Role of Fiscal Policy in Tackling the HIV/AIDS Epidemic in Southern Africa

John C. Anyanwu
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Eijkeme Okonkwo
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Yaovi Gassesse Siliadin
Eijkeme Okonkwo

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¹ John C. Anyanwu is a Lead Research Economist at the Development Research Department, AfDB (j.anyanwu@afdb.org); Yaovi Gassesse Siliadin is a Graduate Student of Ecole Polytechnique de Tunisie Tunis, Tunisia and Eijkeme Okonkwo holds a Master’s degree of the University College London, University of London, UK. The authors sincerely acknowledge the assistance of Daniel Zerfu (Development Research Department, AfDB) and Zuzana Brixiova (UNDP, Swaziland).
Abstract

Three countries in Southern Africa have the highest adult HIV prevalence in the world: Swaziland (25.9%), Botswana (24.8%), and Lesotho (23.6%). Fiscal policy is crucial for addressing this HIV/AIDS crisis. Utilizing a calibrated model, this paper investigates the impact of fiscal policy on reducing the HIV/AIDS incidence rates in these countries. In particular, we studied the welfare impact of different taxation and debt paths in these countries in reducing the HIV/AIDS prevalence rates. This is particularly important given the current concerns about dwindling foreign aid (especially the global AIDS fund), and the fiscal deterioration and sustainability in these countries. Our results show that, acting optimally has not only positive societal welfare effect but also positive fiscal effects. For example, it will alleviate the debt burden by 5%, 1% and 13% of the GDP, respectively for Botswana, Lesotho and Swaziland by the year 2020. Thus, at a time of fiscal crisis in developed countries and dwindling international HIV/AIDS resources, the future of effective and efficient HIV/AIDS intervention in Africa is clearly domestic.

Keywords: Fiscal Policy, HIV/AIDS, Southern Africa.
JEL Classification: *H51, H61, H6*
I. Introduction

Southern Africa is the worst impacted by AIDS; in three countries in this sub-region, the national adult HIV prevalence rate now exceeds 20%. These countries, which have the highest adult HIV prevalence in the world, are Swaziland (25.9%), Botswana (24.8%), and Lesotho (23.6%) (UNAIDS, 2010). The HIV/AIDS epidemic, a major development threat, is responsible for slowing the rate of growth of the gross national product of many heavily affected countries and increases overall health expenditures for both medical care and social support at the same time that it is claiming the lives of doctors and nurses in the those countries. HIV/AIDS is not only expensive to treat but also disproportionately affects poorer populations, causing impoverishment through disability. In addition, it not only impairs government capacities, it also makes additional demands on governments to address pressing health and other social issues. This scourge of our time takes the lives of children and young adults, especially women, and leads to dramatic declines in life expectancy. Especially in the short-term, the loss of a large segment of prime-age adults, particularly women, devastates households while in the long-term, it creates macroeconomic threats just as losses in human capital formation pose a further risk by influencing the intergenerational transfer of knowledge.

There is evidence that antiretroviral therapy (ART) dramatically slows the progression of HIV infection and AIDS by sharply depressing viral load, improving the cluster of differentiation (CD4) cell counts, and delaying clinical progression to AIDS and fatal complications (Khan et al, 2001; Econsult, 2007). However, financing these ART programs has become very challenging with the international debt crisis, reduced prospects for aid and domestic revenues and the need to implement fiscal consolidation in these economies. Affected countries such as Botswana, Lesotho and Swaziland have no choice but to rely more on their own budget to fight the epidemic. The question then is: if these countries use public revenues to fund the intervention against HIV/AIDS, will there not be increase in their debt burden or some negative externalities on other public funded programs? Utilizing a calibrated macro-econometric model, this paper shows that this will not be the case if public finances are used accordingly to achieve socially optimal reduction targets in the HIV prevalence rate. Instead, it will eventually alleviate the debt burden of these countries.

The rest of this paper is organized as follows. Section 2 presents some stylized facts on the HIV/AIDS scourge in Africa and in particular, Southern Africa sub-region while section 3 examines some relevant literature. Section 4 presents the model while section 5 describes its parameterization. The results and the fiscal implications are discussed in section 6 while section 7 concludes.

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3 See, for example, ADE-TDI-AEDES (2010)

II. Some Stylized Facts

Recent estimates by UNAIDS (2010) show that the total number of people living with HIV across the globe rose from around 8 million in 1990 to 34.0 million by the end of 2010. An estimated 22.9 million people – around 68 percent of the global total - are living with HIV in the sub-Saharan Africa (SSA), making it the region carrying the greatest burden of the epidemic although this region contains little more than 10 percent of the world’s population. It has been estimated that in 2010 around 1.2 million (67 per cent of the global total) people died from AIDS in SSA and 1.8 million people became infected with HIV. Indeed, since the beginning of the epidemic, 14.8 million children have lost one or both parents to HIV/AIDS. In 2010, SSA accounted for 70% of new HIV infections. The estimated number of adults and children living with HIV and AIDS, the number of deaths from AIDS, and the number of living orphans in the world’s regions at the end of 2010 are shown in Table 1. Figure 1 shows the trend in HIV prevalence rate in SSA since 1990.

Table 1: Regional Statistics for HIV and AIDS, end of 2010

<table>
<thead>
<tr>
<th>Region</th>
<th>Adults &amp; children living with HIV/AIDS</th>
<th>Adults &amp; children newly infected</th>
<th>Adult prevalence*</th>
<th>AIDS-related deaths in adults &amp; children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>22.9 million</td>
<td>1.9 million</td>
<td>5.00%</td>
<td>1.2 million</td>
</tr>
<tr>
<td>North Africa &amp; Middle East</td>
<td>470,000</td>
<td>59,000</td>
<td>0.20%</td>
<td>35,000</td>
</tr>
<tr>
<td>South and South-East Asia</td>
<td>4.0 million</td>
<td>270,000</td>
<td>0.30%</td>
<td>250,000</td>
</tr>
<tr>
<td>East Asia</td>
<td>790,000</td>
<td>88,000</td>
<td>0.10%</td>
<td>56,000</td>
</tr>
<tr>
<td>Oceania</td>
<td>54,000</td>
<td>3,300</td>
<td>0.30%</td>
<td>1,600</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.5 million</td>
<td>100,000</td>
<td>0.40%</td>
<td>67,000</td>
</tr>
<tr>
<td>Caribbean</td>
<td>200,000</td>
<td>12,000</td>
<td>0.90%</td>
<td>9,000</td>
</tr>
<tr>
<td>Eastern Europe &amp; Central Asia</td>
<td>1.5 million</td>
<td>160,000</td>
<td>0.90%</td>
<td>90,000</td>
</tr>
<tr>
<td>North America</td>
<td>1.3 million</td>
<td>58,000</td>
<td>0.60%</td>
<td>20,000</td>
</tr>
<tr>
<td>Western &amp; Central Europe</td>
<td>840,000</td>
<td>30,000</td>
<td>0.20%</td>
<td>9,900</td>
</tr>
<tr>
<td>Global Total</td>
<td>34 million</td>
<td>2.7 million</td>
<td>0.80%</td>
<td>1.8 million</td>
</tr>
</tbody>
</table>

