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Welfare Implications of HIV/AIDS

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Abstract

The paper evaluates the impact of HIV/AIDS on welfare in several countries affected by the HIV/AIDS epidemic. Unlike studies focusing on the impact of HIV/AIDS on GDP per capita, we evaluate the impact of increased mortality using estimates of the value of statistical life. Our results illustrate the catastrophic impact of HIV/AIDS in the worst-affected countries and suggest that studies focusing on GDP and income per capita capture only a very small proportion of the welfare impact of HIV/AIDS.

JEL Classification Numbers: I10, I30, I31, N37, O10

Keywords: Welfare, HIV/AIDS, value of statistical life, Africa

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I. Introduction

The HIV/AIDS epidemic has resulted in significant increases in mortality rates in the affected countries, and it is now the leading cause of death in Southern Africa (see Table 1 below). In Botswana, the worst-affected country, with an adult HIV prevalence rate of 38.8 percent, mortality rates for the working-age population have increased to 4.3 percent (4.1 percent HIV/AIDS related) by 2003, and are projected to increase to 6.1 percent (6.0 percent HIV/AIDS related) by 2010. Correspondingly, life expectancy has decreased substantially, and is now estimated at less than 40 years for Botswana and Zimbabwe, which means a decline of over 30 years.

A considerable number of studies have addressed the impact of HIV/AIDS on per capita GDP.[2] Some have used a neoclassical growth framework to estimate the impact of HIV/AIDS on aggregate output or income, while others have used a general-equilibrium model with a larger number of sectors. Additionally, the studies may differ according to the types of labor or human capital captured, the extent of labor mobility between sectors, the extent of international or domestic capital mobility, and the assumptions regarding the impact of HIV/AIDS on productivity. While most studies project a small negative impact of HIV/AIDS on per capita output, the estimates are very sensitive to the underlying economic assumptions. For example, a study on South Africa (with an adult HIV prevalence rate of about 20 percent) commissioned by ING Barings projects that the level of per capita GDP will increase by about 9 percent by 2010, compared with a no-AIDS scenario (see ING Barings, 2000). Arndt and Lewis, using similar demographic assumptions, estimate that GDP per capita will be 8 percent lower in 2010 (again, compared with a no-AIDS scenario).[3]

While studies of the impact of HIV/AIDS on GDP are useful in a number of contexts (for example, by informing policymakers of the broader economic repercussions or of the

[2] See IAEN (2002) or Haacker (2002b) for a discussion of the literature.

[3] The differences between the two studies quoted mainly arise because ING Barings (2000) puts much emphasis on demand-side effects, whereas Arndt and Lewis (2001) assume that HIV/AIDS has an impact on productivity growth (rather than the level of productivity), which accumulates over time.

availability of resources to cope with the epidemic), they provide a very crude picture of the economic impact. In particular, estimated changes in GDP give a very incomplete picture of the impact of HIV/AIDS on economic welfare, in light of the broad economic and social repercussions, and do not capture a substantial increase in risk associated with increased mortality and reduced life expectancy, the risk of losing relatives, and a decline in living standards for those infected, their relatives, and — eventually — their surviving dependents.

There are numerous quantitative indicators of the impact of HIV/AIDS on welfare. For example, the losses in life expectancy in the worst-affected countries are reversing all the health gains achieved over the last century (Stanecki, 2000); HIV/AIDS is the biggest factor contributing to decreases in healthy life expectancy in Africa overall (Mathers and others, 2000); and, in Zimbabwe, about 15 percent of the population younger than 15 years were orphans in 2001. More generally, most of the gains in the United Nation's Development Program's Human Development Index over the last century resulted from gains in life expectancy, and in many countries, these gains will be largely lost.[4]

The purpose of the present paper is twofold: (1) we develop new quantitative indicators of the welfare effects of HIV/AIDS by evaluating the welfare cost of increased mortality; and (2) since our approach yields estimates of the welfare cost of HIV/AIDS as a percentage of GDP, it also provides some perspective on the impact studies focusing on output and income.

To do this, we use a technique originally developed to assess the impact of health, environmental, or work safety interventions, focusing on the value of statistical life (VSL). Estimates of the VSL are generally obtained from microeconometric studies relating wage differentials between employment categories to differentials in mortality risks (see Miller, 2000, or Viscusi and Aldy, 2003). Provided that these observed wage differentials accurately reflect the willingness to pay for a change in mortality, these estimates of the VSL can then be used to assess the costs and benefits of certain policy interventions.

[4] UNDP's Human Development Index is based on educational variables, income, and life expectancy. See UNDP (2001) and Crafts (2002).

