Towards mineral accounts for Botswana

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Acronyms

CAR	Centre for Applied Research
Crt	Carat
CSO	Central Statistics Office Botswana
CSO	Central Selling Organisation de Beers
DEA	Department of Environmental Affairs
DDP	District Development Plan
DoM	Department of Mines
DTC	Diamond Trading Company
ER	Economic Rent
GoB	Government of Botswana
MFDP	Ministry of Finance and Development Planning
MoA	Ministry of Agriculture
MRS	Mineral ReSource
MRV	Mineral ReserVe
NA	National Accounts
NCSA	National Conservation Strategy Coordinating Agency
NDP	National Development Plan
NGSI	Net Genuine Savings Index
NRA	Natural Resource Accounting
OS	Operating Surplus (gross and net)
P	Pula
SBI	Sustainable Budget Index
UDP	Urban Development Plan

Acknowledgements
This report is based on recent work on mineral accounts (mostly up-dating) and earlier work done by the then National Conservation Strategy Coordinating Agency, assisted by Dr. Glenn Marie Lange, who is currently based at Columbia University, USA. The team that worked on the 2000 draft mineral accounts also comprised Ms. Mokgadi Monamati, Mr. Edward Karkari (both then at the NCSA) and Jaap Arntzen (CAR).

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Executive summary

Botswana's economy relies heavily on minerals, which account for the period 1980-2005 for on average 37.7% of GDP, 82.5% of exports and 4.5 % of formal employment. Although mining is a critical sector of the economy and mineral assets a major source of Botswana's wealth, the value of this wealth is not included in the asset accounts of the national economic accounts. Consequently, the economic accounts provide a distorted picture of Botswana's economic health because they report the contribution of mining to GDP and income, but not the simultaneous loss of mineral wealth.

Natural Resource Accounts (NRA) correct this omission by estimating the economic value of the mineral assets and the cost of depleting minerals, thus, providing policy-makers with a more accurate picture of whether Botswana is "living off its natural capital." The economic value of minerals is measured as the "resource rent" they earn, i.e. the profit above the normal return on investment, which is due to the scarcity of minerals. Values are estimated for the entire mining sector and for the three major minerals (diamonds. copper/nickel and coal).

The mineral accounts can be used to derive several valuable indicators of sustainability for policy-makers. These include a more accurate measure of Net Domestic Product, which has been adjusted for mineral depletion, the value of total wealth in the economy, the extent to which the depletion of mineral wealth is offset by investment of other forms of wealth, and the extent to which mineral rent is being recovered through taxes.

The mineral accounts are provided in physical and monetary units. The first reflects the amount of mineral reserves; the latter their value. The physical accounts have been prepared for the period 1980-2005. New discoveries are not included; hence the reserves are under estimated. The resource rent of individual minerals could not be estimated after 1997/98 due to data constraints.

The physical mineral accounts show that the life time of copper/nickel is shortest (until 2009), followed by diamonds (until 2024). Known new discoveries of diamond and copper/ nickel reserves have extended the life time of these mineral, but the length of the extension cannot be calculated form the accounts. Coal reserves are plenty (lasting thousands of year given current use), and their use for large scale commercial projects is no immediate threat to the reserves.

The monetary accounts show that despite the extraction, the current value of the minerals has increased. The increase has been most dramatic for diamonds. Diamond mining generates most of the resource rent and accounts for virtually all of the economic value of minerals, 95% or more in most years. Copper/nickel and coal are much less valuable from an economic perspective. In addition, copper/nickel mining generates a significant amount of pollution and uses large quantities of water, so there may be environmental costs to mining which would reduce the net value of copper/nickel.

The mineral accounts were used to add mineral capital to the country's traditional capital estimates. The analysis shows that minerals are the most important capital asset of the country, but their share has declined from 63% in 1984 to 44% in 1997. Other forms of capital (foreign reserves and government assets) increased.

Management of minerals for economic sustainability requires: 1) that the resource rent is recovered by government through taxes, and 2) that the rent is invested in alternative activities that can provide sources of income and employment for future generations once the minerals are exhausted. Government has been highly successful in recovering the

mineral rent. This means that the value of minerals can be exploited to boost development and the country's wealth. The issue of re-investing rent has been measured by assessing total national wealth and by reviewing the nature of government expenditure. The estimated national wealth consists of two components that are traditionally covered in NA "produced assets" (buildings, machinery and equipment) and net foreign financial assets as well as mineral assets, contributed by the mineral accounts. The combined value of all three types of assets and mineral assets increased from 6 billion pula in 1984 to 93 billion by 1997. Over the past decade, the share of produced assets plus foreign financial assets increased from 50% in 1990 to 61% in 1997. This indicates that though minerals are being extracted, other types of capital (produced plus foreign financial assets) are taking their place. Moreover, Botswana is making some progress with diversifying its economy. The government developed SBI has been used to examine the use of mineral revenues by government. For sustainability, it has required that no recurrent expenditures (other than health and education) depend on mineral revenues. Botswana has been in compliance with this strict criterion for sustainability through 1997. In 1998, government spending on recurrent items has started to rely on rents from diamonds, and the situation may have deteriorated since then. The SBI- rule encourages budgetary and fiscal discipline but may be too restrictive. It is possible (and economically sustainable) that only a portion of the revenues be re-invested as long as this portion generates the same revenues as minerals (Hartwick rule). Conservative calculations indicate that the minimum necessary to invest is only about 66% of mineral rent and the remaining 34% could be used to fund expenditures on for example poverty alleviation and improving the renewable natural resources, without endangering the livelihood of future generations. The long term returns are, however, uncertain, and therefore good governance and discipline are essential if the SBI is relaxed.

The policy implications of the mineral accounts are clear-cut and extremely relevant for the long-term development of the country and for achieving Vision 2016. While it is understandable that data on reserves and rent by mineral are treated with care, and that reporting should ensure that no confidential data are published, it is critically important that such data can be used in the mineral accounts. This can be done through close collaboration between the DEA, DoM and CSO. Currently, the reserves in the accounts are underestimates and the monetary accounts for individual minerals are ten years old. As a result, the sustainability of recent economic growth cannot be assessed. An up-dated sustainability assessment is important for the preparation of the planning process for 2009-2014 (NDPO 10, DDP8 and UDP3).

Chapter one
Introduction

This report is part of an on-going project on Natural Resource Accounting and Environmental Economics, carried out by the Department of Environmental Affairs (DEA) as one of its projects under National Development Plan 9 (NDP9). The project continues earlier work of the National Conservation Strategy Coordinating Agency (NCSA) and the Central Statistics Office (CSO) on resource accounting. The earlier work resulted in unpublished reports on water and mineral accounts. This report is an up-date of the previous mineral paper.

The mining sector continues to be the backbone of the country's economy despite efforts to diversify the economy. The use of mineral revenues is of critical importance for sustainable development. The Botswana government has recently received praise that it has managed to avoid what is commonly known as the 'mineral curse' and 'Dutch disease' in the literature (Iimi, 2006). The World Bank has commended the country for investing significant parts of mineral revenues in education, health care and other forms of asset formation, leading to a high net genuine savings ratio (World Bank, 2006).

Given the importance of the mining sector, it is not surprising that the Department of Environmental Affairs (DEA) decided to construct mineral accounts. The study has the objectives to:

- Quantify the major physical trends in resource stocks and changes therein for the major minerals;
- Quantify the major monetary trends in resource stocks and changes therein; and
- Explore to what extent government has captured the benefits of mineral extraction for the country's development and growth.

The Botswana Natural Resource Accounts (NRA) follow the method established by the United Nations and currently cover water, minerals and livestock. Plans exist to cover wildlife resources. These resources are of strategic importance to the country's development and environment.

This report discusses the accounts for mineral assets, the cost of mineral depletion (or accumulation due to new discoveries), the resource rent generated by mineral extraction, and the contribution of resource rent to creating a sustainable economic future for Botswana. Section two describes the role of minerals in the economy of Botswana. Section three explains the concept of resource rent, the conditions necessary for non-renewable resources like minerals to contribute to sustainable development, and the methodology used to measure rent and the economic value of mineral assets. Section four present physical assets accounts and provides an estimate of resource rent generated by mining over the period 1980 to 1997. 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 (manufactured assets and net foreign financial assets). Section five considers the policy implications of the analysis, notably, whether minerals' policy in Botswana meets the criteria for sustainable 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.

Chapter two
Minerals and the mining sector in the economy of Botswana

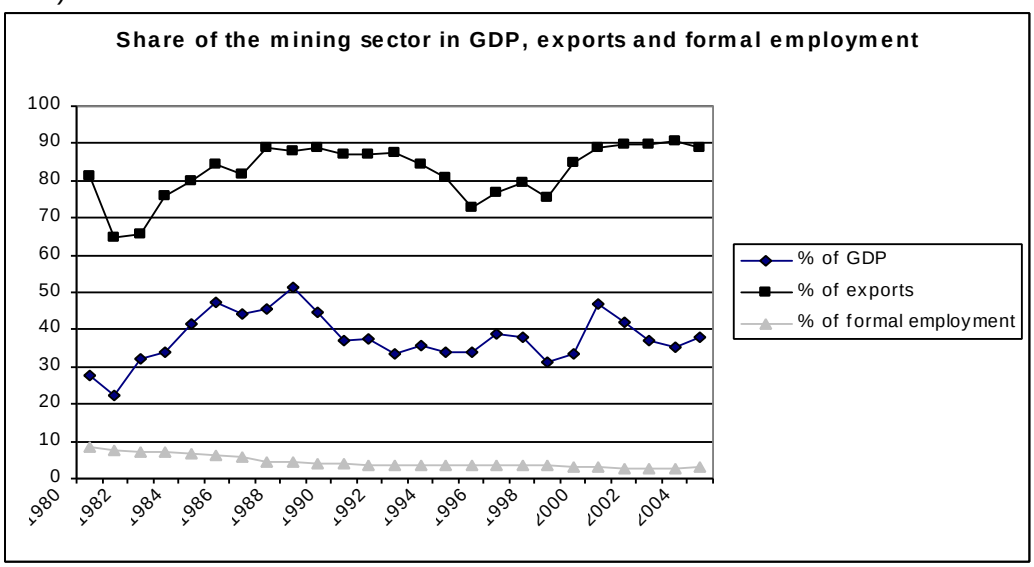
Botswana is highly dependent on its natural resource base: mostly minerals, but also agriculture and wildlife-based tourism. The Government of Botswana has now undertaken the construction of Natural Resource Accounts (NRA) as one of several economic tools to promote sustainable and economically efficient management of its resources. Botswana has a broad range of minerals, including diamonds, copper/nickel, coal, gold and soda ash, but diamonds dominate economically, accounting for most of the value-added and government revenues generated by mining. Government policy has supported large-scale commercial exploitation of mineral resources to maximise economic rent. As the owner of minerals, government charges mining companies for the exploitation of these resources, as any private owner would do. The revenues it collects are used to provide public services, enhance human capital and boost economic growth in line with the objectives of national development planning.