* Proportion of adults aged 15-49 who are living with HIV/AIDS
Source: UNAIDS (2011a)
Also, according to UNAIDS (2010), 34 percent (or 11.3 million) of people living with HIV in 2009 globally resided in the 10 countries of Southern Africa; 31 percent of new HIV infections in the same year occurred in these 10 countries, as did 34 percent of all AIDS-related deaths. Those living with HIV in these 10 countries in 2009 were nearly one third (31 percent) more than the 8.6 million people living with HIV in the region a decade earlier.

Indeed, in SSA, Southern Africa is the worst impacted by AIDS; in three countries in this sub-region of Africa, the national adult HIV prevalence rate now exceeds 20 percent. These countries, which have the highest adult HIV prevalence in the world, are Swaziland (25.9 percent), Botswana (24.8 percent), and Lesotho (23.6 percent). Indeed, Swaziland has acquired the notoriety of having the highest adult HIV prevalence in the world. Figure 2 shows the trend in HIV prevalence rates in these three countries from 1990 to 2009. The number of people living with HIV in the three countries has risen between 2001 and 2009: from 270,000 to 320,000 in Botswana; from 240,000 to 290,000 in Lesotho; and from 130,000 to 180,000 in Swaziland.

Due to the scaling up of treatment, AIDS-related deaths decreased by 18% in Southern Africa, with an estimated 610,000 deaths in 2009, compared with 740,000 five years earlier. For example, in Botswana, where adult antiretroviral therapy (ART) coverage stood at about 83 percent (and 90 percent for children), the estimated AIDS-related deaths declined by nearly two-thirds from 15,000 in 2001 to 5,800 in 2009, though the estimated number of children newly orphaned by AIDS rose from 56,000 in 2001 to 93,000 in 2009. However, in Lesotho, AIDS-related deaths remained unchanged at 14,000 in 2001 and 2009 while in Swaziland, there was in fact an increase from 6,800 to 7,000 – though recently these figures have shown a downward trend. Figure 3 shows the estimated number of AIDS-related deaths in the three countries between 1990 and 2009. Apart from Botswana, estimated number of AIDS orphans increased from 53,000 to 130,000 in Lesotho and from 29,000 to 69,000 in Swaziland.

In 2009, about 37 percent of people eligible for treatment were able to access life-saving medicines in SSA. In particular, the number of people receiving ART in SSA stood at 33 percent, with significant country variations: around 83 percent adults (90 percent of children) in
Botswana, 50 percent (23 percent of children) in Lesotho, and 55 percent (70 percent of children) in Swaziland. Figures 4 and 5, respectively, present the number and percentage of people receiving ART in the three Southern African countries. Between 2009 and 2010 alone, there was a 20% increase in ART coverage in SSA.

Figure 2: HIV Prevalence Rates (%), 1990-2009

Figure 3: AIDS-Related Deaths, 1990-2009

Figure 4: Number of People on Antiretroviral Therapy (ART)

Figure 5: ART Coverage (%)

Spending on AIDS varies widely among the three countries: it ranges from US$339.9 million (2008) in Botswana to US$81.3 million (2008) in Lesotho and US$49.5 million in Swaziland (2007). The domestic public sector accounted for 67.3 percent of the expenditure in Botswana while it was 56.9 percent in Lesotho but only 39.6 percent in Swaziland. This pattern is similar in the countries’ spending on care and treatment for AIDS, including ART (Figure 6 and Table 2).

Regarding the cost burden of HIV/AIDS, data summarized in Table 3 indicate that Lesotho has the highest level of spending relative to GDP at 5.01 percent. The next in spending, at 2.62 percent of GDP, occurs in Botswana. It was only 1.71 percent in Swaziland. Domestic spending as a percentage of GDP was highest in Lesotho at 2.85 percent, followed by 1.76 percent in Botswana and 0.68 percent in Swaziland. The scale of the policy and financing challenges that the HIV/AIDS response poses in these countries is illustrated by HIV/AIDS-related spending as a percentage of total public health spending, which is as high as 46 percent in Lesotho and 41 percent in Botswana but 18 percent in Swaziland. This poses immediate fiscal challenge to these
countries hence reliance on external funding at a time of drying external funding from development partners who are going through serious financial crisis.

The situation appears compounded by the fact that annual funding for HIV/AIDS programs fell to $15 billion in 2010 from $15.9 billion in 2009. This is well below the estimated $22 billion to $24 billion the U.N. agencies estimate that is needed by 2015 to pay for a comprehensive, effective global response. The public-private Global Fund to Fight AIDS, Tuberculosis and Malaria, the world’s largest financial backer of HIV treatment and prevention programs, had indicated in November 2011 that it was cancelling new grants for countries battling these diseases and would make no new funding available until 2014.

![Figure 6: Care, Treatment and ART (US$ million), 2008](image)

### Table 2 ART Spending in the Three Countries

<table>
<thead>
<tr>
<th>Country/Year</th>
<th>Spending from Public Finance Resources (US$ million)</th>
<th>Spending from International Finance Resources (US$ million)</th>
<th>Total ART Spending (US$ million)</th>
<th>Spending on ART per person (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Botswana</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>27.6</td>
<td>5.5</td>
<td>33.1</td>
<td>417</td>
</tr>
<tr>
<td>2007</td>
<td>31.3</td>
<td>13.2</td>
<td>44.5</td>
<td>479</td>
</tr>
<tr>
<td>2008</td>
<td>16.3</td>
<td>32.5</td>
<td>48.8</td>
<td>417</td>
</tr>
<tr>
<td><strong>Lesotho</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>13.7</td>
<td>3.5</td>
<td>17.2</td>
<td>798</td>
</tr>
<tr>
<td>2008</td>
<td>9.6</td>
<td>0.395</td>
<td>9.995</td>
<td>221</td>
</tr>
<tr>
<td><strong>Swaziland</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>2</td>
<td>4.3</td>
<td>6.3</td>
<td>338</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
<td>4.3</td>
<td>6.3</td>
<td>254</td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td>6.224</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: HIV/AIDS Expenditure and Financing

