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Are Diamonds Forever? Using the Permanent Income Hypothesis to Analyze Botswana's Reliance on Diamond Revenue

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Abstract

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This study assesses the sustainability of Botswana's diamond-related fiscal revenue. Diamond reserves are not adequate to generate enough permanent revenue to sustain a high level of expenditure. Under the current fiscal rule that no debt may be accumulated, Botswana will have to save more to avoid an abrupt adjustment in the medium term.

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I. Introduction

The diamond industry has been a major contributor to Botswana's growth. Over the past 10 years, the mining sector has contributed an average of 38.5 percent to GDP, with diamonds constituting nearly 94 percent of the sector's total exports. Half of Botswana's diamonds are used industrially. The remainder of diamonds is used for jewelry, accounting for about 80 percent of diamond sales revenue. Diamond exports, Botswana's main source of foreign exchange, averaged 75 percent of total annual exports over the past 10 years. Botswana's diamond resources are mostly mined by Debswana, Botswana's joint venture with De Beers.

So far, Botswana appears to have avoided the "resource curse."[1] The exploitation of diamond resources has evolved with stable mineral legislation. The latest Mines and Minerals Act, passed in 1999, automated the process and made it more predictable at all stages, from prospecting to mining. No major political tensions or corruption have been linked to diamond resources in Botswana. Dutch disease does not appear to have affected nondiamond sectors (Iimi, 2006).

The management of diamond-related fiscal revenue has been sound. Botswana implicitly applies the Sustainable Budget Index (SBI), under which mineral revenue roughly matches investment expenditure. Since 1990, mineral revenue has averaged 20.9 percent of GDP, while investment expenditure, broadly defined, has averaged 19.9 percent of GDP. Investment expenditure includes not only capital expenditure, but also expenditure on heath and education. Thus, analyzing the sustainability of expenditure is crucial, as Botswana has significant development needs, which have intensified with the HIV/AIDS pandemic.

This study uses an analysis designed for oil-exporting countries, which quantifies the impact of the adjustment of government revenue.[2] We apply the lifecycle approach (Modigliani and Brumberg, 1954) and the permanent income hypothesis (Friedman, 1957) to assess Botswana's diamond-related revenue. The approach proceeds as follows: (i) the total diamond resource is estimated; (ii) its net present value (NPV) is taken to be a financial asset generating a permanent income; and (iii) the income estimate is then used to determine how much the government can spend without eroding its long-term financial position.

This study provides quantitative and simple benchmark scenarios to guide policy discussions. It shows that increased public savings in the short term could help Botswana avoid a too sharp fiscal adjustment in the medium term as diamond resources are depleted. The study does not address what fiscal policy may be optimal; the current fiscal rule of no deficit is considered a given. Thus, government expenditure over the medium and long term

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[1] See Stevens (2003) and Sachs and Warner (1995, 2001) for a general discussion of the resource curse.

[2] See Davoodi (2002), for a general presentation, and Barnett and Ossowski (2003) for an application to oil-producing countries.

must be within the fiscal revenue generated by the economy. Any level of expenditure permanently above fiscal revenue would be unsustainable.

Revenue savings must be increased 1.2 points of GDP a year to limit the adverse impact on government spending once diamond production ends.[3] Botswana adopted a fiscal rule imposing a non-negative fiscal balance, as set out in the Mid-Term Review of the Ninth National Development Plan (NDP 9). Thus, the level of expenditure is strictly constrained by the current level of fiscal revenue. However, with fiscal revenue expected to fall from 42 percent of GDP to about 33 percent once diamond resources are exhausted, the government would need to accumulate savings of about 1.2 percentage points of GDP per year to smooth the reduction of expenditure that will be needed under the current fiscal rule. Equally important, as diamond production declines:

- A convincing fiscal adjustment may be needed to ensure that diamond revenue benefits future generations. Revenue-raising measures would help preserve expenditure, either in level (Section III), or per capita terms (Section IV);

- Unless the economy is diversified to create additional sources of revenue before diamond resources are fully depleted, the contraction of fiscal revenue would be steep and would significantly constrain expenditure (Section IV).

