of capital is said to be 15 percent, presumably measured in U.S. dollars.[17] Junior mining companies presumably would expect the cost of capital to be higher.

For Botswana mineral rent calculations, we use a RoC of 20 percent (for accounts measured in current price pula terms). With an average 5 percent annual depreciation of the pula against the U.S. dollar, this would be broadly comparable to AA's cost of capital.

Source Data and Adjusting for Royalties

Some of the issues relating to source data are presented in Table 5's treatment of royalty payments.

As noted in Section 5 of this report, there are various components to the mineral revenues paid by mining companies to the government. One of these, the mineral royalty, is paid at a specified rate as a percentage of gross revenues (with the rate varying across minerals). In the national accounts, this royalty is treated as "rent that accrues to owners of the assets in return for putting them at the disposal of other institutional units for specified periods of time" (United Nations Statistics Division, 2009, paragraph 7.160). As such, this royalty is part of the cost of production and is included in intermediate consumption. Statistics Botswana follows this approach in the calculation of the mining sector's value added and GOS.

However, from a public finance perspective, this royalty is regarded as simply part of the overall collection of tax and non-tax revenues from the mining sector. Particularly in the case of Debswana, the overall division of revenues between the shareholders is determined in terms of an overall formula (X percent to GoB and 100-X percent to De Beers). The division of the GoB's share of these revenues into royalties, profits tax, withholding tax, and dividends is somewhat arbitrary, and revenues could be shifted between categories without affecting the overall distribution.

Hence, for calculating the mineral rent, the royalty needs to be added back to the value of the mining sector's GOS (i.e., its inclusion in intermediate consumption needs to be reversed). As figures for royalties are not published, they have to be estimated—although with the royalty rates known, and for most minerals the value of gross output also known (equal to exports), this is straightforward.

However, this raises an interesting question regarding the calculation of GDP. If royalties are deducted as part of intermediate consumption, representing payments from one institutional unit (a mining company) to another (the government), in return for a service rendered (the rights to exploit a mineral resource), it should be recorded as part of the income of the government sector and hence form part of overall GDP. It is not clear if this is done in Botswana. If it

[17] *Anglo American plc Chief Executive Mark Cutifani was quoted in MiningNews.net on December 13, 2013, as saying, "Fifteen per cent RoC is a break-even number."*

is not, then GDP may be under-measured by the amount of mineral royalties—which would amount to around 2 percent of GDP.


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