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Total (US$ million)</th>
<th>Total as % of GDP</th>
<th>Spending Per Capita (US$)</th>
<th>External Financing (% of total)</th>
<th>Domestically Financed (% of GDP)</th>
<th>Domestically Financed (% of government expenditure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>2008</td>
<td>339.868</td>
<td>2.62</td>
<td>178.3</td>
<td>32.7</td>
<td>1.76</td>
<td>4.4</td>
</tr>
<tr>
<td>Lesotho</td>
<td>2008</td>
<td>81.315</td>
<td>5.01</td>
<td>40.34</td>
<td>43.1</td>
<td>2.85</td>
<td>2.6</td>
</tr>
<tr>
<td>Swaziland</td>
<td>2007</td>
<td>49.447</td>
<td>1.71</td>
<td>42.96</td>
<td>60.4</td>
<td>0.68</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Source: Authors’ computation from UNAIDS (2010) Data

### III. Brief Literature Review

Of the abundant economic papers dealing with the HIV/AIDS epidemics, very few focus on its fiscal implications and scarcer are those conducted on the small satellite states of South Africa, namely Botswana, Lesotho and Swaziland. The major concern of previous HIV/AIDS related studies on these countries was the assessment of the macroeconomic and demographic impacts of the epidemic. A pioneering paper was that of Haacker (2002) who estimated that, in 1998, AIDS has lowered by 20 years life expectancy for almost all Southern African countries and that, for the 15-49 age group, AIDS caused at least 65% of all deaths. He also estimated using a neoclassical growth framework, that For Botswana, Lesotho and Swaziland, the steady-state change in the per capita income in the long term would be -3.2%, -2.1%, and -2.3%, respectively. Another study conducted by Econsult (2007) on Botswana, estimated that the population would be 18-23% less due to AIDS by 2021 compared to a “no AIDS” scenario, and that the average annual population growth rate would be 0.8 to 1.1% less. A recent Lesotho-specific study by ADE-TDI-AEDES (2010) estimated that the epidemic resulted in 15% of GDP in the “without-AIDS” case being lost. The study also concludes that if the National Strategic Plan for HIV is met, the average GDP growth rate in the current decade would be 110% of that in the base scenario (continuing the status quo). Productivity is 2.2-2.5% lower in this baseline case than if there was no AIDS, and removing all HIV intervention funding makes this 3.6%. A 2001 World Bank report on Swaziland used the SPECTRUM model to estimate that the reduction in the population growth rate due to AIDS would increase from 1% in 1998 to 2.4% in 2010. Also, AIDS-related deaths will surpass normal deaths by 19,523 in 2015, with over 80% occurring for those 15-49 years old. The life expectancy reduction due to AIDS is 35.5 years in 2015. Hence, this implies a great reduction in the labor force size which will exacerbate the skilled labor shortage in Swaziland and seriously affect the country’s output.

Interestingly, whatever the data or the model used, all studies conclude that AIDS is a serious threat to Southern African economies. Clearly, there is urgent need to curb the epidemics and the role of government is crucial as private benefits are negligible compared to social benefits of acting against AIDS. Unfortunately, governments have been reluctant to increase their spending on HIV/AIDS intervention citing budget constraints.\(^5\) Such an attitude unveils a fear of negative fiscal impacts noted by some studies such as that of MacFarlan and Sgherri (2001) who claimed that, assuming lifetime treatment cost of 40% of GDP per capita and conservative interventions, public expenditure could reach over 5% of GDP with the possibility of rising even further while revenues will also be lesser due to the effects of the disease on output growth. But this is to forget that positive macroeconomic impacts such as increased labor force and productivity

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resulting from early interventions will increase income per capita and investments and through these channels fiscal revenues. Nevertheless, most of previous studies are conducted imposing a lifetime budget constraint to the government as an assumption instead of focusing on the required intervention and seeking to determine whether such interventions are fiscally cost-efficient or not. An exception, however, is the 2010 ADE-TDI-AEDES study on Lesotho which estimated the impact of interventions on taxes and tried to find the level of intervention that would maximize the fiscal benefit. The study concluded that net indirect taxes would rise with higher levels of intervention and predict the greatest fiscal benefit both by 2013 and 2020 is the scenario where interventions are increased to reduce HIV measures to levels between the current situation and the National Strategic Plan. Yet, the question should be asked the other way around. Governments are not meant to maximize fiscal benefits at the expense of social ones. Therefore, we should first determine the socially optimal level of interventions and then look at its fiscal implications. If it is negative then one can now impose lifetime budget constraint on the governments and estimate the optimal level of intervention. If it is positive then we have a Pareto optimal solution both socially and fiscally.

The rationale behind the existence of a socially optimal level of intervention is presented by Robalino et al (2002). Indeed, there might be a trade-off between the positive consequences of the intervention stated above and the negative impacts linked to the fiscal tool used by the governments to finance the interventions. If the government hikes taxes, workers’ motivation as well as consumption might be affected and then demand and output might fall. If it decides not to hike taxes, then it has to cut spending on other social programs and use the saved money to finance the intervention. This might have a negative spill-over on societal welfare. Robalino et al (2002) then designed a stochastic demographic model and a Solow growth type model similar to Cuddington (1993) to examine the optimal HIV prevalence rate path from 2000 to 2020 that maximizes social welfare in Kenya. Inter-temporal social welfare is measured by a lifetime utility function of consumption per capita. No budget constraint is imposed on the government. However, Robalino et al (2002) were partially interested in the fiscal implication of the optimal reduction. They assumed governments finance their intervention against HIV/AIDS through distortionary taxes which negatively impact output. He failed to answer the question: will the socially optimal intervention increase or not increase public debt burden?

Johansson (2007) focuses on the fiscal implication of AIDS and policy interventions in South Africa over a 30 year timeframe from 2000. In particular, the paper tries to answer the question as to whether such interventions can be financially sustainable, as well as to find the optimal taxation (fiscal) policy for a given intervention strategy. The study uses an infinite dynamic Ramsey growth model as in Flodén (2003) to find a competitive equilibrium that maximizes inter-temporal utility using the labor supply of economically active households and the consumption of both active and inactive households as control variables. This is subject to the household budget constraint, as well as the firm’s profit maximization problem. The solutions to these problems, their constraints and a government budget constraint are then used in the maximization of household utility by the government, using consumption taxes as the instrument. An absolute credit constraint is generally assumed.