More recently, this approach has been used in macroeconomic studies assessing the impact of improved health standards on economic welfare. For example, Nordhaus (1998 and 2002) finds that for the United States the contribution of health improvements to living standards was similar in size as the contribution of increased consumption over the period 1900–95. Crafts (2001), drawing on Nordhaus (1998), reports similar findings for the United Kingdom over the period 1870–1998.

Our paper adapts this method to the study of the economic impact of HIV/AIDS. While the key concept translates very easily to the study of HIV/AIDS, it is important to bear in mind certain limitations. As few empirical studies on the VSL are available for lower-income countries and none are available for sub-Saharan Africa, the usual shortcomings associated with out-of-sample predictions apply (see Bowland and Beghin (2001) for a discussion of this point). In particular, the level of income in sub-Saharan Africa is lower than in those countries for which studies are available; life expectancy is lower; the informal sector is larger; the structure of (formal sector) labor markets, including the coverage of social insurance systems, is different; the level of education is lower than in those countries for which empirical studies are available; and, in most countries, the changes in mortality associated with HIV/AIDS are generally larger than those in the available studies. Also, it is important to note that our estimates reflect only the impact of increased mortality, but not of the deterioration in overall health.[5] However, while our point estimates are subject to considerable uncertainty, our results show that HIV/AIDS does have a catastrophic welfare impact that dwarfs the economic assessments based on per-capita income.

Section II outlines the methodology used in this paper; Section III discusses the demographic data and projections used; Section IV presents estimates of the impact of HIV/AIDS on welfare for selected countries; and Section V concludes. Appendix Table 1 provides estimates of the aggregate welfare impact of HIV/AIDS for a larger number of countries.

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[5] A more refined measure of the impact of HIV/AIDS on life expectancy is the "diability-adjusted life expectancy" (DALE), used, for example, by the World Health Organization (see Mathers and others, 2000). We have not followed this approach because sufficiently detailed demographic projections are not available and because extending our method of accounting for the value of statistical life to changes in DALE is not straightforward.

II. A Method of Accounting for Increased Mortality

The approach followed in this paper can be illustrated in terms of an individual who values both higher income and longer life, and whose utility U is defined by the function

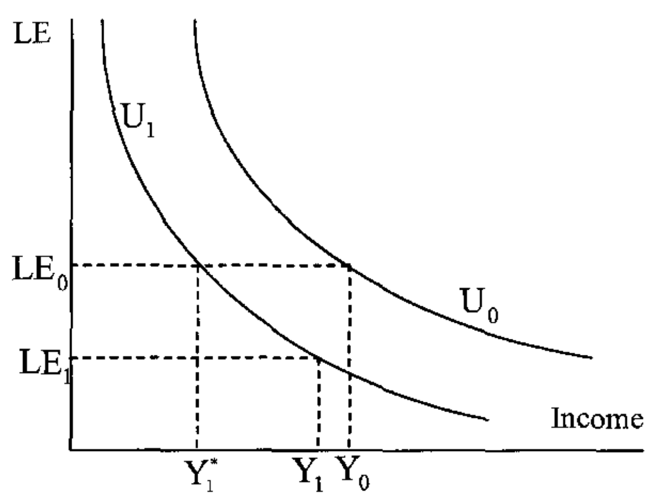
$$U = F(Y, LE), \tag{1}$$

where Y and LE stand for income and life expectancy, respectively. Consider a situation with $Y = Y_0$ and $LE = LE_0$, and, hence, $U = F(Y_0, LE_0)$. Owing to HIV/AIDS, income falls to $Y = Y_1$, life expectancy declines to $LE = LE_1$, and utility becomes $U = F(Y_1, LE_1)$. The decline in real income, including an imputation for increased mortality, is then defined as the difference between Y_0 and Y_1^*, where Y_1^* is the income level which gives the same level of utility as (Y_1, LE_1) at the previous level of life expectancy LE_0, that is,

$$F(Y_1^*, LE_0) = F(Y_1, LE_1). \tag{2}$$

The difference between this approach and studies focusing either on the change in mortality or on the change in per capita GDP can be illustrated by means of a simple diagram. In Figure 1, the "no-AIDS" scenario is represented by the point (Y_0, LE_0), with associated utility level U_0, and the situation including the impact of HIV/AIDS by the point (Y_1, LE_1), with utility level U_1.

Figure 1. The Impact of HIV/AIDS on Welfare



In Figure 1, the two indifference curves describe combinations of Y and LE for which the level of utility is equal to U_0 and U_1, respectively. Demographic studies measure the impact of HIV/AIDS by the distance $LE_1 - LE_0$, while studies of the impact of HIV/AIDS on income focus on the distance $Y_1 - Y_0$. Our method focuses on the distance $Y_1^* - Y_0$, that is, the change in real income adjusted for the change in life expectancy.