The rest of this paper is organized as follows: Section II summarizes Botswana's diamond sector. Section III introduces a simple model of permanent income that aims to smooth the needed adjustment. Section IV analyzes Botswana's capacity to meet its development objectives in terms of expenditure per capita. Section V concludes.

II. DIAMOND RESOURCES COULD BE DEPLETED BY 2029, INDUCING A SHARP FALL IN FISCAL REVENUE

This section presents stylized projections for diamond production and prices, using data from Debswana and the Ministry of Minerals and Water Resources. The rest of this section presents the stylized data on production and prices from which we derive projections for diamond-related fiscal revenue. These data are then used to generate a baseline scenario of fiscal viability under the current fiscal rule using a permanent income approach (Section III.A). We then test how alternative assumptions for production and prices affect our conclusions (Section III.B).

Botswana's diamond reserves could be depleted by 2029 (Figure 1.A). From 2005 to 2017, diamond production is expected to increase from 32 million carats to 44 million carats, largely because a new plant to be opened by Debswana. This plant will use modern

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[3] This paper is based on data available as of June 2006. However, there is a lot of uncertainty around the actual diamond resources, as underlined by recent scaling up of exploration by private exploration companies. Changes to resources stock since June 2006 do not change the conclusions significantly.

techniques both to extract more (though smaller and thus less profitable) diamonds from mine tailings and to recycle large stocks of waste. It should increase the company's diamond extraction by an estimated 35 percent and its income by a more modest   12–15 percent. From 2017 to 2021, diamond production is expected to decrease as diamond reserves are drawn down and surface mines are closed. Then, from 2021 to 2029, as diamond resources draw down, Debswana will need to shift to underground mining. Higher extraction costs and decreased output will result in lower profits; in fact, it is not clear that underground mining in Botswana will be economically feasible or profitable. However, Botswana's market power could result in higher prices, reducing the impact of diamond resource depletion. The impact of increased prices, analyzed in Section III.B, does not significantly alter the baseline scenario, which recommends early adjustment.

The average diamond price is assumed to be constant in real terms (US$120), except when waste is recycled (Figure 1.B). In 2013–17, the period when waste is recycled, the average price is assumed to drop by about 10 percent, to US$110. This hypothesis assumes diamonds extracted from waste are of lower quality.