The parameters of Johansson’s model are then derived from assumptions, calibrations to current data and other calculations. Also, unlike Robalino et al (2002) above, this study chooses to
exogenously forecast South Africa’s demographic situation using the 2003 ASSA model. These are then used in the model to get macroeconomic and fiscal projections. The study looks at three levels of HIV epidemics mitigation interventions. The basic level is believed to be near completion at 2000, the start of the model. The mid-level includes mother-to-child transmission prevention program (MTCTP), while the full level supplements this with ART programs. The direct costs of these programs are generally excluded and the latter two commence around 2000.

In the baseline case, where debt to GDP is assumed fixed (i.e. the optimal taxation problem is ignored), the effects of different intervention policies are assessed. The full level program results in lower dependency ratios and lower consumption taxes. Loosening the debt assumption but applying the same taxation scheme for all policies, an extra debt of 10% of GDP can be incurred to implement the full program in 2000, and by 2030, the debt ratio will be the same as the basic level program. Using rough calculations later, the study finds that this fiscal gain would largely pay for the direct costs of this program. In comparing fiscal policies, the basic intervention policy is assumed. The study finds that the consumption tax for the optimal policy is kept low at the beginning when dependency ratios are high before it eventually rises above that of the fixed debt ratio policy just before 2030. The welfare gain is seen as 12% of GDP that can be incurred as extra government debt in the optimal policy situation in order to make the discounted utility equal to that under the fixed debt ratio policy.

The model presented in this paper is very close to that of Robalino et al (2002) with the differences that it does not incorporate a stochastic productivity shock, it improves upon the original demographic model by relaxing the assumption of a constant exponential decay of the labor force growth rate, it uses better econometric tools for parameter estimations and it has an additional bloc to assess the fiscal implication of the optimal reduction targets in the prevalence rate. To some extent, the way we analyze the fiscal implication of the optimal intervention is similar to Johansson (2007). The main difference is that Johansson uses the ASSA model to project the demographic profiles of South Africa under different types of intervention. He then used the demographic profiles as input of a Flodén (2003) type model to find the fiscal implications. In our case, the ASSA model is not available for Swaziland and Lesotho. Although the ASSA model for South Africa can be calibrated for other countries and year, the architects behind the ASSA clearly warned against such a practice because of the countless assumptions and interdependent parameters of the model. Hence we have not used the ASSA model and have preferred to stick to the Robalino et al type demographic model. Also unlike Flodén (2003) and Johansson (2007) we will not estimating the Ramsey tax schedule.

Recently, Lule and Haacker (2012), used an analytical framework resting on three pillars—a demographic and epidemiological module, a set of tools to assess the fiscal costs of HIV/AIDS, and a macroeconomic model, to analyze the fiscal implications of HIV/AIDS in Botswana, South Africa, Swaziland, and Uganda. Their demographic and epidemiological module translates assumptions regarding the scale and the effectiveness of national HIV/AIDS responses, notably regarding changes in HIV incidence and scaling-up of access to antiretroviral treatment, into projections of demographic variables and variables describing the state of the epidemic, such as the number of people living with HIV/AIDS and the number of people requiring and receiving treatment. The macroeconomic model builds on a neoclassical growth framework, tracking the implications of the reduced rate of population growth and the costs of the impact of and response
to HIV/AIDS for GDP and government revenues. Their findings show that, absent adjustments to policies, HIV/AIDS treatment is not sustainable. But they also show that, by accompanying treatment with prevention, and making existing programs more cost-effective, the countries can manage both treatment and fiscal sustainability. However, according their analysis, in some of the countries examined, the quasi-liability implied by the cost of the HIV/AIDS program are in a neighborhood that would be considered unsustainable using standard tools of debt-sustainability analysis.

IV. The Model

Our model draws from Robalino et al (2002) model in order to capture the fiscal implications of government interventions against HIV/AIDS epidemics. Capital stock level as well as labor force is assumed to be optimally chosen by a unique representative firm. HIV/AIDS affects the economy through the labor force and labor productivity. The government raises taxes to finance its intervention against the HIV/AIDS epidemics and chooses the optimal reduction in the prevalence rate that maximizes the inter-temporal societal welfare. Data on demographic, epidemiologic and macroeconomic indicators used in this study are from the World Bank’s 2011 World Development Indicators (WDI).

4.1 The firm

There is a single representative competitive firm that maximizes its profit $\pi_t$ given by

$$\pi_t = Y_t - N_t w_t - \left((1 + \tau) r_t + \delta\right) K_t$$

where $Y_t$ is aggregate output modeled by the usual Cobb-Douglass constant return to scale production function.

$$Y_t = (A_t N_t)^{1-\theta} K_t^{\theta}$$

$K_t$ is the capital stock and the capital income tax rate is $\tau$. $r_t$ is the factor price and $\delta$ the annual depreciation rate of capital. $A_t$ is the productivity. The first order conditions implies that

$$w_t = (1 - \theta) y_t$$

With $y_t$ is the output per unit labor

And that

$$r_t = \frac{\theta(Y_t / K_t) - \delta}{1 + \tau}$$

4.2 Labor dynamics

Following the lines of Robalino et al (2002), the effect of AIDS on the labor $N_t$ is modeled by the following dynamics:
\[
\begin{align*}
N_t &= N_{t-1} \exp(y_n(t)) - \Delta H_{t-10} \\
H_t &= \beta_t (1 - \mu_t) N_t
\end{align*}
\]

\(y_n(t)\) is the labor force growth rate in absence of AIDS. \(\beta_t\) is the prevalence rate and \(\mu_t\) is the reduction in the prevalence rate. \(H_t\) is the number of individuals living with HIV/AIDS at time \(t\) and \(\Delta H_t\) is the number of newly infected individuals at time \(t\) and who are assumed to be dead at time \(t + 10^6\). Hence, one may think that the model assumes that PLHIVs\(^7\) have no access to ART programs but we argue that in our model, ART life expectancy increasing effect is captured by \(\mu_t\) because PLHIVs who get access to ART treatments can be considered as healed. Robalino et al (2002) assumed that in absence of AIDS, the labor force growth rate decays at a rate \(\delta_n\) and has an initial value equal to \(y_n\). However the assumption of an exponential decay in the no AIDS labor growth rate at a constant rate is inconsistent with data on Botswana, Lesotho and Swaziland where the growth rate is rather cyclical with an upward trend according to Figure 7. The most intriguing case is perhaps that of Swaziland whose no AIDS labor growth rate peaks at a regular interval of 10 years. It clearly appears that the growth rate would be best fitted by a time series decomposition model.

\[N_t = N_{t-1} \exp(y_n(t)) - \Delta H_{t-10}\]