More specifically, we assume that an individual values consumption and life expectancy according to the lifetime utility function

$$U[\{c_t\},\{\mu_{s,t}\},\rho,s] = \int_s^{\infty} u(c_t)e^{-(\rho-\mu_{s,t})t}\,dt\,, \tag{3}$$

where $\{c_t\}$ denotes the individual's consumption stream over time, s stands for the individual's initial age, $\{\mu_{s,t}\}$ is the set of time-varying mortality rates of an individual with initial age s at time t, with $t \in [s,\infty)$, and ρ gives the discount rate. The individual's budget constraint is

$$\int_s^{\infty} c_t e^{-(\mu_{s,t}-r)t}\,dt = \int_s^{\infty} y_t e^{-(\mu_{s,t}-r)t}\,dt\,, \tag{4}$$

where y_t stands for the individual's income at time t. For simplicity, we assume that income is constant over an individual's life span (i.e., $y_t = y^*$), and that the real interest rate is equal to the discount rate. In this case, the optimal level of consumption is $c_t = c^* = y^*$, and the optimized level of lifetime utility is equal to

$$V(\{\mu_{s,t}\},y^*,\rho,s) = u(y^*)\int_s^{\infty} e^{-(\rho+\mu_{s,t})t}\,dt\,, \tag{5}$$

or $\quad V(\{\mu_{s,t}\},y^*,\rho,s) = u(y^*)LE(\{\mu_{s,t}\},\rho,s)$, $\quad$ with $\quad LE(\{\mu_{s,t}\},\rho,s) = \int_s^{\infty} e^{-(\rho+\mu_{s,t})t}\,dt\,, \qquad (6)$

i.e. the product of an individual's flow utility from the consumption stream y^* and the discounted life expectancy LE.

Empirical studies of the VSL generally link observed differences in income, for example across professional categories, to differences in mortality risk. For a constant mortality rate ($\mu_{s,t} = \mu$), using Eq. (5), lifetime utility becomes $V = \frac{u(y^*)}{\delta + \mu}$, and the change in income y^* that would compensate for an increase in mortality, leaving V unchanged, is equal to

$$\left.\frac{dy^*}{d\mu}\right|_{V=\bar{V}} = -\frac{dV/d\mu}{dV/dy^*} = \frac{u(y^*)}{u'(y^*)(\delta+\mu)} = \frac{u(y^*)}{u'(y^*)}LE, \tag{7}$$

or, equivalently,

$$\frac{dy^*}{y^*} = \frac{u(y^*)}{u'(y^*)y^*(\delta+\mu)}d\mu = \frac{u(y^*)LE}{u'(y^*)y^*}d\mu, \tag{8}$$

which is the specification most empirical studies are based on. Once the coefficient of $d\mu$ is estimated based on Eq. (8), the value of statistical life can be obtained as

$$VSL = \frac{u(y^*)}{u'(y^*)y^*(\delta+\mu)}y^* = \frac{u(y^*)LE}{u'(y^*)y^*}y^*, \tag{9}$$

i.e. the implied compensation for one statistical death.

Because, in the context of the HIV/AIDS epidemic, we deal with mortality rates that differ across age groups and over time, it is more convenient to focus on the induced change in (discounted) life expectancy, rather than the changes in mortality rates. Using Eq. (6), the change in utility can be described as the sum of the change in income (weighted by marginal utility) and the change in the discounted life expectancy:

$$\frac{dV}{V} = \frac{u'(y^*)dy^*}{u(y^*)} + \frac{dLE}{LE}. \tag{10}$$

In terms of Figure (1), Eq. (10) describes a shift between two indifference curves. The decline in real income (corresponding to the shift along indifference curve U_1) is equal to

$$\frac{dy^*}{y^*} = -\frac{u(y^*)}{y^*u'(y^*)}\frac{dLE}{LE}, \tag{11}$$

i.e. the decline in income that agents would accept in order to return to the previous (higher) level of life expectancy. Equation (11) directly relates to the empirical estimates of the value of statistical life (see Eq. (9)), as

$$\frac{dy^*}{y^*} = -\frac{VSL}{y^*LE}\frac{dLE}{LE}. \tag{12}$$

While most studies, focusing on small changes in mortality rates, use a linear framework, this approach seems inappropriate in the present context, where comparatively large changes in mortality rates or life expectancy are considered. Integrating Eq. (12) yields

$$y^* = constant \cdot LE^{-\frac{VSL}{y^*LE}}, \tag{13}$$

and the discrete change in income that would restore the previous level of utility following a change in life expectancy is

$$\frac{\Delta y^*}{y^*} = \left[\frac{LE + \Delta LE}{LE}\right]^{-\frac{VSL}{y^*LE}} - 1. \tag{14}$$

III. Data

All demographic estimates and projections used in this paper were provided by the International Programs Center of the U.S. Bureau of the Census (IPC). These estimates and projections include annual data on population size and mortality, by age group (five-year cohorts) and gender, from 1985 through 2050. Importantly for the purpose of the present paper, they also include a counterfactual scenario excluding the impact of HIV/AIDS. While the IPC provides mortality rates by five-year cohort, we have derived mortality rates by age through linear intrapolation (compare also Figure 2).