Because the country's economy is dependent on minerals, especially diamonds, it is vulnerable to fluctuations in global mineral prices and demand. Figure 2.1 shows the share of minerals in GDP, exports and formal employment. Since 1980, the mining sector has contributed:

- almost a quarter to just over half of gross domestic product or GDP (average of 37.7%);
- just under two thirds to 90.8% of exports (average of 82.5%); and
- 2.6 to 8.6% of formal employment (average of 4.5%).

Clearly, the mining sector is critical for exports and GDP. It is less important for direct employment due to its capital intensive nature. In fact, the sector's share of formal employment has declined from 8.6% in 1980 to 3.3% in 2004. The trends of Figure 2.1 show that government efforts to diversify the economy and make it less dependent on the mining sector have had limited success. Some progress has been made by developing tourism and the textile industry, but recent projects of mining expansion (Orapa and Jwaneng) and establishment of new mines have accentuated the dominance of the sector.

Figure 2.1: Percent contribution of mining to GDP, exports and employment (1980-2004).



Sources: Statistical Yearbook 2004 and 2006 Annual Economic Report.

Chapter three
Framework for mineral accounts

3.1 Introduction

Section two showed that Botswana's mineral assets form a major source of its wealth. At this time, however, the Central Statistics Office (CSO) compiles accounts only for manufactured capital, which includes buildings, construction works, machinery and equipment; the value of natural capital is omitted. This omission is problematic because minerals are non-renewable resources that are gradually being depleted and therefore mineral-led growth cannot be sustained forever. Mining generates income, which is included in the national accounts and economic indicators like GDP, but at the same time depletes national wealth by using up the limited supply of mineral assets. The national economic accounts, thus, give a distorted picture of economic health because they report the contribution of mining to GDP but not the simultaneous loss of mineral wealth.

To correct this omission, the most recent revision of the national accounts, the 1993 System of National Accounts (United Nations, 1993a), proposed including minerals in the asset accounts. Strengthening and expanding the inclusion of natural capital, NRA were proposed by the United Nations (UN, 1993b) as a set of satellite accounts to the SNA 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, policy-makers can anticipate and plan for the eventual exhaustion of mineral assets.

A growing number of mineral rich countries such as Namibia and Australia are preparing mineral accounts to monitor depletion and the built of national wealth (in response to mineral depletion).

The mineral accounts in Botswana focus on the asset account as most minerals are hitherto exported unprocessed (e.g. diamonds, copper, nickel, gold) or used on a small scale domestically (coal for electricity generation and small scale uses by schools, companies and households). This situation will change in future due to two developments, leading to higher priority to construct use accounts for minerals. The first development is the construction of diamond processing facilities in Botswana through the Diamond Trading Company (DTC) and private diamond traders (due for completion in 2007). The second development is the construction of a large coal fired power plant for export of electricity to southern Africa (due for completion in 2010/1) in response to regional electricity shortages. Both projects create of employment and value added in Botswana, and increase links between the mining sector and other domestic economic sectors.

3.2 Mineral resources and reserves

Mineral reserves are most important for the mineral stock accounts. SAMREC (2000) argues that the terms 'mineral resources' and 'mineral reserves' need to be clearly distinguished in reporting on minerals[1]. Three categories of mineral resources can be identified: inferred, indicated and measures; two types of reserves are distinguished; probably and proved. Detailed descriptions of each type of resource and reserve are summarised below (Table 3.1).

[1] The UNSO is preparing a new classification of reserves that need to be considered for future mineral accounts (pers. comm.. Lange).

For the stock accounts, the mineral reserves are most relevant. Where possible, probable and proved reserves should be separated, but data constraint may not permit this. The following reserves have been used. For diamonds, probable, indicated and inferred reserves have been used (data available for 1999 only). The physical characteristics of Botswana make it likely that inferred reserves will be economically exploited at a certain point in time in future. For copper and nickel, probable and proved reserve figures were available until 1987, but both categories could not be separated after 1982. Finally, for coal proved reserves for two coal fields have been used. Estimates for other coal fields have not been included, as the current use is minimal compared to the reserves of both fields.

Table 3.1: Definitions of mineral resources and reserves

Type	Description
Overall mineral resource (MRS)	Concentration of material of economic interest in or on the Earth's crusts in such a form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction
Inferred MRS	Part of a mineral resource for which tonnage, grade and mineral content can be estimated with a ***low*** level of confidence
Indicated MRS	Part of a mineral resource for which tonnage, densities, shape physical characteristics, grade and mineral content can be estimated with a ***reasonable*** level of confidence
Measured mineral resource	Part of a mineral resource for which tonnage, densities, shape physical characteristics, grade and mineral content can be estimated with a ***high*** level of confidence
Mineral reserve (MRV)	Economically mineable material derived from a measured or indicated MRS; mineral reserves are sub-divided into probable and proved mineral reserves.
Probably MRV	Economically mineable material derived from a Measures or indicated MRS (estimated with lower level of confidence than proved reserves)
Proved MRV	Economically mineable material derived from a Measures or indicated MRS (estimated with high confidence level

Source: SAMREC, 2000.

3.3 Measuring resource rent and valuing mineral assets

The economic value of the mineral resource itself is measured by the *resource rent*. Resource rent is an extra economic return above the costs of extracting the mineral and occurs because of the scarcity of a resource. Unless there are government policies to recover resource rent, it will accrue as "windfall" profits to mining companies. According to the law in many countries, certain natural resources, like minerals, belong to the state. Thus, as the owner of the resource, the government is entitled to a return on the resource. 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.

Non-renewable resources like minerals will eventually 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 non-renewable resources are, by definition, not biologically sustainable. This principle, of reinvesting revenues from non-renewable resources in other activities, is known as Hartwick's Rule (Hartwick, 1977). Most countries, including Botswana, levy special taxes and royalties on minerals to capture resource rent.

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

- calculating the rent per unit of output generated by current production; and
- calculating the economic value of minerals as the discounted value of future rent (usually based on assumptions relative to current rates of rent).

Figure 3.1: An example of the role of rent in managing non-renewable resources[2]

Suppose a country has an oil field containing 100 barrels of oil. This constitutes its "natural capital." The country can hire an international oil company to pump its oil at a cost of $1 a barrel. This cost includes payments for labour, intermediate inputs like electricity, for accounting and marketing services, and for the use of capital equipment needed to extract the oil. Since oil is a scarce resource, the price of oil on the world market gets bid up to $2 a barrel, which is well above the $1 a barrel cost of extraction. This scarcity results in a ***resource rent*** *of $1 a barrel from its production.*

The country has a choice of extracting the oil (or some part of it) now for the economic benefit of the current generation, or leaving it in the ground for future generations to extract and sell. If all 100 barrels are extracted in one year, the country earns an economic profit, or resource rent, of $100 (the revenue of $200 minus extraction costs of $100), but leaves no oil for future generations. What might the country do with this profit? The country has a choice of either spending it on current consumption or investing it in other economic activities that will generate income and employment in the future. If the resource rent is used only for consumption by the current population—for example, buying television sets for all the country's citizens—then nothing is left for future generations. Future generations are worse off than if the oil had been left in the ground because there is nothing left for them to extract.

On the other hand, the country could invest the $100 (or some part of it) in an investment fund to replace the now-depleted natural capital. As long as this investment is intact, it will generate income, benefiting both current and future generations. The current generation will not have as much to spend as if they had the entire $100 profit, but this policy ensures that all citizens, current and future, will have some benefit from the country's natural capital. An example of such a fund is the Permanent Fund created from oil revenues in the state of Alaska in the U.S. Part of the resource rent is held in an investment fund and the annual proceeds from this fund, above the amount needed to keep the real value of the fund intact, are distributed to all residents of the state.

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- Calculating the rent per unit of output generated by current production; and
- Calculating the economic value of minerals as the discounted value of future rent (usually based on assumptions relative to current rates of rent).

Both of these steps require certain assumptions, which are described in detail in appendix 2.

3.4 Data availability and limitations

Due to the strategic importance of minerals and confidentiality requirements, data availability has been problematic. This applies in particular to the reserves, new discoveries and economic rent. The data issues and their handling are listed in Table 3.2.

[2] Based on Goodstein (1994).

Table 3.2: Data availability and approaches

Variable	**Data availability**	**Approach adopted**
Reserves of minerals by type	No time series data on reserves (probable and proved). Data for copper & nickel reserves until 1987; diamond data only for 1999; coal reserves for two coal fields.	Work with limited data on reserves and assumptions. No new discoveries incorporated in stock accounts; therefore most stocks are underestimated
Mineral extraction by type	Data available from CSO and Dep. of Mines	Used in stock account
Resource rent	No data on gross operating surplus and capital stock after 2001.	No rent calculated for mining sector beyond 2001
	Sector-wide data only; no detailed data by type of mineral without permission from Department of Mines.	Rent calculation at national level. Mineral specific calculations restricted to earlier work, made available to NCSA at that time.
	Data from 1995/6 onwards are based on quarterly NA only; these quarterly assessments were not reconciled through an annual survey as happened before.	Some caution with data and interpretation. CSO is currently doing an annual survey to remedy this shortcoming.