\(y_n(t)\) is the labor force growth rate in absence of AIDS. \(\beta_t\) is the prevalence rate and \(\mu_t\) is the reduction in the prevalence rate. \(H_t\) is the number of individuals living with HIV/AIDS at time \(t\) and \(\Delta H_t\) is the number of newly infected individuals at time \(t\) and who are assumed to be dead at time \(t + 10^6\). Hence, one may think that the model assumes that PLHIVs\(^7\) have no access to ART programs but we argue that in our model, ART life expectancy increasing effect is captured by \(\mu_t\) because PLHIVs who get access to ART treatments can be considered as healed. Robalino et al (2002) assumed that in absence of AIDS, the labor force growth rate decays at a rate \(\delta_n\) and has an initial value equal to \(y_n\). However the assumption of an exponential decay in the no AIDS labor growth rate at a constant rate is inconsistent with data on Botswana, Lesotho and Swaziland where the growth rate is rather cyclical with an upward trend according to Figure 7. The most intriguing case is perhaps that of Swaziland whose no AIDS labor growth rate peaks at a regular interval of 10 years. It clearly appears that the growth rate would be best fitted by a time series decomposition model.

\[N_t = N_{t-1} \exp(y_n(t)) - \Delta H_{t-10}\]

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is a dummy variable that takes the null value when the year index $t$ is greater than 2000. $\varphi_1$ and $\varphi_2$ are the prevailing trend respectively before 2000 and after 2000. We had earlier shown the evolution of the HIV prevalence rates in Botswana, Lesotho, and Swaziland in Figure 2. Before 2000 when governments’ actions to curb the HIV epidemics have started paying off, the prevalence rate path displays a sharp rising trend. After 2000 the slope is almost flat in Swaziland and even negative in Botswana and Lesotho. It is important to note that equation (8) implies that the term “reduction” employed in the present paper is not absolute but rather relative to the prevailing trend.

### 4.3 Labor productivity

If we denote $A^*$, the actual productivity (in presence of AIDS) and $A$ the potential productivity (In absence of AIDS and $\hat{A}$ the percentage reduction in productivity due to AIDS, we have

$$A^* = A(1 + \hat{A}) \approx A \exp(\hat{A})$$

From the production function we have

$$\hat{A} = \frac{1}{1 - \theta} \hat{Y}$$

where $Y$ is the output and $\hat{Y}$ the percentage reduction in output due to AIDS. Such a reduction can be decomposed into the $c\%$ lost resulting from interventions designed to control the HIV/AIDS prevalence and the $b\%$ lost resulting from an increase in the prevalence rate. Hence

$$\hat{Y} = -c - b \approx \log(1 - c) - \log(1 + b)$$

And we find that

$$A^* = \left(\frac{1 - c}{1 + b}\right)^{1/1-\theta} A$$

If $b_1$ is the cost of avoiding the first additional case, let’s assume that the marginal cost of avoiding an HIV/AIDS infection is increasing so that the average cost of avoiding $\beta_t N_t \mu_t$ new cases is $b_1^{1+b_2 \mu_t}$. Then the total cost of achieving a $\mu_t$ percent reduction per unit output is

$$\hat{c} = b_1^{1+b_2 \mu_t} \left(\beta_t N_t \mu_t / Y_t\right)$$

If we further assume that these interventions would be financed by tax revenues and that mobilizing 1% of GDP for HIV/AIDS interventions would cost 1% of GDP\(^8\) then $c$ equals $\hat{c}$.

Finally, let’s assume that the reduction in GDP due to a one point increase in the prevalence rate is $d_0$ so that

$$b = d_0(\beta_t - \beta_{t-1})$$

Plugging (13) and (14) into (12) we get

\(^8\) Such an assumption is pessimistic. Indeed as Robalino et al (2002) discussed, mobilizing 1% of GDP for HIV/AIDS interventions is highly likely to cost between 0.25 and 0.5% of GDP. However we have preferred to be cautious as overestimating costs is better than underestimating them. Hence our question becomes: is there any benefit in optimally intervening against HIV/AIDS even under pessimistic assumptions about the intervention cost?
The household chooses the consumption level that maximizes its utility by solving the following optimization problem:

\[
\max: V(C_t) = \sum_t \rho^t N_t \frac{(C_t/N_t)^{\tau}}{1 - \tau}, \text{s.t.}
\]

\[
Y_t = (A^*_t N_t)^{1 - \theta} K_t^\theta
\]

\[
K_{t+1} = K_t (1 - \delta_a) + (Y_t - C_t)
\]

\[
\ln(A_t) = \ln(A_{t-1}) + \gamma_a \exp(-\delta_a t)
\]

\( \tau \) is the constant risk aversion parameter and \( \rho \) is the discount factor assumed to be constant. The utility function is population weighted in order to capture the welfare losses due to the death of HIV/AIDS infected individuals. Equation 16c results from the assumption that in absence of AIDS, labor productivity grows at a rate \( \gamma_a \) which is decaying at a rate \( \delta_a \). According to Robalino et al (2002) the solution to this problem can be approximated by equations 17a and 17b:

\[
S^*_t Y_t = K_{t+1} - K_t (1 - \delta_k)
\]

\[
\Delta \ln(k_{t+1}) = \alpha_1 + \alpha_2 \ln\left(\frac{k_t}{A_t}\right)
\]

where \( k_t \) is capital per output and \( S^*_t \) is the optimal saving rate.

### 4.5 The government

The government budget constraint is given by

\[
D_{t+1} = D_t (1 + \tau_w) + G_t + b_1^{1+b_2} \beta_t N_t \mu_t - \frac{1}{\alpha} (\tau_a r_t K_t + C_t \tau_{c,t} + N_t w_t \tau_t).
\]

\( D_t \) is the public debt, \( r_w \) is the world interest rate and \( G_t \) is the total government expenditures including transfers but excluding \( b_1^{1+b_2} \beta_t N_t \mu_t \), the cost of government additional interventions to reduce the prevalence rate. The government imposes a tax rate \( \tau_{c,t} \) on consumption \( c_t \). Each labor force \( N_t \) pays an income tax \( \tau_i \) on its wage \( w_t \). \( \alpha \) is the share of tax revenues in the government total revenue.

---

9 The exact productivity dynamics in absence of AIDS could be much more complex. In fact there are many other determinants of labor productivity such as the level of foreign direct investment, the openness of the economy and the level of investment in human capital (see Ghani and Suri, 1999; Robalino et al, 2002). Nonetheless, we made the assumption 16c, in order to enable analytical solving of system 16 and reflect the fact that structural reforms undertaken by governments to increase labor productivity would have been paying off if there were no AIDS.