As diamond resources are drawn down, fiscal revenue is expected to shrink by about two-thirds in 2021–29 (Figure 1.C and D). Botswana's diamond resources generate about 60 percent of tax revenue. Over the past 10 years, mineral revenues,[4] 95 percent of which were from diamonds, accounted for 63 percent of tax revenues. Although Botswana is expected to continue to be the world's leading producer of diamonds well beyond the next decade, it will run into economic difficulties as diamond resources are depleted. These challenges will require policies that bring about fiscal adjustment and economic diversification.
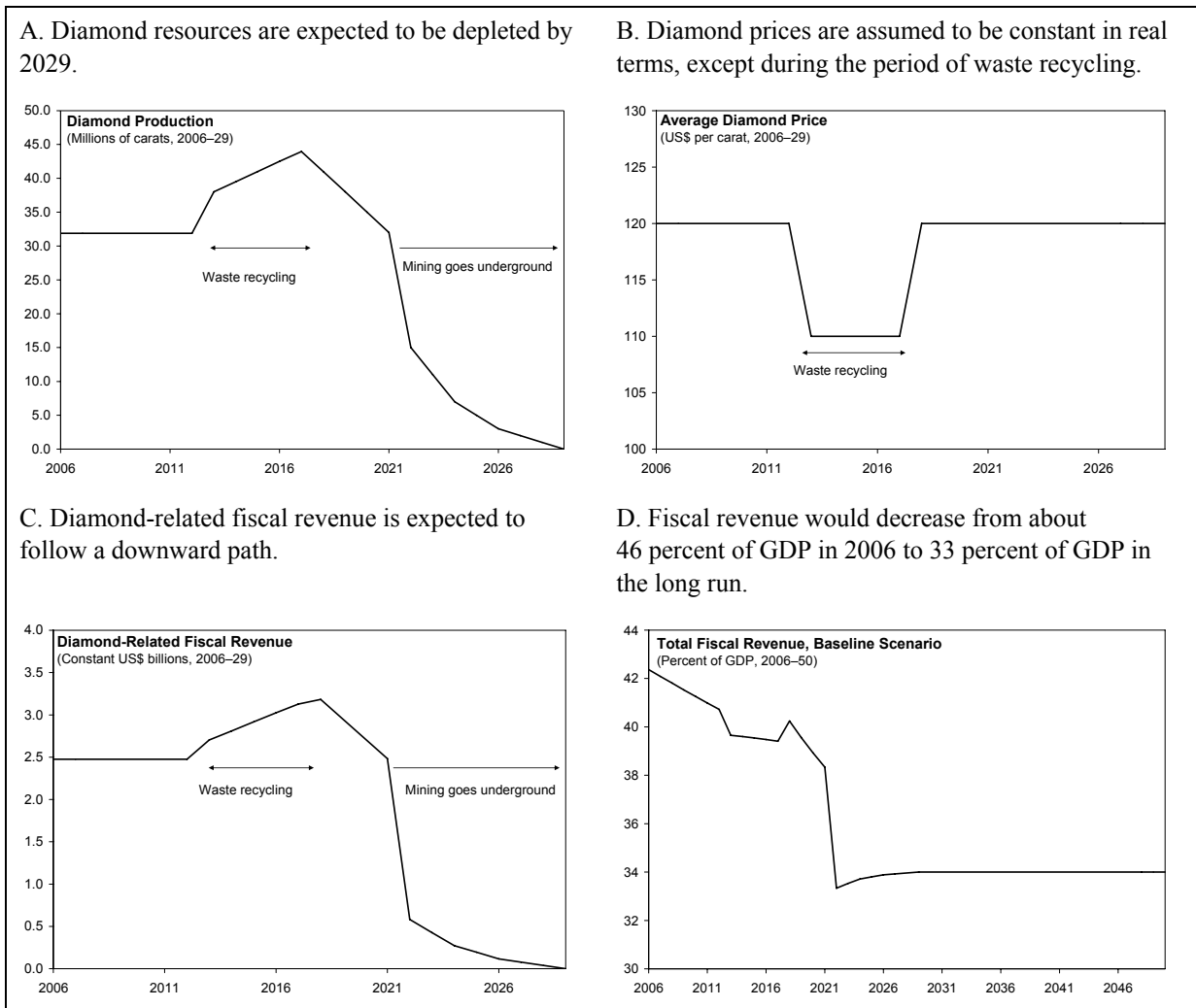
III.   PRESERVING THE FISCAL STANCE WHILE SMOOTHING THE ADJUSTMENT

A.   Smoothing the Fiscal Adjustment

Saving diamond-related fiscal revenue in the near term would help smooth the adjustment in government spending. Revenue saved while production is still strong could be used to finance expenditure once diamond production ends, easing the adjustment in the medium term. Such adjustment would require the existing fiscal rule to be approached differently. Instead of targeting a balanced budget, the short-term objective would be to reach a certain level of savings each year to smooth the adjustment of government spending later on. The fiscal rule would therefore be preserved, while leaving room for intertemporal trade-offs.

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[4] Despite expected new production of other minerals (copper, nickel, and gold), their profits are likely to be relatively modest.

Figure 1. Fiscal Revenue Though Diamond Depletion

A. Diamond resources are expected to be depleted by 2029.

B. Diamond prices are assumed to be constant in real terms, except during the period of waste recycling.

C. Diamond-related fiscal revenue is expected to follow a downward path.

D. Fiscal revenue would decrease from about 46 percent of GDP in 2006 to 33 percent of GDP in the long run.

Source: IMF staff calculations and estimates, based stylized data.