Chapter four
Mineral accounts and resource rent from mining

The physical accounts are discussed in section 4.1, followed by a discussion of the monetary accounts in 4.2 and the country's economic wealth in section 4.3.

4.1Physical asset account for minerals

Diamonds are Botswana's primary mineral resources. Copper/nickel and coal are also economically important, and there is also mining of some other minerals (e.g. gold, soda ash). The physical asset accounts constructed for diamonds, copper/nickel, and coal are shown in Tables 4.1-3. Other minerals, such as soda ash and gold, are not yet included in the current mineral accounts for Botswana because of their negligible economic value. The construction of physical accounts for each mineral is discussed below.

4.1.1 Diamonds

Diamond accounts are reported in Table 4.1 for the period 1980-2005. Information about extraction of diamonds is publicly available from the Annual Reports of the Department of Mines and De Beers Annual Reports. Information about the reserves of diamonds proved difficult to obtain, making it impossible to publish the full accounts for diamonds. In its 1999 Annual Report, De Beers, the 50% partner in Debswana, published the estimated reserves for each of its mines throughout the world. For Botswana, reserves were reported for the three mines in operation: Orapa, Jwaneng, and Letlhakane. Mineral resources were classified as probable, indicated, and inferred. The geological characteristics of Botswana's diamond mines make the probability of economically feasible mining very high, even for the inferred reserves, so Botswana's diamond asset accounts include all three categories as reserve. Diamond reserves have not been reported for earlier and later years, even though a small new diamond mine (Damtshaa) started production in 2000. Therefore, the reserves prior to 1999 were calculated by adding back annual extraction; the reserves after 1999 were calculated by subtracting the annual extraction. Consequently, the accounts for the period 1980 to 2003 do not show new discoveries or other volume changes. Thus the reported physical stock is an under-estimate.

Damtshaa mine is located 20 km east of Orapa and was commissioned on 28 October 2002. It has an expected life time of 32 years (De Beers Annual Report 2003). Assuming an average annual production of 250 000 crts, the diamond reserve of the mine could be 8 million crts.

According to the 2001 De Beers Annual Report, two new kimberlites were discovered in Botswana (out of a total of 38 in nine countries)

Source: De Beers Annual Reports 2001 and 2003.

Table 4.1 shows that stocks have declined by 43.5% and that extraction has increased by six fold from 5.1 million carats in 1980 to 31.9 million carats in 2005. This has been primarily achieved by expansion of existing mines and to a small extent by the new Damtshaa mine east of Orapa. Given the current extraction level, the life time of the reported reserves is almost 19 years, but it must be remembered that the reserves are under-estimated.

Table 4.1: Physical asset accounts for diamonds (1980- 2005; millions of carats)

	Opening Stocks	Extraction	New Discoveries	Other volume changes	Closing stocks
1980	1,053	5.1	Na	Na	1,048
1981	1,048	5.0	Na	Na	1,043
1982	1,043	7.8	Na	Na	1,035
1983	1,035	10.7	Na	Na	1,024
1984	1,024	12.9	Na	Na	1,012
1985	1,012	12.6	Na	Na	999
1986	999	13.1	Na	Na	986
1987	986	13.2	Na	Na	973
1988	973	15.2	Na	Na	957
1989	957	15.3	Na	Na	942
1990	942	17.4	Na	Na	925
1991	925	16.5	Na	Na	908
1992	908	15.9	Na	Na	892
1993	892	14.7	Na	Na	878
1994	878	15.6	Na	Na	862
1995	862	16.8	Na	Na	845
1996	845	17.7	Na	Na	828
1997	828	20.1	Na	Na	807
1998	807	19.8	Na	Na	788
1999	788	20.7	Na	Na	767
2000	767	24.6	Na	Na	742
2001	742	25.6	Na	Na	717
2002	717	28.4	Na	Na	689
2003	689	30.4	Na	Na	658
2004	658	31.1	Na	Na	627
2005	627	31.9	Na	Na	595

Note: Na means not available

Sources: Extraction, Dept of Mines Annual Reports. 1999 closing stocks: DeBeers 1999 Annual Report.

4.1.2 Copper and nickel

The Annual Reports of the Department of Mines (DoM) published figures for annual extraction, production and reserves for copper/nickel until 1987. Reserves included both proved and probable, though this distinction was not indicated after 1982. Reserves were reported in terms of tons of ore reserves and the percentage content of nickel and copper in the ore. From these figures, the tons copper plus nickel were calculated and are shown in Table 4.2. After 1987, the Department of Mines discontinued publication of reserves; for 1988 to the present, reserves are calculated as closing stock in 1987 (1.1 million tons) minus extraction in each subsequent year. No information about new discoveries or other volume changes is estimated after 1987.

Changes in reserves normally consist of three categories: extraction, new discoveries, and other volume changes. Because mining and initial processing of the minerals are an integrated process, the category of extraction has been disaggregated for copper/nickel mining into two components:

- Final production measured as the copper and nickel content of the matte produced for export, which is reported in the Department of Mines Annual Report, and
- Losses of copper and nickel during the process of milling and smelting.

To accurately calculate the change in reserves, it is necessary to subtract from the opening stock both the minerals in the final product as well as the losses during processing. Until 1991, the Department of Mines published detailed information which included the losses at each stage of processing. Since that time, the Department of Mines discontinued that data series and the losses had to be estimated by assuming the same loss percentage as in the previous three years (roughly 22% of the metal content of ore milled). Figures for the calculation of changes in reserves due to extraction are shown in Table 4.2 for the years 1979 to 1991. The account shows that the reserve has declined by 36% in the period 1980-1998. Given an annual extraction of around 55 000 tons, the reserves would last until 2008/9. It must be remembered that new discoveries and other volume changes are not incorporated in this estimate, and therefore the lifetime is expected to be longer.

Table 4.2: Physical asset accounts for copper/nickel (1980-2005; in tons)

		Extraction					
	Opening Stocks	**Total extraction**	**Final production (metal content of matte)**	**Losses of metal**	**New discoveries**	**Other volume changes**	**Closing stocks**
1980	872,618	44,478	30,995	13,483	Na	14,253	842,394
1981	842,394	41,879	36,097	5,782	Na	-38,946	761,569
1982	761,569	41,830	36,131	5,699	Na	171,859	891,599
1983	891,599	48,363	38,477	9,886	Na	94,581	937,817
1984	937,817	51,007	40,075	10,932	Na	182,601	1,069,411
1985	1,069,411	53,574	41,257	12,317	Na	-78,020	937,817
1986	937,817	53,056	40,310	12,746	Na	267,897	1,152,658
1987	1,152,658	53,480	35,461	18,019	Na	15,821	1,114,998
1988	1,114,998	53,274	46,967	6,307	Na	Na	1,061,725
1989	1,061,725	51,038	41,468	9,570	Na	Na	1,010,687
1990	1,010,687	48,518	39,634	8,884	Na	Na	962,169
1991	962,169	48,318	39,870	8,448	Na	Na	913,851
1992	913,851	47,929	39,286	8,643	Na	Na	865,922
1993	865,922	50,939	41,753	9,186	Na	Na	814,984
1994	814,984	51,022	41,821	9,201	Na	Na	763,962
1995	763,962	47,030	38,549	8,481	Na	Na	716,932
1996	716,932	55,381	45,394	9,987	Na	Na	661,552
1997	661,552	48,772	39,977	8,795	Na	Na	612,780
1998	612,780	54,870	44,975	9,895	Na	Na	557,910
1999	557,910	53,507	43,858	9,649	Na	Na	504,403
2000	504,403	49,005	40,168	8,837	Na	Na	455,398
2001	455,398	50,829	41,663	9,166	Na	Na	404,570
2002	404,570	55,493	45,486	10,007	Na	Na	349,077
2003	349,077	63,061	51,689	11,372	Na	Na	286,016
2004	286,016	53,054	43,487	9,567	Na	Na	232,016
2005	202,316	66,998	54,916	12,082	Na	Na	165,964

Note: Na means not available.

Sources: Department of Mines Annual Reports.

4.1.3 Coal

Eleven coal fields have been identified in Botswana but reserves have been measured only for two of these fields, i.e. Morupule and Mmamabule. Measured coal reserves at the two coal fields are vast relative to the current annual extraction (Table 4.3). The indicated and inferred reserves for other coal fields have not been included in the coal account; therefore, the reserves are under-reported. Large scale commercial use of coal makes it important to estimate the total proved and probable coal reserves of the other coal fields.

The physical asset account is presented in Table 4.3. While extraction has grown almost threefold between 1980 and 2005, it remains negligible compared to the coal reserve. Given current use, the life time of the two coal fields would be over 7 000 years. This warrants the search of beneficial large scale commercial use of coal reserves, such as by constructing a coal fired power plant for export purposes.

Table 4.4: Physical asset accounts for coal (1980-2005; thousands of tons)

	Opening Stocks	Extraction	New discoveries	Other volume changes	Closing stocks
1980	7,188,645	371	0	0	7,188,273
1981	7,188,273	381	0	0	7,187,893
1982	7,187,893	415	0	0	7,187,478
1983	7,187,478	395	0	0	7,187,083
1984	7,187,083	393	0	0	7,186,690
1985	7,186,690	437	0	0	7,186,253
1986	7,186,253	499	0	0	7,185,754
1987	7,185,754	579	0	0	7,185,174
1988	7,185,174	613	0	0	7,184,561
1989	7,184,561	663	0	0	7,183,898
1990	7,183,898	794	0	0	7,183,104
1991	7,183,104	784	0	0	7,182,320
1992	7,182,320	901	0	0	7,181,419
1993	7,181,419	890	0	0	7,180,529
1994	7,180,529	900	0	0	7,179,629
1995	7,179,629	898	0	0	7,178,730
1996	7,178,730	763	0	0	7,177,967
1997	7,177,967	777	0	0	7,177,190
1998	7,177,190	928	0	0	7,176,262
1999	7,176,262	928	0	0	7,175,317
2000	7,175,317	945	0	0	7,174,370
2001	7,174,370	947	0	0	7,173,439
2002	7,173,439	930	0	0	7,172,486
2003	7,172,486	953	0	0	7,171,663
2004	7,171,663	823	0	0	7,170,750
2005	7,170,750	985	0	0	7,170,765

Sources: Central Statistics Office, statistical bulletins and Department of Mines, Annual Reports.