10 It is important to introduce this parameter, otherwise the model overestimates the government deficit and the public debt would skyrocket. In fact, non-fiscal revenues represent respectively 30%, 65% and 60% of government
The wage $w_t$ can be replaced by its expression given by equation 3 and we get

$$D_{t+1} = D_t(1 + r) + G_t + b^{1+b(1+	au)}N_t\mu_t - \frac{1}{\alpha}(r\pi\tau_tK_t + C_t\tau_{c,t} + (1 - \theta)\gamma_t\tau_t),$$

4.6 The optimal reductions in the HIV/AIDS prevalence rate

Achieving a certain level of reduction in the HIV/AIDS prevalence rate is twofold. It can be beneficial as it will increase the labor force and improve upon workers’ health and productivity, decrease the dependency ratio, and increase available income per capita and overall societal welfare. On the other hand, the intervention is costly and financing it through distortionary taxes will negatively affect demand, production, consumption and the societal welfare. The question is then, what level of reduction is optimal for the society? Implicitly we are in fact asking the question: what level of distortionary tax is socially optimal? We can answer these questions by solving the following problem:

$$\max: V(\mu_t) = \sum_t \rho^t N_t \frac{(C_t/N_t)^t}{1 - \tau},$$

s.t. 1,2,3,4,11,13,14,15,16b, 17a, 17b,

and $\beta_t(1 - \mu_t) \geq \frac{H_{t-1} - \Delta H_{t-10}}{N_t}$

The last constraint in our optimization problem states that the minimum prevalence rate that can be observed at a certain period is actually achieved when there is a zero incidence rate. Once we get the optimal reductions, we compare the current trend macroeconomic aggregates to the optimal intervention ones and compute the benefit of the latter. Second, we use the government budget constraint equation (19) to estimate the fiscal implications of the optimal intervention. Would it put additional debt burden on the government or rather alleviate it?

V. Model Calibration

The parameters can be grouped into three categories, labor force dynamics parameters, macroeconomic parameters and fiscal parameters.

5.1 Labor force dynamics parameters

Parameters $a$ and $b$ have been computed by a simple regression of the labor force growth rate in absence of AIDS on time. The number of seasons $p$ can be easily determined by a simple glance at Figures 8. The seasonal effect of period $j$, $S_j$ is computed as the average of the residuals $e_{it}$ for $t \equiv j[p]$. $\phi_1$ and $\phi_2$ have been estimated as the slope of the prevalence rate path respectively before and after 2000. The year when the first case of AIDS was reported is 1985 for total revenue in Botswana, Lesotho and Swaziland. Most of these revenues come from the SACU. The alternative to our model would be to impose fictitious high tax rates as Johansen (2006) did. He assumed the profit tax rate in South Africa was 72% while it is actually 28%.

(www.lowtax.net/lowtax/html/offon/southafrica/sasummary.html)
Botswana\textsuperscript{11}, 1986 for Lesotho\textsuperscript{12} and 1987 for Swaziland\textsuperscript{13}. Therefore we can assume that in 1980 the labor force of these countries was not affected by AIDS. Hence, we use 1980 as the initial year for labor force dynamics. Figures 8 show how well our model output fits the actual data on labor force.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figures}
\caption{Comparison of model output of labor force and actual labor force}
\end{figure}

5.2 Macroeconomic parameters

Equation (2b) implies a linear relationship between the capital per worker $k_t$ and output per worker $y_t$, both taken in logarithm.

$$\log y_t = \theta \log k_t + u_t$$

Given the non-stationarity of $\log y_t$ and $\log k_t$ the capital share $\theta$ have been obtained from the VEC estimate of the long run relationship between the two variables. Once $\theta$ was known, the unobserved productivity $A_t$ have been computed using equation (2b). Instead of assuming equation 16c for forecasting purposes, we have estimated and used the actual data generating process.

The capital stock dynamic parameters $\alpha_1$ and $\alpha_2$ have been estimated through the Johansen long run relationship between $\Delta \ln(k_{t+1})$ and $\ln \left( \frac{k_t}{A_t} \right)$ to control for non stationarity. Concerning the utility function parameters $\tau$ and $\rho$, Robalino et al (2002) claimed it could be estimated from data. In fact parameters $\alpha_1$ and $\alpha_2$ are functions of $\tau$ and $\rho$. Therefore, estimates of $\alpha_1$ and $\alpha_2$ could be used to solve backward for $\tau$ and $\rho$. However in our case, the system had a solution only for Botswana. We overcome the issue by taking the same Botswana’s $\tau$ and $\rho$ for Lesotho and Swaziland.

According to a UNAIDS report\textsuperscript{14} 2010, the cost of cheapest WHO recommended first line treatment is currently $110 per case. Hence we set $b_1$ to $110$. Robalino et al (2002) explored

\textsuperscript{11} see \url{http://www.botswanamission.org/aids.html} or \url{www.who.int/hiv/HIVCP_BWA.pdf}
\textsuperscript{12} Source: \url{www.sadcitizen.net/regiondocs/3000301.pdf}
\textsuperscript{13} Source: \url{http://www.who.int/hiv/HIVCP_SWZ.pdf}
the case where the incremental cost $b_2$ was ranging between 0 and 0.5. We have pessimistically considered the extreme case where $b_2$ is set to 0.5. He also showed $[0, 1.5]$ to be a reasonable range for the parameter $d_0$. We have set $d_0$ to 1. In fact, an extremely high $d_0$ would overestimate the potential benefits from reducing the prevalence rate, while an extremely low $d_0$ would underestimate the macroeconomic impact of HIV/AIDS.

5.3 Fiscal implication parameters
The fiscal consequences of government actions are assessed through equation (19). The initial fiscal position is calibrated to fit 2009 national accounts reports. The world interest rate $r_w$ was set arbitrarily to a reasonable level of 2%. We use the prevailing tax rates in the three countries of interest. Indeed average profit tax rate is 25% in Botswana and Swaziland and 35% in Lesotho. Average income tax rate is 20% in Lesotho and Swaziland and 15% in Botswana. Average consumption tax rate is 8% in Botswana and Swaziland while it is 14% in Lesotho.

Concerning the future development of expenditures, the common practice in the literature is to assume that the level of expenditures and transfers per capita is constant by age group. Then using demographic forecasts disaggregated per age group, one can construct the future path of public expenditures and transfers. Unlike previous authors such as Johansson (2007) and Flodén (2003), we do not have the population projections by age group. So we have simply assumed a constant annual growth of respectively 6%, 5% and 6% in the total expenditures including the transfers in Botswana, Lesotho and Swaziland. The reason why we use a relatively smaller public expenditures growth for Lesotho is that the country is already heavily indebted compared to its neighbors. In 2001 the country’s total public debt peaked at more than 110% of GDP. Since then the government took actions to reduce it. In 2009, Lesotho’s public debt has shrunk but was still culminating at 52% of its GDP while its neighbors Swaziland and Botswana were enjoying a relatively lower debt to GDP ratio of respectively 18% and 7%.