To investigate the impact of revenue savings, we propose a permanent income hypothesis. The net present value of expected diamond-related fiscal revenue at date *t* can be viewed as a financial asset. Let A_t be this asset. A_t can either be used to finance a permanent income (growing at the same rate as long-term GDP growth), or a nonpermanent one, referred to here as quasipermanent income. As shown below, the strict application of a permanent income implies immediate sharp cuts in government expenditure, leaving few resources for the long run. A quasipermanent income, by contrast, is more flexible, as A_t can be used over a period of time, enabling the government to avoid sharp expenditure cuts in the short run. The cost of such an approach is that a long-run source of income is lost.

Diamond resources are not adequate to permanently finance a large share of government expenditure. A_t is defined as follows:

$$A_t = \sum_{j=t}^{T} \frac{D_j}{\left(1+i_t\right)^{-1}\prod_{\tau=t}^{j}\left(1+i_\tau\right)}, \quad\quad (1)$$

where D is diamond-related revenue, i is the real interest on net government financial assets, and T the time-horizon, after which diamond resources will be depleted (2029). Assuming a constant i, equation (1) becomes

$$A_t = \sum_{j=t}^{T} \frac{D_j}{\left(1+i\right)^{j-t}}. \quad\quad (2)$$

A_t is used to generate a permanent income growing at the same rate as long-term GDP growth. Assuming that government expenditure would grow at a constant rate, g: $\forall\,\tau \geq t$ $G_\tau = \left(1+g\right)^{\tau-t}G_t$, with G_t being defined as[5]

$$A_t = G_t \sum_{j=0}^{+\infty}\left(\tfrac{1+g}{1+i}\right)^j \Leftrightarrow G_t = A_t\,\frac{i-g}{1+i}. \quad\quad (3)$$

Once converted, this sum yields a long-run annuity equal to 1.5 percent of GDP (Figure 2.A). That amount is quite low, considering that the ratio of diamond revenue to GDP over the next 10 years is expected to be above 20 percent. This permanent income exercise implies that, unlike some oil-producing countries, Botswana cannot rely on its diamond resources to finance expenditure over the long term. Thus, it would need to implement a strategy to save revenue before diamond production ends, or in addition to, other revenue-generating measures.

The short-term adjustment is smoother under the quasipermanent income approach than under the permanent income approach. Strictly applied, the permanent income hypothesis would require government revenue to be cut to such an extent that Botswana would be unlikely to achieve its development objectives (Figure 2.B). Of the adjustment options available, the ideal would be to smooth the adjustment in the short term, while ensuring a "soft landing." We shorten the time horizon from infinity to a period T (2050 in the baseline), leaving 20 years of annuities after diamond production ends. Formally, the quasipermanent approach investigates a sequence of government expenditure $G_j, j\in\{t,...,T\}$, which satisfies:

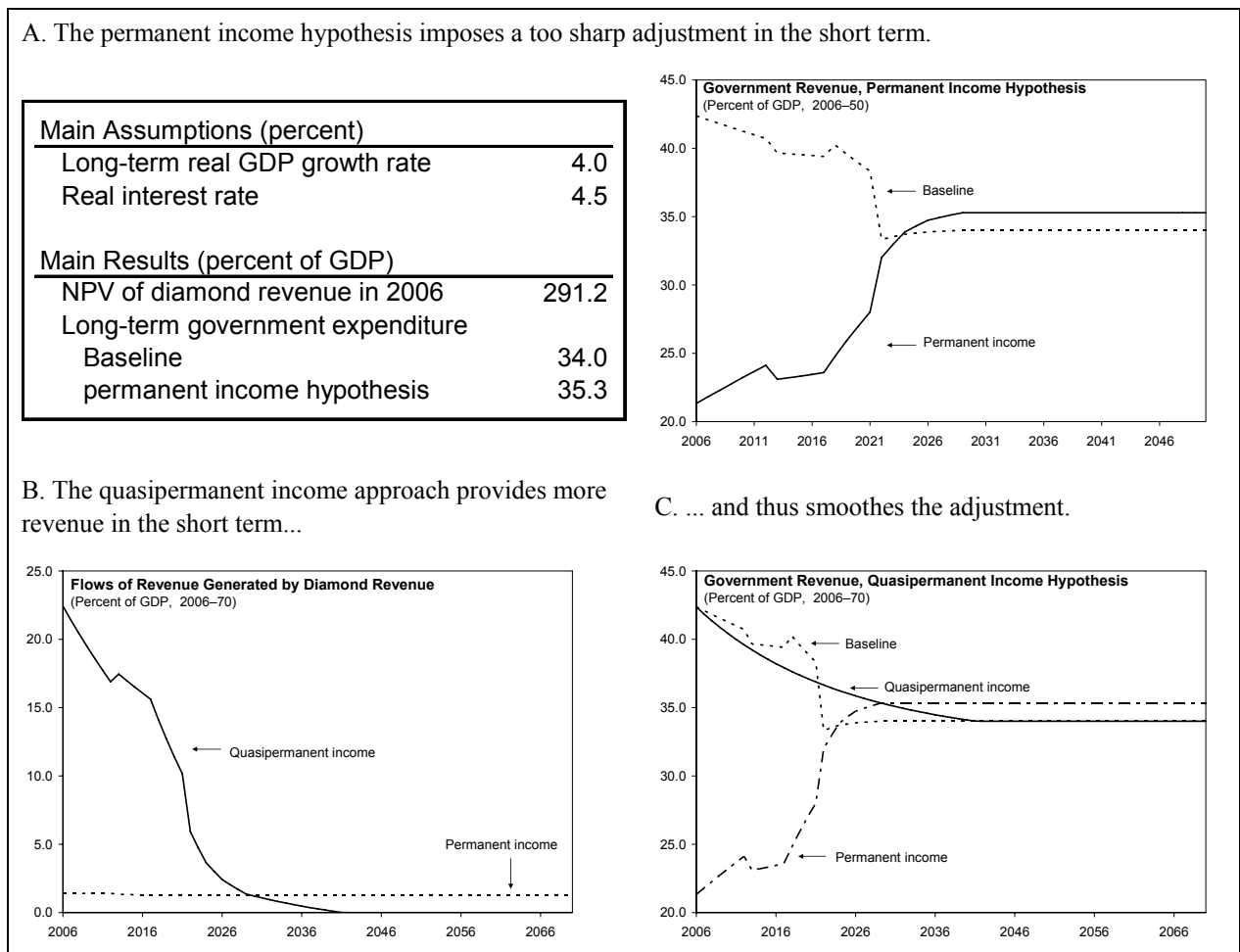$$A_t = \sum_{j=0}^{T}\left(\tfrac{1}{1+i}\right)^j G_j. \qu\quad (4)$$

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[5] This assumes that $i>g$, which corresponds to Botswana's recent trends for central bank lending rates to be 1 to 2 points higher than real GDP growth.

Instead of assuming a constant growth rate for G, the whole sequence of G_j is chosen so that it starts with the existing value as of 2006 and slowly adjusts to its long-term level (i.e., the government revenue-to-GDP ratio once diamond resources are depleted). A hypothetical pattern for G_j, shown in Figure 2.C, implies saving fiscal revenue of about 1.2 percent of GDP a year. This gradual adjustment in savings would smooth the fiscal impact on development and poverty-related expenditures once diamond production declines. By contrast, under a pure permanent income hypothesis, spending would need to be slashed by about 20 percent of GDP in the first few years.

Beyond the horizon of the quasipermanent approach, more adjustment would be needed. Here the quasipermanent income hypothesis leaves an adjustment beyond period T (2050), which could in the interim be addressed through structural and growth-oriented measures that create more public resources for spending.