4.2 Resource rent and the monetary accounts

The resource rent has been estimated for the mining sector as a whole and for individual sub-sectors (diamonds, cooper/nickel and coal).

The resource rent of the sector was estimated from published NA statistics (Table 4.4). The mining sector has generated substantial amounts of resource rent, increasing considerably over time in nominal terms from P131 million in 1980 to over P10.3 billion in 2001 (current prices). This been a tremendous source of revenue for the country, as government managed to cream off most of the resource rent (see later).

Table 4.4: Resource rent from all mining activities (1979-2001; millions of Pula in current prices)

Year	Operating Surplus	Consumption of Capital	Capital Stock	Return to Capital (10%)	Resource Rent
1979	220	22	372	37	160
1980	217	35	520	52	131
1981	170	45	601	60	66
1982	330	61	732	73	196
1983	415	63	744	74	278
1984	696	62	713	71	563
1985	1,062	66	783	78	918
1986	1,149	78	909	91	981
1987	1,625	84	993	99	1,441
1988	2,913	96	1,269	127	2,690
1989	2,766	117	1,566	157	2,492
1990	2918	150	1,862	186	2,582
1991	2,960	189	2,201	220	2,552
1992	2,737	211	2,447	245	2,281
1993	3,672	242	2,739	274	3,156
1994	3,791	277	3,026	303	3,211
1995	4,399	299	3,184	318	3,782
1996	6,430	312	3,362	336	5,781
1997	7,063.2	310	3,371	337	6,416
1998	6,035.8	309	3,655	366	5,362
1999	7,703.8	340	3,870	387	6,977
2000	9,355.5	371	4,497	450	8,535
2001	11,238.4	425	5,111	511	10,302

Notes: The year is 1 April – 31 March; Operating Surplus for 1990/91, 1994/95 - 1996/97 are estimated by CSO under the assumption that profits for the mining sector are declining; Rent was calculated assuming a 10% return to capital.

Source: based on NA data.

The breakdown of the resource rent shows that most of the resource rent has been generated by diamonds (Table 4.5). The rent generated by copper/nickel has been extremely volatile, significant in some years but low and even negative in others. Coal has generated very little rent in all years. Due to data constraints, the economic rent for individual minerals could only be calculated for the period 1980-1997/8.

The per unit rent (5-year moving average) for each mineral is shown in Table 4.5 for two different rates of return to produced capital invested, 10% and 20%. Rent per carat of diamonds has shown a fairly steady increase over time. Although diamonds are traded on

the international market, this market has been tightly controlled by the Central Selling Organisation, in which Botswana participates, to preserve the value of diamonds. By contrast, copper/nickel is extremely vulnerable to uncontrolled world markets and has shown the greatest volatility. Coal is only used domestically and is not subject to international market forces. The unit rent for coal has always been quite low except for the years 1991-1993. If a 20% return to capital is assumed, unit rent is negative in some years. A negative figure for rent means that the costs of extraction (including a normal profit) are higher than the receipts from extraction.

Table 4.5: Resource rent per unit from diamonds, copper/nickel and coal (1980-1996)

	Rent calculated assuming 10% return on capital			**Rent calculated assuming 20% return on capital**		
	Diamonds (pula per carat)	**Copper/nickel** (pula per ton)	**Coal** (pula per ton)	**Diamonds** (pula per carat)	**Copper/nickel** (pula per ton)	**Coal** (pula per ton)
1980/81	26.8	179.7	1.9	20.6	-160.8	1.2
1981/82	22.9	-31.9	2.2	15.9	-389.0	1.4
1982/83	24.4	-255.8	1.9	17.5	-634.2	1.0
1983/84	25.3	-354.0	2.0	18.8	-734.1	1.0
1984/85	27.6	-357.3	1.7	21.3	-742.0	0.6
1985/86	37.1	-349.7	1.2	31.3	-733.6	0.1
1986/87	49.2	-415.7	0.6	44.1	-801.0	-0.6
1987/88	62.9	100.7	0.6	58.1	-281.0	-0.7
1988/89	85.9	1,584.3	0.4	80.9	1,182.8	-1.0
1989/90	105.5	2,558.6	1.7	99.8	2,105.2	0.0
1990/91	119.1	2,704.8	5.6	112.8	2,182.4	3.6
1991/92	132.9	2,866.8	10.2	125.7	2,266.9	7.5
1992/93	142.5	2,367.7	10.6	134.2	1,674.5	7.2
1993/94	154.8	1,039.6	11.2	145.1	248.7	7.3
1994/95	165.0	621.2	9.3	154.1	-265.7	4.9
1995/96	179.5	1,452.5	5.6	167.5	448.0	0.7
1996/97	205.3	2,968.2	1.6	192.6	1,879.7	-3.5
1997/98	236.3	4,628.6	1.9	223.5	3,440.0	-3.4

Notes: Unit rent reported above is 5-year moving average.

Source: Unpublished data from CSO and authors' calculations.

Short-term losses in mining due to fluctuations in world mineral prices can be expected and are no cause for concern if the industry makes a positive net economic contribution over the long term. However, there are environmental costs that are not included in the financial costs of extraction. Copper/nickel operations, in particular, generate considerable amounts of pollution. The air and water around the copper/nickel mine are monitored and concentrations in the past have been within the standards set by government, although there have been concerns about more recent levels of pollution.

In estimating the value of the resource, some assumptions must be made about future volumes of extraction, future costs of production and future prices, which determine the rent that will be earned. Where information about planned extraction profiles, production costs, or projected world prices are available, these figures are used. Where this information is not available, the convention is to use the figures from the most recent year.

With regard to diamonds, the conventional assumptions may raise some questions. In the past, the price of diamonds has been artificially maintained through a marketing cartel. The diamond market may change in the future because of several factors, including the growth in independent producers, public campaigns such as the 'blood diamond' campaign and the threat of artificial diamonds. Market threats have so far been successfully addressed by showing the role of diamonds in developing countries such as Botswana, sales promotion and stockpiling. The current market outlook is that shortages of diamonds may emerge in future, which requires expansion of supply.

Botswana does not expect its diamond revenues to be much affected in the future; its level of production is expected to stay high because it is the lowest cost producer in the world. The only factor which would affect the value of Botswana's diamonds would be a severe decline in the market price of diamonds. However, while DeBeers has abandoned its strategy of controlling supply, it still controls over 60% of world production, and expects that its marketing and advertising efforts will maintain the high price of diamonds. For the monetary accounts reported here, the conventional assumptions are used in calculating the value of Botswana's minerals, i.e., the current volume of extraction and per unit rent.

Table 4.6 reports the monetary value of minerals. The value of diamonds is, not surprisingly, much higher than that of copper/nickel or coal. The value of copper/nickel is reported as zero in the few years for which resource rent was negative. The value of coal is extremely low. This result may seem surprising because of the huge volume of coal reserves. However, because the resource will only be used far in the future, its current value is very low. The power of discounting future income reduces the value of the assets considerably—at a 10% discount rate reduces rent accruing 10 years in the future by 60%, while rent accruing 50 years in the future is worth only 1% of its nominal value. The slow rate of extraction of Botswana's extensive coal reserves means that rent, even if positive, will occur so far in the future as to have virtually no economic value today.

Table 4.6 shows that the country's mineral wealth has greatly expanded despite extraction. The value of the diamond stock has increased from P 1.4 billion in 1980 to p 46.5 billion in 1997/8. Diamonds accounts for almost all mineral wealth. In recent years, the share of diamonds in total mineral wealth has been above 95%. Coal has never accounted for even 1% of mineral wealth. The share of copper/nickel has fluctuated with the world price. In some years, when the value of copper/nickel was near zero, diamond wealth accounted for more than 99% of total mineral wealth.

Table 4.6: Monetary asset accounts for diamonds, copper/nickel and coal (1980-1997; P million current prices)

A. Diamonds

	Opening stock	Extraction	New discoveries	Other volume changes	Revaluation	Closing stock
1980/81	1,350	137	na	na	154	1,367
1981/82	1,367	114	na	na	-116	1,137
1982/83	1,137	190	na	na	949	1,897
1983/84	1,897	272	na	na	1,093	2,719
1984/85	2,719	355	na	na	1,185	3,548
1985/86	3,548	468	na	na	1,601	4,681
1986/87	4,681	644	na	na	2,401	6,437
1987/88	6,437	832	na	na	2,709	8,314
1988/89	8,314	1,308	na	na	6,039	13,045
1989/90	13,045	1,609	na	na	4,608	16,045
1990/91	16,045	2,067	na	na	6,561	20,539
1991/92	20,539	2,194	na	na	3,474	21,820
1992/93	21,820	2,272	na	na	3,060	22,608
1993/94	22,608	2,280	na	na	2,394	22,722
1994/95	22,722	2,566	na	na	5,378	25,534
1995/96	25,534	3,017	na	na	7,398	29,916
1996/97	29,916	3,635	na	na	9,645	35,926
1997/98	35,926	4,752	na	na	15,306	46,481

B. Copper/nickel

	Opening stock	Extraction	New discoveries	Other volume changes	Revaluation	Closing stock
1980/81	117	8	Na	3	-44	67
1981/82	67	-1	Na	1	-69	
1982/83		-11	Na	-44		
1983/84		-17	Na	-33		
1984/85		-18	Na	-65		
1985/86		-19	Na	27		
1986/87		-22	Na	-111		
1987/88		5	Na	2	50	46
1988/89	46	84	Na	Na	756	718
1989/90	718	131	Na	Na	521	1,108
1990/91	1,108	131	Na	Na	137	1,114
1991/92	1,114	139	Na	Na	181	1,157
1992/93	1,157	113	Na	Na	-111	932
1993/94	932	53	Na	Na	-465	414
1994/95	414	32	Na	Na	-142	241
1995/96	241	68	Na	Na	351	523
1996/97	523	164	Na	Na	758	1,117
1997/98	1,117	226	Na	Na	684	1,576

C. Coal

	Opening stock	Extraction	New discoveries	Other volume changes	Revaluation	Closing stock
1980/81	6	1			1	7
1981/82	7	1			2	8
1982/83	8	1			*	8
1983/84	8	1			1	8
1984/85	8	1			-1	7
1985/86	7	1			-1	5
1986/87	5	*			-2	3
1987/88	3	*			1	3
1988/89	3	*			-1	2
1989/90	2	1			10	12
1990/91	12	4			38	45
1991/92	45	8			43	80
1992/93	80	10			25	96
1993/94	96	10			14	99
1994/95	99	8			-7	84
1995/96	84	5			-29	50
1996/97	50	1			-37	12
1997/98	12	1			4	15

*Less than 1. Na: not available. Note: Values calculated assuming a 10% return on capital and a 5-year moving average per unit rent. A blank space indicates a zero. When the rent is negative, a zero value is assigned to the asset. Revaluation is calculated only for years when Opening and Closing stocks are both non-zero.