All parameters values are presented in Table 4.

VI. Findings and Fiscal Implications

6.1 Optimal HIV prevalence rate path
Simulations were carried out with Matlab R2008a which offers sophisticated tools for non-linear optimization problem-solving. The first remark is that the optimal reduction targets don’t depend on the prevailing trend. Hence, during the next 10 years the additional effort a government should make in order to maximize societal welfare is the same whether there are some ongoing efforts or not. This result was predictable as the optimal reduction is not linked to the prevalence rate level but rather to the incidence rate which must be zero at the optimum.

15 Source: http://www.taxrates.cc/
Table 4: Values for model parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Botswana</th>
<th>Lesotho</th>
<th>Swaziland</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varphi_1$</td>
<td>Slope of the prevalence rate path before 2000</td>
<td>0.025</td>
<td>0.028</td>
<td>0.021</td>
</tr>
<tr>
<td>$\varphi_2$</td>
<td>Slope of the prevalence rate path after 2000</td>
<td>-0.0022</td>
<td>-0.001</td>
<td>0.0017</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Capital share</td>
<td>0.69</td>
<td>0.42</td>
<td>0.53</td>
</tr>
<tr>
<td>$b_1$</td>
<td>Cost parameter 1</td>
<td>US $110</td>
<td>US $110</td>
<td>US $110</td>
</tr>
<tr>
<td>$b_2$</td>
<td>Cost parameter 2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>$d_o$</td>
<td>% reduction in GDP due to a one point increase in the prevalence rate</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$\tau_p$</td>
<td>Profit tax rate</td>
<td>25%</td>
<td>35%</td>
<td>25%</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Capital depreciation rate</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>$\gamma_a$</td>
<td>Average growth rate of productivity</td>
<td>0.024</td>
<td>0.008</td>
<td>0.049</td>
</tr>
<tr>
<td>$\gamma_n$</td>
<td>Average growth rate of labor force</td>
<td>0.041</td>
<td>0.027</td>
<td>0.42</td>
</tr>
<tr>
<td>$\alpha_1$</td>
<td>Capital stock dynamic parameter 1</td>
<td>0.109</td>
<td>-0.096</td>
<td>-0.081</td>
</tr>
<tr>
<td>$\alpha_2$</td>
<td>Capital stock dynamic parameter 2</td>
<td>-0.031</td>
<td>0.039</td>
<td>0.026</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Share of tax revenues in the government total revenues</td>
<td>70%</td>
<td>35%</td>
<td>40%</td>
</tr>
<tr>
<td>$\tau_w$</td>
<td>World interest rate</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>$\tau_i$</td>
<td>Income tax rate</td>
<td>15%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>$\tau_c$</td>
<td>Consumption tax rate</td>
<td>8%</td>
<td>14%</td>
<td>8%</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Risk aversion</td>
<td>3.33</td>
<td>3.33</td>
<td>3.33</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Discount factor</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Initial debt to GDP ratio</td>
<td></td>
<td>7%</td>
<td>52%</td>
<td>18%</td>
</tr>
<tr>
<td>Growth rate of government expenditures</td>
<td></td>
<td>6%</td>
<td>5%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Table 5 presents the optimal reduction targets. The optimal intervention consists of achieving sharper reductions in the early years. In fact, Botswana should optimally cut its prevalence rate by 15.83% annually during the first five years and reduce it by only 2.22% annually each year during the remaining seven years. In Lesotho, from 2009 to 2013, the prevalence rate should optimally decline by 4.24% each year while from 2014 to 2020 it should decline by only 0.86% annually. In Swaziland, the average optimal yearly reduction during the first five years is 4.96% while it is 2.75% during the last 7 years. These results are similar to those on Kenya estimated by Robalino et al (2002) who have also highlighted the importance of early actions. The rationale behind this is that early sharp reductions are at the benefit of future reductions which can be smaller and cheaper. The economy will then benefit from important accrued macroeconomic gains that will offset intervention costs.
Table 5: Optimal reductions in the HIV prevalence rate

<table>
<thead>
<tr>
<th></th>
<th>Botswana</th>
<th>Lesotho</th>
<th>Swaziland</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>9.44%</td>
<td>7.04%</td>
<td>7.69%</td>
</tr>
<tr>
<td>2010</td>
<td>18.08%</td>
<td>6.13%</td>
<td>7.27%</td>
</tr>
<tr>
<td>2011</td>
<td>17.77%</td>
<td>4.88%</td>
<td>6.52%</td>
</tr>
<tr>
<td>2012</td>
<td>17.45%</td>
<td>2.20%</td>
<td>3.33%</td>
</tr>
<tr>
<td>2013</td>
<td>16.43%</td>
<td>0.94%</td>
<td>0.00%</td>
</tr>
<tr>
<td>2014</td>
<td>0.00%</td>
<td>0.86%</td>
<td>0.00%</td>
</tr>
<tr>
<td>2015</td>
<td>0.00%</td>
<td>3.28%</td>
<td>4.46%</td>
</tr>
<tr>
<td>2016</td>
<td>1.50%</td>
<td>0.44%</td>
<td>6.78%</td>
</tr>
<tr>
<td>2017</td>
<td>2.74%</td>
<td>0.45%</td>
<td>2.29%</td>
</tr>
<tr>
<td>2018</td>
<td>0.00%</td>
<td>0.35%</td>
<td>4.01%</td>
</tr>
<tr>
<td>2019</td>
<td>0.00%</td>
<td>0.25%</td>
<td>0.22%</td>
</tr>
<tr>
<td>2020</td>
<td>11.29%</td>
<td>0.39%</td>
<td>1.46%</td>
</tr>
</tbody>
</table>

Average annual reduction in the first 5 years: 15.83%  4.24%  4.96%
Average annual reduction in the last 7 years: 2.22%  0.86%  2.75%

Figures 9 show the prevalence rate paths under four possible situations. The “no intervention” case relates to the situation where the trend during the peak period of the epidemics (1990s) continues. The current trend is referred to as “current intervention”. The fictitious case where the optimal reductions efforts are performed without the previous efforts is termed “optimal relatively to the no intervention case” while the case where the optimal reduction efforts are added to the current one is termed “optimal considering current intervention”.