Figure 2. Permanent and Quasipermanent Income

A. The permanent income hypothesis imposes a too sharp adjustment in the short term.

Main Assumptions (percent)	
Long-term real GDP growth rate	4.0
Real interest rate	4.5
Main Results (percent of GDP)	
NPV of diamond revenue in 2006	291.2
Long-term government expenditure	
Baseline	34.0
permanent income hypothesis	35.3

B. The quasipermanent income approach provides more revenue in the short term...

C. ... and thus smoothes the adjustment.

Source: IMF staff calculations and estimates, based stylized data.

B. Sensitivity Analysis

The net present value of diamond revenue is uncertain because the extent of existing resources is unknown and diamond prices could change. The analysis in the previous section constructs a simple benchmark using data on the estimated stock of diamonds and prices. Because Botswana is a price maker in the diamond market, if production there falls, world diamond prices are likely to rise. However, the extent to which Botswana can offset future production declines with price increases is unknown. As Botswana's production falls, the market's structure (both its demand and supply features) could change, which could impact Botswana's market power. No hard data, however, are available to quantify this market power. Also complicating the analysis is uncertainty about diamond reserves. Although both Debswana and the Ministry of Mineral and Water Resources expect above-ground production to decline from 2022 onward, diamond resources could prove greater than estimated. This would boost the net present value of diamond-related revenue, curbing reducing the need for a strong adjustment in public expenditure.

The uncertainty surrounding prices and production is unlikely to change the need for adjustment. Table 1 summarizes the impact of increased NPV of diamond revenue on the long-term ratio of government expenditure to GDP (under the permanent income hypothesis). Even a 10 percent increase in the NPV would have a negligible impact on the long-term annuity; an expenditure adjustment would still be needed to gradually adjust to the long-run value. Although small, a change of NPV of about 10 percent would require a significant change in either prices or production assumptions. These results are not surprising when Botswana's diamond resources are compared to oil reserves in many oil-producing countries in the Middle East; the life span of Botswana's diamond resources, even in an optimistic scenario, is far shorter and thus cannot generate a permanent source of income.

Table 1. Impact of higher NPV of diamond revenue (percent of GDP)

	NPV	Long-term government expenditure, permanent income hypothesis
baseline	291.2	35.3
5 percent increase	305.7	35.4
10 percent increase	320.3	35.4

Corresponding assumptions on production and prices vs. baseline scenario

5 percent increase	one more year of ground extraction at a high level of about 30 million carats	or	price increase of 75 percent once production starts declining
10 percent increase	two more years of ground extraction at a high level of about 30 million carats	or	price increase of 150 percent once production starts declining

Source: IMF staff calculations and estimates.

IV. PRESERVING DEVELOPMENT OBJECTIVES

The end of diamond production could induce lower growth, which could impede Botswana's development. The previous section assumes a stable growth path over the medium term. This implies that growth diversification will fully compensate for the decline in diamond production. Alternatively, if we assume that the economy diversifies more slowly, growth is likely to flag in 2022–29, when diamond production slows and reserves are depleted. Such a scenario, however, does not fundamentally alter the fiscal analysis of the previous section, which effectively balances diamond-related revenue with expenditure financed out of this revenue. Indeed, the results in percent of GDP change only slightly (Figure 3.A). If growth were lower, however, fewer resources would be available to finance Botswana's development objectives.

Without diversification, government revenue per capita would fall sharply at the end of diamond production (Figure 3.A). Botswana could experience a period of low growth in 2018–24, including a steep recession in 2022 (-9.5 percent) as diamond production declines sharply. Government revenue per capita after 2021 would fall by 27 percent. This negative impact would be temporary, as diversification takes place. However, prospects for diversification, notably with diamond processing activities, already exist. It is thus plausible that Botswana's GDP growth could be between the rates projected in the baseline and the alternative outlined here.