Sources: Calculated using the formula given in section 2, rent per unit from Table 4.5 and reserves from Tables 4.1-3.

4.3 Minerals and national wealth

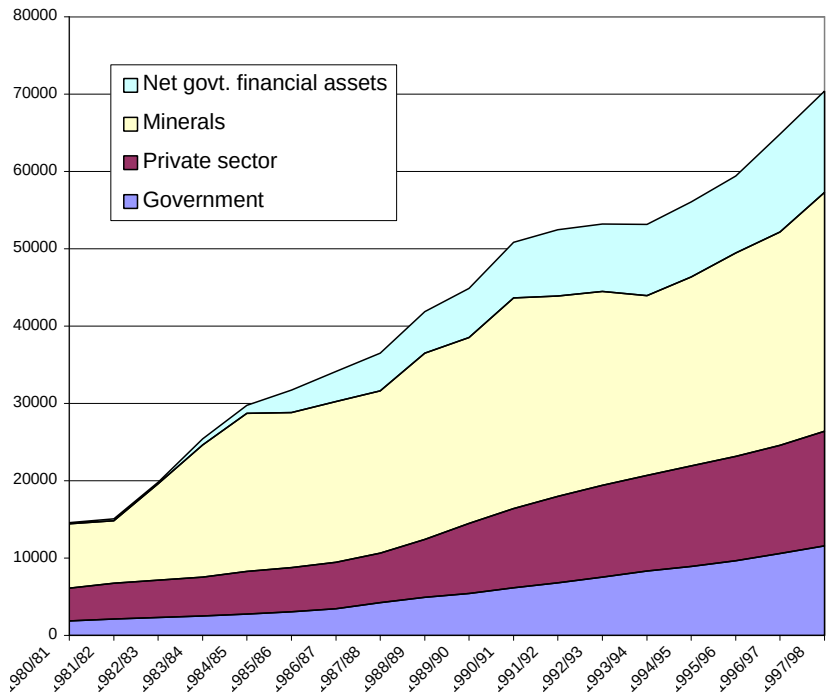
The value of a country's capital assets constitutes its wealth, and no economic activity can take place without capital. The earlier quoted World Bank study (2006) distinguishes three types of capital: produced, natural capital and intangible capital (skills and institutions). All three capital sources are essential as substitution opportunities exist but are limited. The study shows that natural capital tends to be most significant for developing countries (primary production sectors), but that intangible capital is most important for traditional growth, reflecting its dominance among developed countries. Mineral rich countries are exceptions, where natural capital constitutes a large share of the country's wealth. The challenge then becomes versions of natural capital into productive and intangible capital through high genuine savings index. Proper skills and effective institutions facilitate development and efficient use of productive and natural capital. As argued in the introduction, natural resource accounts provide insight in the development of a country's natural capital. Below, we examine the composition of Botswana's national wealth by adding the estimated mineral wealth (section 4.2) to traditional measurements of the country's assets. Without updated physical reserves, it was impossible to up-date the estimate of national wealth beyond 1997/8.I

Figure 4.1 reports total national wealth for the period 1980/1-1997/8, which includes two kinds of non-financial capital, manufactured and mineral, as well as financial capital measured as government net foreign financial assets. Financial capital is especially important to include in the wealth of a country like Botswana because its limited domestic investment opportunities require that at least some of the revenue from minerals be invested overseas.

Manufactured capital can be further disaggregated into two components: private sector capital and government, or public sector, capital. Government capital consists largely of construction works such as public buildings (schools, clinics, buildings for public administration) and major construction works such as roads, which are not used directly in economic production; private sector capital consists of buildings, machinery and equipment used in production. This distinction is important because the private sector faces pressure from the marketplace, through competition among producers, to ensure that its investments are productive, and the productivity of this capital can be readily measured. Government does not face competition in most of its activities and, hence, does not face the same pressure to ensure productivity. Moreover, for various reasons, it is much more difficult to measure the productivity of government capital. Government may accumulate a great deal of capital, but it may not be a productive investment.

Over time, all forms of capital have been increasing, from almost 15 billion pula in 1984 to over 70 billion in 1997, measured in constant 1993/94 prices. During this time, the composition of national wealth has changed, especially over the last 15 years. Since 1985, both manufactured capital and government net foreign financial assets have been increasing more rapidly than natural capital, increasing their shares of total capital from 28% and 9%, respectively, in 1985 to 38% and 19%, respectively, in 1997. The share of mineral wealth has declined from 63% to 44% over the period. The substitution of produced and financial capital for mineral capital is an indicator of sustainable development. In addition, it is an indication that Botswana is achieving another of its fundamental goals for development—diversification of its economy, and reducing its dependence on minerals.

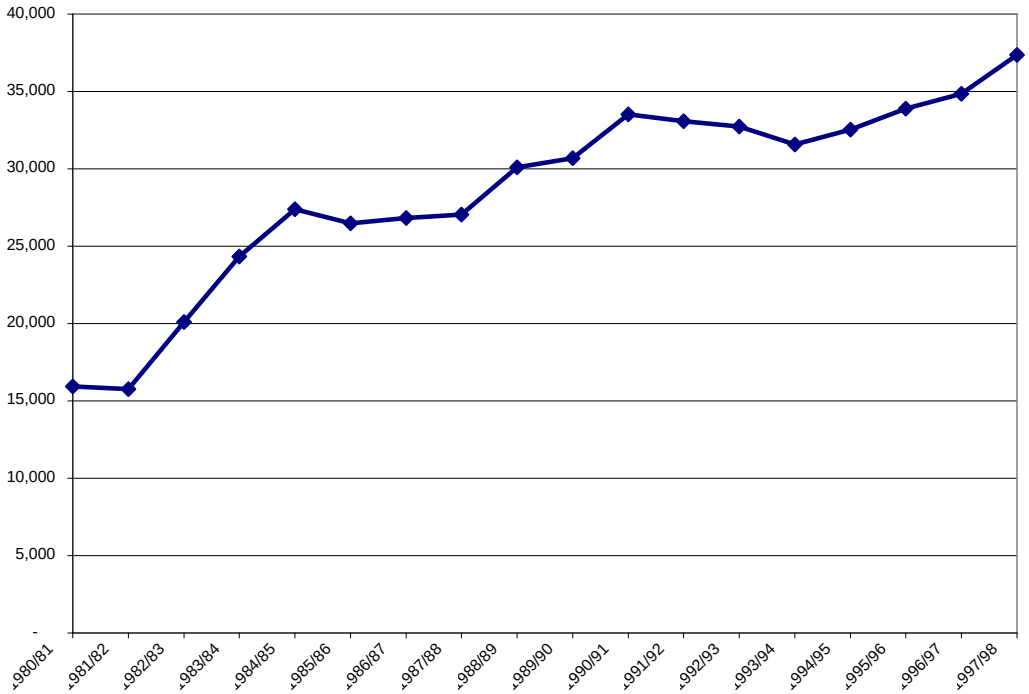
Figure 4.1: Value of assets by type of asset in constant 1993/94 prices, 1980 to 1997



Note: net government financial assets converted to constant prices using the GDP deflator.
Source: Manufactured capital, (CSO 1998); mineral capital from Tables 4.6; financial assets from Bank of Botswana.

More important than the total value of capital stock is the *per capita* value of capital stock. Capital stock must grow at least as fast as population in order to maintain living standards. To improve living standards, capital stock must grow more quickly. In addition, the figures must be adjusted for inflation to measure trends in the real value of capital stock. *Per capita* assets have been growing (Figure 4.2); per capita assets more than doubled between 1980 and 1997, increasing from almost P16,000 to over P37,000

Figure 4.2: Per capita assets in Botswana, 1990 to 1997 (in constant 1993/94 prices)



Sources: Produced assets in constant prices from (CSO, 1998), mineral assets from this study; population figures from (CSO, 1997).

The figures 4.1 and 4.2 show that Botswana has expanded its national wealth, and confirms that the country is on a solid path towards sustainable economic growth and development. The productive and financial capital has expanded, reflecting public and private investments as well as expanding foreign reserves of government.

It must be noted that natural capital, mostly diamond resources, remains the largest source of capital. Therefore, prudent use of mineral revenues and enhanced efforts towards economic diversification aimed at building productive and intangible capital remain essential.

Chapter five
Mineral revenues and development policies

5.1 Introduction

This chapter reviews the appropriation of the mineral rent and the use of mineral revenues by government. Sustainable management of mineral resources requires that resource rent be recovered by government and reinvested in other activities which will generate income after the mineral is exhausted. The previous section indicates that replacement of mineral wealth by other forms of wealth has, indeed, been occurring. Examination of the collection and use of resource rent provides a clearer picture of the process by which this has happened.

The policy implications of the mineral accounts are clear-cut and extremely relevant for the long-term development of the country and for achieving Vision 2016. While it is understandable that data on reserves and rent by mineral are treated with care, and that reporting should ensure that no confidential data are published, it is critically important that such data can be used in the mineral accounts. This can be done through close collaboration between the DEA, DoM and CSO. Currently, the reserves in the accounts are underestimates and the monetary accounts for individual minerals are ten years old. As a result, the sustainability of recent economic growth cannot be assessed. An up-dated assessment would have been important information for the preparation of the planning process for 2009-2014 (NDP10, DDP8 and UDP3).