For the three countries, the prevalence rate is lowest in the last situation as one could have expected. In that situation, the prevalence rate will be brought down from more than 20% to nearly 10% (even less in Botswana). If there were no intervention to curb the epidemics, by 2020 more than half the population would be affected by AIDS. If governments maintain current trend, the prevalence rate will slightly decline in Botswana and Lesotho, slightly increase in Swaziland, but will stay at relatively high level above 20% of the population. Henceforth, we will simply refer to the “optimal considering current intervention” case as “optimal intervention”.


Figures 9: HIV prevalence rate paths under different interventions
6.2 Fiscal implications

Implementing socially optimal reduction policy might be very appealing but what does it imply on public debt? If governments finance such interventions through taxes, what happens at the end? Will the fiscal revenues exceed the expenses? Are they financing the interventions at the expenses of future generations? As developing countries government are usually budget constrained one way to answer these questions is to compare the consumption tax rate schedules that would help keep the debt to GDP ratio constant under the different interventions.

Figures 10 display the results which show that for each country, except for one year, the needed tax in the optimal intervention tax case is lower than needed if the current trend continues. In other words fiscal deficit is almost always lower in the optimal situation than the current one. Hence optimal reductions will positively affect the public debt.

Another natural way of analyzing the fiscal implications of the optimal policy is to compare the debt to GDP ratio under the different interventions. As Figures 11 show, by 2020 Botswana could bring its debt down to only 6% of GDP by implementing the optimal reductions while the current intervention would cause an increase of the debt to 11% of the GDP. In Lesotho, either intervention would significantly shrink the debt to GDP ratio which will fall from 52% to 12% with current intervention and to 11% in optimal intervention. In Swaziland, in the short term, optimal intervention imposes a higher debt to GDP ratio than does the current intervention. However, in the long term, the trend is reversed. By 2020, instead of having a debt to GDP ratio of 8% with the current interventions, Swaziland could become a world creditor by nearly 5% of its GDP if it chooses to act optimally.

To sum up Botswana, Lesotho and Swaziland don’t need to worry. In the long term, acting optimally has not only positive societal welfare but also positive fiscal effects. It will alleviate the debt burden by respectively 5%, 1% and 13% of the GDP of Botswana, Lesotho and Swaziland by the year 2020. This means that the government could spend more money than implied by our model on the optimal reductions without increasing the public debt. Hence even if we have underestimated some costs optimal intervention would still be socially and fiscally beneficial.

Obviously, these figures depend heavily on the tax rates and the assumed constant annual growth rate in the current government expenditures. Therefore, we carried out the simulations for various tax rates and government expenditure growth rate. Interestingly, by 2020, whatever the tax rates used or the growth rate in the government expenditure is, optimal interventions will put less debt burden on the government than the current intervention will do.
Figures 10: Consumption tax rate (Fixed Debt to GDP Ratio)
VII. Concluding remarks

The main contribution of this paper is that it demonstrates the cost-effectiveness of the fiscal tool in the fight against HIV/AIDS if optimally used during the next decade. By acting optimally, Lesotho, Botswana and Swaziland could respectively alleviate their debt burden by around 1%, 5% and 13% of GDP, respectively, while maximizing simultaneously the inter-temporal societal welfare. This suggests that these countries’ governments should not be reluctant in using the fiscal tool to fight HIV/AIDS due to fear of an increase in public debt. More importantly, it suggests that these countries should not wait for foreign aid, which, in any case, is fast dwindling in era of fiscal crisis, especially in Europe. They can use their tax revenues to increase, at the optimal level, their spending on combating the epidemics. Such a finding comes timely, as international aid is expected to be negatively impacted in the coming years by the financial and debt crisis faced by developed countries.

Fortunately, this totally agrees with the declaration by all participants of a group of high level representatives from leading political, economic and regional institutions in Africa during a
consultation organized by UNAIDS on 16 November 2011 at UNAIDS Headquarters in Geneva. They declared that “Africa is taking ownership of its AIDS response” and that African leaders have the power to create change in their countries (UNAIDS, 2011b). This conclusion has also been endorsed by the President of the African Development Bank, Dr. Donald Kaberuka when he declared that Africa will have to take ownership of its AIDS response (Kaberuka, 2011). According to him, “Africa's economic emergence will transform the way we think about global health” hence “tomorrow's agenda will be domestic” (Kaberuka, 2011; 1904-1905). This calls for using evidence-based budgeting tools (such as the marginal budgeting for bottlenecks (MBB) approach developed in Rwanda and Ethiopia), the introduction of performance-based budgeting and result-based financing, improvement in the efficiency of private spending in health (including on HIV/AIDS) through increased risk pooling, as has been successfully done in Ghana as well as value for money through more transparent budgeting practices. One of the greatest implications of our results therefore is that African countries can make much better use of their own resources to fund development projects, by increasing tax revenues. That doesn’t necessarily mean increasing tax rates, but making the tax collection system more efficient, improving general tax administration and extending the tax base.

Second, optimal intervention leads to early sharp reductions in the prevalence rate, stressing the urgency of increasing expenditures on the expensive but cost-effective ART programs. Traditional fight against AIDS includes mother to child transmission prevention, condom distribution, information campaigns and counseling. But as Johansson (2007) showed in a paper on South Africa, implementing these “cheap” interventions without the ART interventions is fiscally worse than the no-intervention case and less macro-economically efficient than the full ART intervention case. Again, here, Kaberuka (2011) has this to say: “The global health agenda in the coming decade will also be about sustainable delivery of the high-impact interventions that were previously supported by development partners”.

Third, it is important to note that we have been pessimistic about intervention costs and that our approach to measuring societal welfare omits some important negative consequences of HIV/AIDS for Southern Africa such as increase in number of orphans and human suffering of the infected. Thus estimates of welfare gains from HIV/AIDS reductions in our paper are likely to be underestimated, underscoring further the importance of immediate and optimal government interventions.

Finally, our results are useful to policy makers in National AIDS commissions, Ministries of Health, and Ministries of Finance, in assessing the financial sustainability and allocative efficiency of the national HIV/AIDS programs, and in formulating effective national HIV/AIDS strategies to treat and provide care and support for those affected. At the same time, it will inform the global policy dialogue regarding the financing of HIV/AIDS programs, particularly the roles of domestic public and private resources and of external assistance. The findings from this study, and the analytical tools developed in it, could help governments in defining policy objectives and improving fiscal planning. The study’s findings could also contribute to the Development Finance Institutions’ (DFI’s) (including the African Development Bank’s) policy advice on implementing the HIV/AIDS response, especially with respect to fiscal management and fiscal sustainability.
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