Additional savings early in the transition would prepare the economy for potential recession (Figure 3.B). By increasing savings an average of 2.5 percentage points of GDP through 2021, Botswana could prevent a decrease in per capita expenditure from 2022 on. However, since such savings would have a short-term impact on expenditure, this approach would require committed political and social support.

Diversifying the economy will continue to be the main challenge to Botswana's development objectives. Over the past 15 years, the share of nondiamond sectors in total GDP has been roughly constant (about 38 percent), reflecting its lack of diversification. Despite having a favorable business climate overall (Table 2), as well as sound institutions, Botswana's nondiamond sectors are not as strong as they would need to be to offset declines in diamond production. Two notable impediments to diversification are the labor market—public sector wages exceed, on average, private sector wages by about 60 percent—and slow privatization.

Lack of diversification, combined with potentially reduced poverty-related expenditure, could trigger a more permanent reduction in growth potential (Figure 3.C). The HIV/AIDS epidemic is likely to lower the economy's growth potential while increasing government expenditure. In this context, the contraction of government revenue per capita, could have a lasting impact both on growth and on Botswana's development objectives. For example, a growth rate of 2 percent, as shown in Figure 3.C, would leave little scope for expenditure per capita to increase over the medium and long term. Although analysis of these linkages is beyond scope of this study, the likely effect of the HIV/AIDS epidemic reinforces the need for Botswana to initiate the adjustment soon.
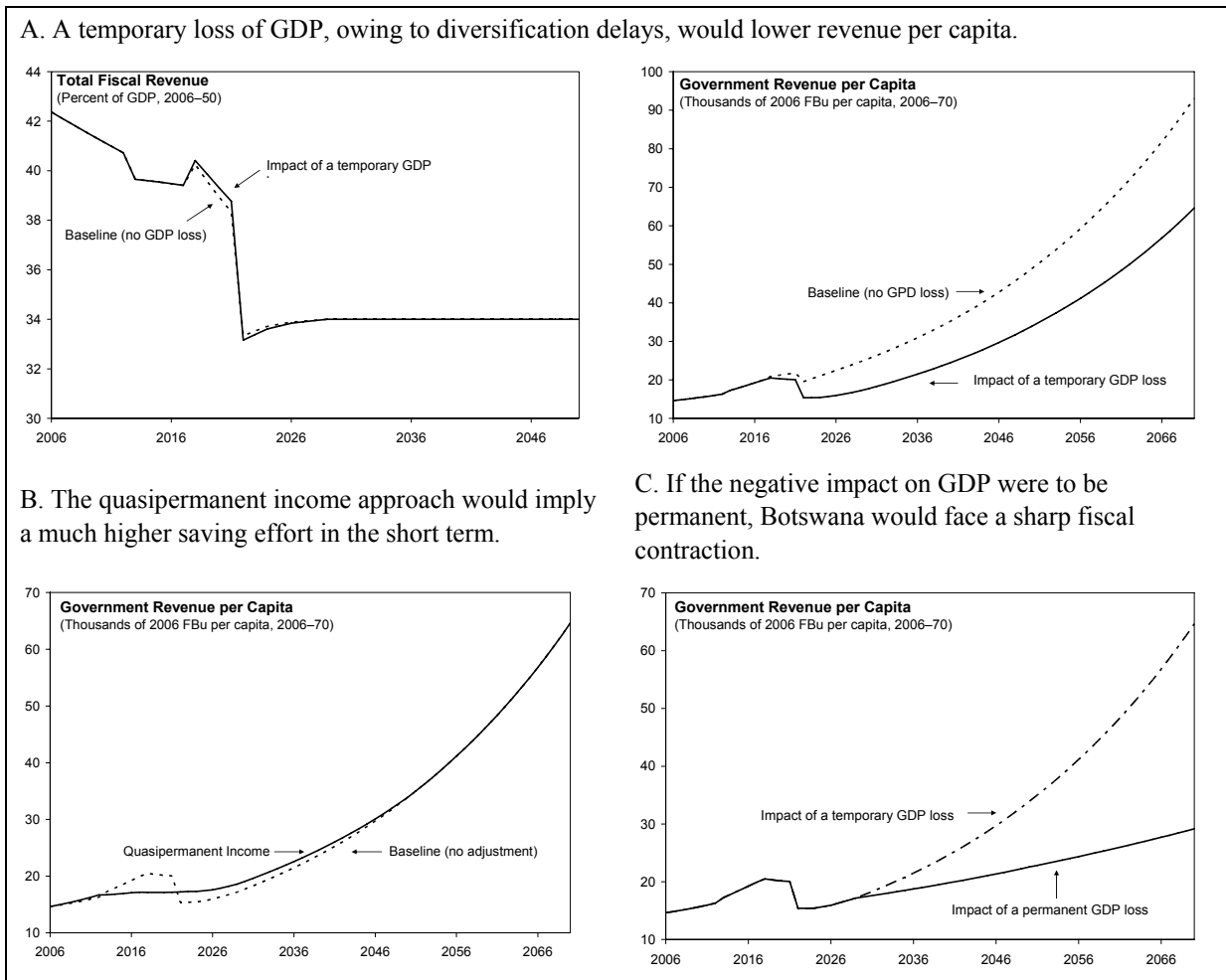
Table 2. Doing Business in Botswana