5.2 Rent recovery

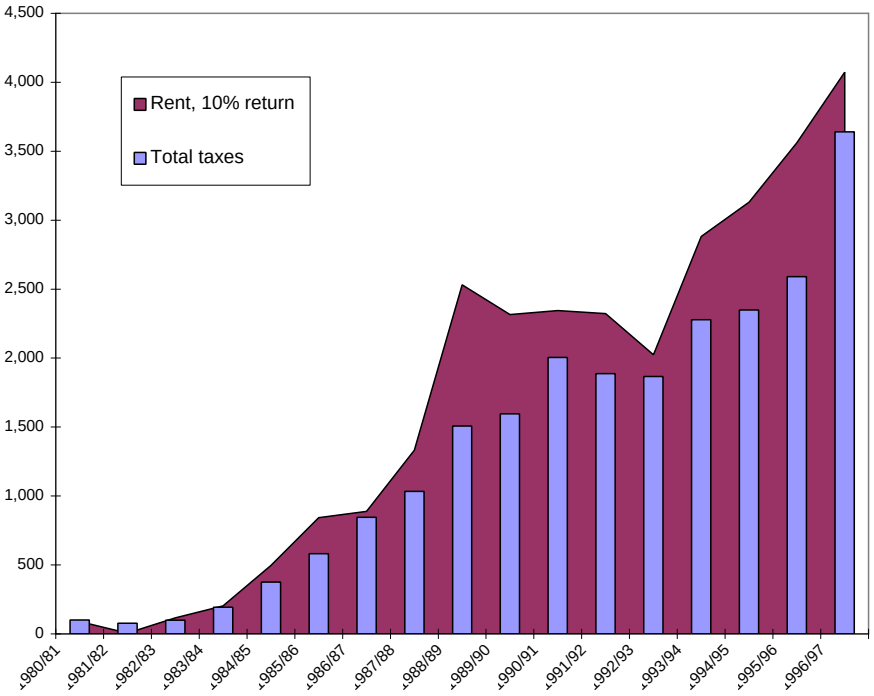
Most countries, including Botswana, levy special taxes and royalties on minerals to capture resource rent. The Government has been remarkably successful in recovering the resource rent generated by mining in the period 1980/1-1997/8 (Figure 5.1). Most of the rent is recovered by government through royalties and different forms of taxation.

Mineral revenues have been driving the growth in government revenues (Figure 5.2). In many years, mineral revenues accounted for more than half of total government revenue. Since 1980, mineral revenues contributed on average 47.8% of government revenues and grants.

5.2 Use of mineral revenues

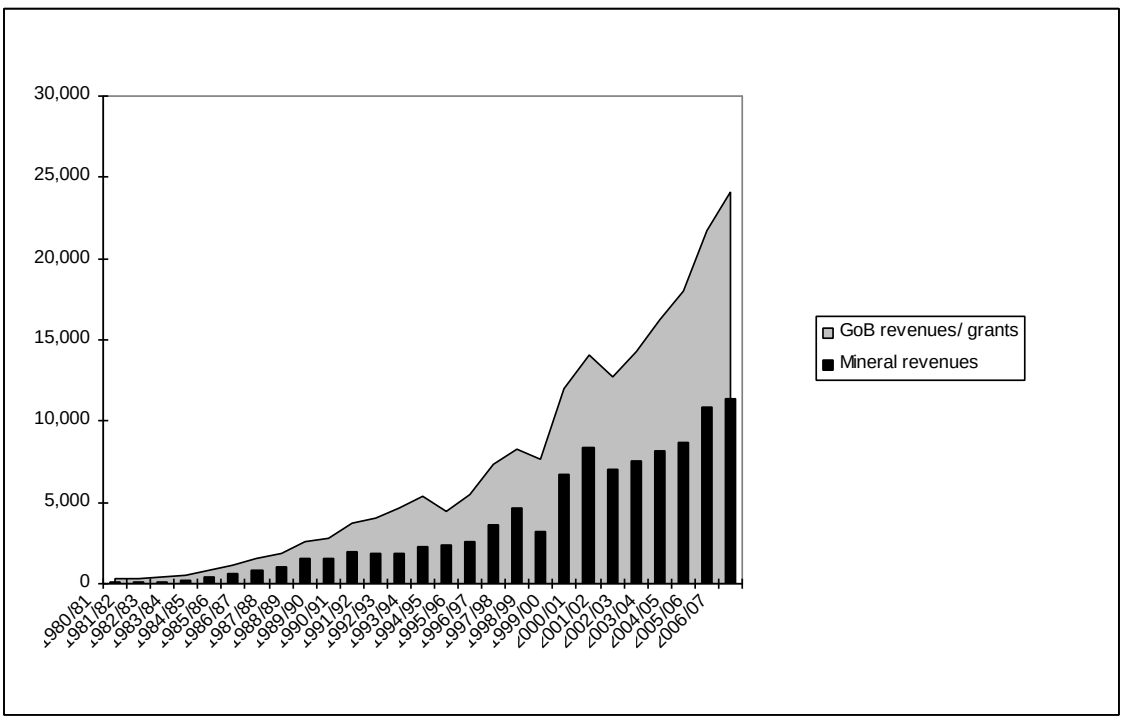
The government has developed a measure, the Sustainable Budget Index (SBI), to monitor whether the mineral revenues it collects are being used in a manner that promotes sustainable development.

Figure 5.1: Resource rent and taxes from mining in Botswana (1980-1997)



Source: Authors' calculations based on unpublished data from CSO.

Figure 5.2: Mineral revenues and total government revenues (1980/1-2006/7)



Note: 2005/6 and 2006/7 figures are revised and budget estimates respectively.

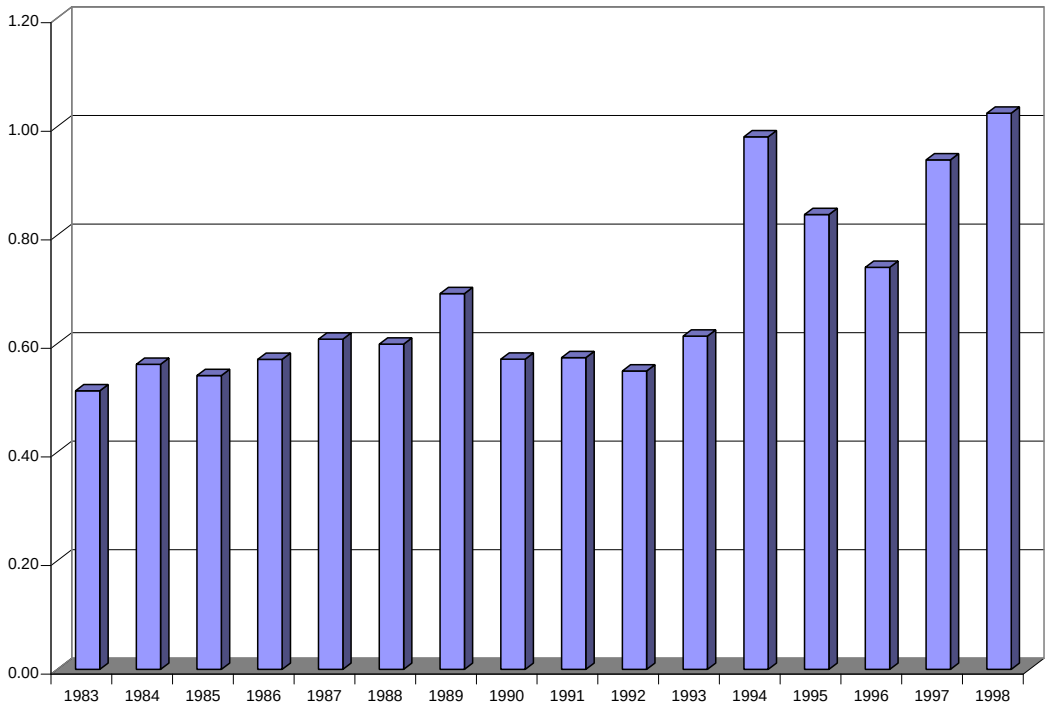
Source: Bank of Botswana, various years.

A study by Auty and Mikesell (1998) found that over the past thirty years, the average resource-rich developing country grew more slowly than the average developing country without resources. The study found that most resource-rich countries squandered their wealth and did not manage resources to promote economic sustainability. A World Bank study (2006) found that mineral-rich countries such as Angola and Nigeria had high economic growth rates coupled with a low genuine-savings index, indicative of consuming the mineral resources. The same study noted that Botswana combined a high growth rate with a high net genuine savings index, implying prudent use of the mineral revenues. Iimy (2006) also found that Botswana had escaped the mineral curse and provides a model for prudent, sustainable management.

In order to better monitor the purpose for which the mineral revenues are used, Botswana has constructed a Sustainable Budget Index (SBI). The SBI indicates the extent to which annual consumption by the public sector is financed out of mineral revenues, which are considered non-recurrent revenues. The SBI is the ratio of non-investment recurrent expenditures to recurrent revenues (that is, revenues except for mineral revenues). Non-investment recurrent expenditure is measured as the recurrent expenditures minus spending for health and education. Health and education are considered an investment in human capital which is more appropriately considered part of the development and capital budget (Ministry of Finance and Development Planning, 1996; Wright, 1997).

An SBI value of 1 or less has been interpreted to mean that current government consumption is sustainable because it is financed entirely out of revenues other than minerals, so that all the revenue from minerals is used for public investment. An SBI value greater than 1 means that government consumptive expenditures rely in part on the mineral revenues, which is fiscally unsustainable. Through the early 1990's, the SBI has, in fact, been less than 1 (Figure 5.3). However, in recent years, the ratio has increased, reaching 1.02 in 1998. If this trend has continued, the SBI could be in the range of 1.10 to 1.20. It is unclear whether the SBI is still used in government budgetary planning, as it no longer appears in government budgetary and planning reports. The rapid rise in HIV/AIDS expenditures poses an enormous budgetary challenge, which is recorded separate form the health budget. If HIV/AIDS expenditures would be treated as consumption, it is likely that the SBI has appreciated considerably above 1.

Figure 5.3: Trend in the sustainable budget index (1983-1998)



Source: Calculations based on (Ministry of Finance and Development Planning, various years).

While there have been a number of criticisms of this index (Wright, 1995, 1997), it is a useful first approximation of the use of mineral revenues. One of the problems is the distinction between investment and consumption expenditures—not all public investments are productive and likely to be able to replace mineral revenues once these are exhausted. Also, it is not necessary, and may be harmful, to insist on fiscal sustainability in every year; it may be more useful to consider fiscal sustainability averaged over time. Capital projects typically occur over multiple years while mineral revenues can fluctuate a great deal from year to year due to causes beyond the control of the Government. It would be counter-productive to curtail capital projects, or postpone new ones deemed necessary, because of short-term fluctuations in mineral revenues. Finally, it may not be necessary to invest all mineral revenues. Instead, it may be sufficient to invest that part that generates the same revenues as the depleted minerals would have done (Hartwick rule). Conservative calculations indicate that the minimum necessary to invest is only about 66% of mineral rent and the remaining 34% could be used to fund expenditures on for example poverty alleviation and improving the renewable natural resources, without endangering the livelihood of future generations. The long-term returns are, however, uncertain, and therefore good governance and discipline are essential if the SBI is relaxed.

5.3 Mineral abundance and economic growth

Many mineral abundant countries fail to achieve sustained rapid economic growth due to the ‘resource curse’ and the Dutch disease. The resource curse refers to a situation where high revenues lead to corruption, conflicts, social lethargy and rent-seeking behaviour of the current population at the expense of future generations. The Dutch disease refers to a situation where mineral exports lead to an overvalued currency, which hampers the growth of non-mineral sectors.

Iimi (2006) analysed whether Botswana had managed to escape the resource curse and Dutch disease. He concludes that the country has escaped the resource curse, primarily due to good governance and budgetary discipline (e.g. SBI). This is supported by a recent World Bank study Where is the Wealth of Nations (World Bank, 2006), which concluded that Botswana has achieved a high genuine net savings rate3 together with high economic growth. Iimi (2006) concludes that particularly good governance and prudent fiscal planning is responsible for the high economic growth. Four components of governance are considered to be critical:

- Accountability, strong public voice, civil liberty and political rights, providing controls on resource extraction and revenue use;
- Quality of public service and competence of civil servants, leading to effective government operations;
- Avoidance of market unfriendly policies such as price controls and excessive regulations;
- Control of corruption leading to a fair and transparent distribution of mineral revenues.

According to the WB study (2006), the quality of institutions and the skills of the population are the primary determinant of development and growth. Both are critical components of governance. The study finds that rich countries have developed strong institutions and high levels of human skills to develop and deal with external shocks. The study provides strong endorsement of Botswana's development path by stating (World Bank, 2006, p. xv): There are no sustainable diamond mines, but there are sustainable diamond-mining countries (e.g. Botswana).

3 The estimate has serious limitations for Botswana. The most important limitation is that mineral resources were excluded. Moreover, pollution control measures were also excluded.

Chapter six
Conclusions and recommendations

The current mineral accounts cover diamonds, copper/nickel and coal. Currently less important minerals such as gold and soda ash are not covered, but this may be necessary in future. The accounts consist of physical stock accounts for the three minerals for the period 1980-2005. In addition, the resource rent has been calculated for the mineral sector (1980-2001) and individual minerals (1980-1997/8). No data could be obtained for new discoveries and for resource rent of individual minerals after 1997/8.

6.1 Findings

The mineral sector remains the major source of exports, government revenues and development in the country. Minerals accounts for over a third of GDP, almost half of government revenues and more than 80% of exports.

In terms of mineral stocks, coal reserves are most significant and deplete very slowly as until now coal is mined for domestic use only. The reserves of both diamonds and copper/nickel have decreased by around 30 to 40% with an estimated lifetime of 19 and 3 years. Unfortunately, no data on new reserves were available. As it is known that new reserves have been found, the reserves and remaining lifetime of the stocks have been estimated.

While the physical reserves have declined, the value of the reserves have increased, in particularly for diamonds. This means that the mineral wealth of the country has increased despite extraction. The value of diamonds has increased from Pula 1.4 billion in 1979 to Pula 46.5 billion in 2001. The value of copper-nickel has increased from Pula 0.1 billion in 1979 to Pula 1.6 billion in 1997/8. The value of coal reserves has increased from a low P 6 million to P 15 million in 2001.

For the country's development, it is important that government captures the resources rent and uses mineral revenues wisely. The study showed that government has been very successful in capturing resource rent, in particular of diamonds. Moreover, available data show that national wealth has increased significantly (also wealth other than minerals) and that government has used most mineral revenues for productive purposes, including education and health. Unfortunately, the rent could only be estimated up to 2001 (for the entire sector) and up to 1997/8 for individual minerals. Thus the wealth estimates are ten years old. The SBI figures are available up to 1998 when the SBI just exceeded 1 (1.02). If the upward trend has continued, the SBI could be structurally above 1, indicative of consumption of part of the mineral revenues.

6.2 Policy implications

	Findings	Policy implications
1	Decreasing mineral reserves of diamonds and copper/nickel; almost infinite coal reserves given domestic use only.	Planning for life after diamonds and copper/nickel
2	Very few data on reserves and no data on new discoveries	Reserves and their life time are underestimated Dep. Of Mines could maintain mineral accounts and insert best estimates of reserves/ new discoveries. Confidential information could be hidden in reports but would be available to mining and macro-economic planners
3	Mineral wealth is mostly diamonds. The value of copper/ nickel and coal is low to very low	Government needs to critically examine the contribution of non-diamond mining to the country when new projects are being considered.
4	The value of diamonds has tremendously increased during the period 1980-1997/8	Mining and mineral growth is primarily driven by the increase in diamond value and not by the amount. This fortunate

		situation cannot be taken for granted and may not prevail in future. Therefore, continued capturing of resource rent and prudent use of its revenues is required.
5	Government is successful in capturing resource rent from minerals	To continue this in future negotiations
6	Mineral revenues have been used to increase national wealth and have been mostly invested	To continue in future. It is however critical that estimated resource rents are up-dated to 2005 to permit updates of national wealth estimates It is equally important that the SBI is up-dated from 1997/8 and used to analyse use of mineral revenues. If GoB would decide not to re-invest part of the mineral revenues, this part could be used for poverty reduction, institutional strengthening and promoting efficient use of renewable natural resources It is important to calculate a comprehensive net genuine net savings index (NGSI) for a period of time. National wealth and the NGSI are important indicators of economic sustainability and need to be regularly monitored.
7	Access to data and confidentiality	Mineral reserves and resource rents are important data for macro-economic planning (e.g. NDP 10) as they provide estimates of mineral wealth, national wealth and the life span of minerals. Such data need not be published.

6.3 Recommendations for further work

It is most important that the current mineral accounts are improved in terms of estimates of reserves and updating of mineral rents. This is essential for the efficient use of mineral accounts as a planning tool.

Other areas for future work include:

- Construction of use accounts to deal with future domestic processing (coal and diamonds)
- Coverage of other minerals: gravel/construction material, gold and soda ash.

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Appendix 1: Economic indicators and the mining sector

	VA mining sector	VA Botswana	% of GDP	Export of mining (P 000)	total export	% of exports	Employment in mining	Total formal employment	% of formal employment
1980	241.3	869.5	**27.8**	318,787	391,492	**81.4**	7,200	83,400	**8.6**
1981	201.6	895.8	**22.5**	214,547	332,381	**64.5**	7,300	97,400	**7.5**
1982	366.6	1,146.8	**32.0**	307,682	467,413	**65.8**	7,100	100,200	**7.1**
1983	466.4	1,382.5	**33.7**	529,677	696,663	**76.0**	7,200	100,500	**7.2**
1984	753.1	1,812.8	**41.5**	684,234	857,144	**79.8**	7,500	110,000	**6.8**
1985	1,133.9	2,402.6	**47.2**	1,167,986	1,384,284	**84.4**	7,300	116,800	**6.3**
1986	1,229.8	2,788.5	**44.1**	1,323,466	1,619,265	**81.7**	7,500	130,100	**5.8**
1987	1,702.5	3,745.6	**45.5**	2,369,622	2,664,671	**88.9**	7,000	150,200	**4.7**
1988	2,969.3	5,803.4	**51.2**	2,350,353	2,678,258	**87.8**	7,500	169,500	**4.4**
1989	2,896.1	6,490.7	**44.6**	3,332,768	3,742,602	**89.0**	7,600	189,500	**4.0**
1990	3,074.8	8,322.1	**36.9**	2,884,738	3,319,091	**86.9**	8,100	209,000	**3.9**
1991	3,125.9	8,298.6	**37.7**	3,259,766	3,738,009	**87.2**	7,700	228,900	**3.4**
1992	3,042.3	9,045.4	**33.6**	3,208,116	3,674,991	**87.3**	8,300	224,800	**3.7**
1993	3,965.2	11,041.4	**35.9**	3,609,659	4,270,398	**84.5**	8,400	227,700	**3.7**
1994	4,144.8	12,261.7	**33.8**	4,013,363	4,964,998	**80.8**	7,900	231,200	**3.4**
1995	4,800.0	14,203.9	**33.8**	4,333,933	5,941,470	**72.9**	8,300	230,600	**3.6**
1996	6,908.3	17,740.2	**38.9**	6,235,691	8,133,358	**76.7**	8,300	233,400	**3.6**
1997	7,665.1	20,162.6	**38.0**	8,260,422	10,390,700	**79.5**	8,400	227,226	**3.7**
1998	6,692.9	21,523.7	**31.1**	6,574,840	8,696,922	**75.6**	8,600	241,700	**3.6**
1999	8,389.4	24,943.1	**33.6**	10,371,262	12,227,848	**84.8**	8,300	257,100	**3.2**
2000	16,236.3	34,787.1	**46.7**	12,312,038	13,834,682	**89.0**	7,900	265,400	**3.0**
2001	15,012.7	35,693.4	**42.1**	12,811,447	14,306,488	**89.5**	7,000	270,600	**2.6**
2002	14,704.5	39,479.5	**37.2**	13,763,324	15,341,940	**89.7**	7,500	279,700	**2.7**
2003	15,078.9	42,580.4	**35.4**	14,204,278	15,635,318	**90.8**	8,000	285,400	**2.8**
2004	18,526.5	48,630.6	**38.1**	11,893,727	13,400,152	**88.8**	9,700	296,400	**3.3**
Long term average			**37.7**			**82.5**			**4.5**

Sources: 2006 Annual Economic Report, Statistical Yearbook 2004 and National Accounts.