Rank [1]	2005	2006	Change
Doing Business	44	48	-4
Starting a Business	84	93	-9
Dealing with Licenses	115	136	-21
Employing Workers	62	62	0
Registering Property	34	34	0
Getting Credit	13	13	0
Protecting Investors	114	118	-4
Paying Taxes	63	67	-4
Trading Across Borders	80	89	-9
Enforcing Contracts	73	77	-4
Closing a Business	27	22	5

Source: World Bank, Doing Business.

[1] 175 countries were ranked. 2005 rankings have been recalculated to reflect changes to the 2006 methodology and the addition of 20 new countries.

Figure 3. Permanent and Quasipermanent Income

A. A temporary loss of GDP, owing to diversification delays, would lower revenue per capita.

B. The quasipermanent income approach would imply a much higher saving effort in the short term.

C. If the negative impact on GDP were to be permanent, Botswana would face a sharp fiscal contraction.

Source: IMF staff calculations and estimates, based stylized data.

V. CONCLUSION

Botswana's diamond reserves cannot generate enough permanent revenue to sustain high expenditures. To observe the fiscal rule forbidding the accumulation of debt, as dictated by its fiscal rule, Botswana needs to save more to avoid having to make a painful adjustment in public expenditure in the medium term. Several points should be emphasized:

- Political consensus on saving more in the short and medium term would be needed because the current economic situation is favorable. Thus, adjustment would be viable only if the authorities could gather enough political and social support. This is likely to be difficult because any adjustment is likely to restrain expenditure.

- To diversify the economy and improve growth, Botswana would likely need to attract more foreign investment. New partnerships with the private sector might also be considered to finance infrastructure improvements.

- Budget contingency planning might be needed to accommodate uncertainty about the actual stock of diamonds and future prices.

- The nondiamond fiscal deficit may need to be adjusted given that the economy cannot rely on diamond resources over the long term.

Investment in infrastructure and human capital, which is critical for diversification and growth, could be financed with debt, which would reduce the magnitude of the short-term fiscal adjustment. As an alternative to reducing expenditure, Botswana could change the fiscal rule so that it allows debt to be accumulated to finance investment in infrastructure and human capital. Substituting deficit financing for mineral revenues might make it possible to preserve more expenditure than under the current rule, strictly applied. To keep debt sustainable, the authorities would have to balance expected fiscal revenue with debt service, which means the macroeconomic impact of expenditure financed by debt would have to be assessed carefully. For instance, the positive impact of public investment in human capital on growth takes 10 to 15 years to fully materialize and is of course dependent on the quality of public institutions (see Baldacci et al., 2004).

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