Appendix 3: Details of stock accounts

Table 4.3 Changes in copper/nickel reserves, 1979 to 1991
(in tons)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. Ore Milled (this = mined + change in inventories)													
1.1 tons	2,233,249	2,541,589	2,463,476	2,460,566	2,844,884	3,110,175	3,246,911	3,235,142	3,280,972	3,329,609	3,335,785	3,369,300	3,451,279
1.2% Ni	0.99%	0.93%	0.89%	0.84%	0.81%	0.79%	0.81%	0.79%	0.78%	0.78%	0.71%	0.69%	0.68%
1.3 % Cu	0.78%	0.82%	0.81%	0.86%	0.89%	0.85%	0.84%	0.85%	0.85%	0.82%	0.82%	0.75%	0.72%
2. Content of ore milled													
2.1 ni	22,109	23,637	21,925	20,669	23,044	24,570	26,300	25,558	25,592	25,971	23,684	23,248	23,469
2.2 Cu	17,419	20,841	19,954	21,161	25,319	26,436	27,274	27,499	27,888	27,303	27,353	25,270	24,849
3. Metal contained in final matte													
3.1 Ni	16,173	15,442	18,278	17,756	18,216	18,604	19,565	18,974	16,528	22,539	19,759	19,022	19,294
3.2 Cu	14,563	15,553	17,819	18,375	20,261	21,471	21,692	21,336	18,933	24,428	21,709	20,612	20,576
4. Metal in ore as % of usable metal contained in matte													
4.1 NI	136.7%	153.1%	120.0%	116.4%	126.5%	132.1%	134.4%	134.7%	154.8%	115.2%	119.9%	122.2%	121.6%
4.2 Cu	119.6%	134.0%	112.0%	115.2%	125.0%	123.1%	125.7%	128.9%	147.3%	111.8%	126.0%	122.6%	120.8%
5. Difference between extraction and production (rows 2 minus rows 3)													
5.1 Ni	5,936	8,195	3,647	2,913	4,828	5,966	6,735	6,584	9,064	3,432	3,925	4,226	4,175
5.2 Cu	2,856	5,288	2,135	2,786	5,058	4,965	5,582	6,163	8,955	2,875	5,644	4,658	4,273
6. Total metal extracted													
6.1 Production of Ni + Cu (rows 3.1+3.2)	30,736	30,995	36,097	36,131	38,477	40,075	41,257	40,310	35,461	46,967	41,468	39,634	39,870
6.2 Losses of Ni+Cu in mining and processing (rows 5.1+5.2)	8,793	13,483	5,782	5,699	9,886	10,932	12,317	12,746	18,019	6,307	9,570	8,884	8,448

Source: Department of Mines Annual Report, various years and author's calculations.

Appendix 2: Estimation of resource rent (derived from the old mineral account paper)

Current rent

Rent is calculated as the value of production minus the marginal exploitation costs, which include intermediate consumption, compensation of employees, consumption of fixed capital, and the opportunity cost of capital invested in the business. In actual implementation, average cost is used rather than marginal cost because data about marginal costs are not generally available. This practice may introduce an upward bias into the measure of rent because average cost is usually lower than marginal cost, though some evidence suggests that mining is often subject to constant costs for much of the life of a mine (J, Vincent, pers. comm. 2000). Constant costs result in marginal costs being equal to average costs, so the distortion introduced into the measurement of rent is substantially reduced or eliminated.

$$R = TR - IC\text{-}CE\text{-}CFC\text{-}NP$$

Where

R	Rent
TR	Total revenue form the mining sector
IC	Intermediate consumption
CE	Compensation of employees
CFC	Consumption of fixed capital
NP	Normal profit, calculated as r x capital stock invested in the sector
r	Opportunity cost of capital

This methodology requires an assumption about normal profit, 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 his or her 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 he or she could invest in adjusted for the degree of risk relative to other economic activities.

In practice, the opportunity cost, and therefore the 'normal rate' of return on capital, is difficult to measure and is, therefore, often defined as either the average return on capital in an economy, or the average cost of borrowing capital, i.e., the long-term bond rate. The opportunity cost of capital can vary from country to country, can vary over time within a country, and can vary among industries due to factors like risk and uncertainty. Because of the difficulty of measuring a normal rate of return, a sensitivity analysis may be performed in which the normal profit is estimated for different rates of return to capital stock. In Norway, for example, 8% was used (Statistics Norway, 1998); the United States used a range of 3%, 6%, and 10% (Bureau of Economic Analysis, 1994); 10% and 15% were used in the Philippines (International Resources Group, 1994), rates from 8.8% to 11.4% were used in Papua-New Guinea (Bartelmus *et al*., 1993), 10% was used in Namibia (Lange and Motinga, 1997).

The rent calculations for Botswana use a 10% rate of return on capital stock, which is in line with the rate used by the Ministry of Finance and Development Planning in its economic evaluations. To assess the sensitivity of the results to this assumption, a 20% return is also reported.

Value of mineral assets

The formula for calculating the value of mineral assets is:

$$VC_t = UR_t * Qde_t * \frac{(1+r)^N - 1}{r*(1+r)^N}$$

$$N_t = QC_t / Qde_t$$

Where

VC	Value of the mineral stock at the close of the period
UR	Unit rent, total rent divided by extraction
Qde	Volume of depletion
QC	Volume of the mineral stock at the close of the period
r	Discount rate
N	Number of years that depletion can take place at the current rate.

A number of assumptions are required for implementing this formula: a) future rates of extraction, b) expected future per unit rent, and c) the discount rate. Ideally, information about planned future extraction would be obtained from mining companies and used for the calculation. Similarly, where available, information about expected production costs and projected market prices for the mineral would be used in the calculations. However, in most instances this information is lacking, so, rather than tying to predict these variables, an accepted and widely used methodology is to assume that both the volume of extraction and the per unit rent remain constant over time. This assumption is used in the calculation of the value of Botswana's mineral assets.

A discount rate of 10% is used, which is within the range of 8 to 12% used by the Ministry of Finance and Development Planning (MFDP) in evaluating projects. Because mineral prices can fluctuate a great deal from one year to the next, the real value of mineral assets is not always best represented by the price (the per unit rent) in any single year. In order to reduce volatility and better represent the longer-term value of mineral assets, a number of countries use a multiple-year moving average per unit rent in calculating asset values. Australia, for example, uses a 5-year moving average; this method is also used for Botswana.

There has been some controversy over whether accounts for minerals should include only economically proven reserves, or whether both proven and probable reserves should be valued. In the past, most countries included only proven reserves because of the difficulties in valuing probable reserves. The costs of extraction and, hence, the per-unit rent for probable reserves may differ significantly from extraction costs for proven reserves.

Increasingly, countries are including other categories of reserves because omission of these reserves gives a misleading picture of the mineral assets. For example, the proven petroleum reserves of United Kingdom have shown no depletion for the last 20 years, despite massive extraction (Harris, 2000). Even when probable reserves were added to proven reserves, no depletion was seen. Only when all three categories of reserves—possible, probable, and proven—were included could the depletion of reserves due to extraction be seen. This is because depletion of proven reserves was constantly being offset by further development of probable and possible reserves which added to proven reserves. "Proving" reserves—undertaking the exploration and development necessary to move reserves from probable or possible into proven—is expensive and companies do not undertake this expense until it is profitable for them to do so, i.e., when the current level of proven reserves has declined sufficiently. In principle, the Botswana accounts would include at lest some of all categories of reserves. In practice, the category of reserves included depends on the information available for each mineral and is discussed in the section on physical accounts.

The amount that must be invested depends on two factors—the remaining life expectancy of the resource and the real rate of return earned on the amount saved. If a country has 40 years' extraction remaining, it needs to set aside a much smaller portion than if it has only 20 years'. Similarly, if proceeds can be invested at a 10% rate of interest, a smaller share need be invested than if the return is 5%. The formula for X, the share of rent that can be consumed as income, is

$$X_t = R_t * \left(1 - \frac{1}{(1+r)^{N+1}}\right)$$

Where

X is the share of rent that can be consumed as income
R is the total resource rent.
r is the rate of return
N is the number of years depletion can take place at the current rate.

The remaining amount of rent, R-X, must be reinvested.

Appendix 4: Mineral revenues and total government revenues & grants

Year	GoB revenues/ grants	Mineral revenues	Mineral revenues as % of total GoB revenues & grants
1980/81	307	101	32.9
1981/82	323	77	23.8
1982/83	394	100	25.4
1983/84	563	194	34.5
1984/85	803	376	46.8
1985/86	1,133	581	51.3
1986/87	1,548	845	54.6
1987/88	1,825	1,035	56.7
1988/89	2,556	1,508	59.0
1989/90	2,751	1,596	58.0
1990/91	3,741	2,005	53.6
1991/92	4,069	1,888	46.4
1992/93	4,652	1,866	40.1
1993/94	5,359	2,279	42.5
1994/95	4,473	2,349	52.5
1995/96	5,464	2,591	47.4
1996/97	7,395	3,640	49.2
1997/98	8,281	4,681	56.5
1998/99	7,678	3,187	41.5
1999/00	11,963	6,687	55.9
2000/01	14,115	8,368	59.3
2001/02	12,709	6,996	55.0
2002/03	14,318	7,503	52.4
2003/04	16,197	8,163	50.4
2004/05	17,957	8,682	48.3
2005/06	21,697	10,889	50.2
2006/07	24,144	11,389	47.2
Average for period	7,275	3,688	47.8

Note: 2005 and 2006 figures are revised and budget estimates respectively.