Table 1 provides some demographic indicators for the impact of the HIV/AIDS epidemic. The countries in Table 1 have been chosen to include not only some of the worst-affected countries overall (such as Botswana, South Africa, and Zimbabwe), but also some of the worst-affected countries from other regions (Côte d'Ivoire, Ethiopia, Thailand, and Haiti).[6] The impact of HIV/AIDS on mortality rates and life expectancy is catastrophic in the worst affected countries. In Zimbabwe, for example, life expectancy has dropped to 39 years, compared with 69 years in a scenario excluding the impact of HIV/AIDS; overall

[6] Appendix Table A1, which summarizes the results of our analysis, also includes some demographic indicators for a larger number of countries.

mortality has risen about fourfold (to 2.2 percent); mortality for the working-age population (age 15-49) has risen elevenfold (to 2.7 percent) and is expected to rise further. Even in countries where the HIV/AIDS epidemic has not (or not yet) escalated to the dimensions seen in Zimbabwe, the impact is extremely severe. In Ethiopia, with an adult HIV prevalence rate of about 6 percent, overall mortality more than doubles, and life expectancy decreases by about 12 years. In Thailand, with an adult HIV prevalence rate of 1.8 percent, life expectancy decreases by 1.7 years, and mortality for the working-age population increases by 60 percent.[7]

Table 1. The Demographic Impact of HIV/AIDS

	Adult HIV Prevalence Rate, End-2002 (In percent)	Mortality, All Ages, 2003 (In percent)		Mortality, Ages 15–49, 2003 (In percent)		Mortality, Ages 15–49, 2010 (In percent)		Life expectancy at birth, 2003 (Years)	
		Total	Of which AIDS	Total	Of which AIDS	Total	Of which AIDS	Actual	Without AIDS
Botswana	38.8	3.1	2.6	4.3	4.1	6.1	6.0	32.2	76.6
Côte d'Ivoire	9.7	1.9	0.8	1.8	1.3	1.9	1.5	42.7	56.0
Ethiopia	6.4	2.0	0.7	1.8	1.2	2.0	1.5	41.2	53.5
Haiti	6.1	1.3	0.3	0.9	0.5	0.9	0.6	51.6	59.0
South Africa	20.1	2.7	2.0	3.1	2.9	3.4	3.1	46.6	66.5
Thailand	1.8	0.7	0.1	0.3	0.1	0.3	0.1	71.2	72.9
Zimbabwe	33.7	2.2	1.7	2.7	2.5	3.6	3.4	39.0	69.4

Sources: UNAIDS (2002) for column 1; and International Programs Center at the U.S. Bureau of the Census (2002) for columns 2-9. Adult HIV prevalence rates refer to the population aged 15-49.

Complementing the aggregate data, Figure 2 shows the impact of HIV/AIDS on mortality by age and gender, using Zimbabwe as an example. Male mortality rates reach 5.4 percent for the age group 40-44, of which 5.0 percent is HIV related; female mortality rates peak somewhat earlier (owing to higher rates of male-to-female viral transmission and a younger age of sexual activity) at 5.4 percent for the age group 35-39, of which 5.2 percent is HIV related.

[7] The adult HIV prevalence rates for Thailand, in turn, are not very far off from those observed in some European countries, such as Russia (0.9 percent), Ukraine (1.0 percent), or Spain (0.5 percent).

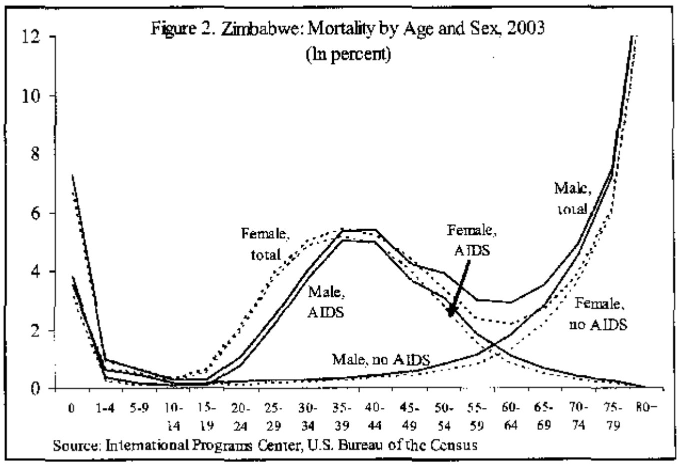


Figure 2. Zimbabwe: Mortality by Age and Sex, 2003
(In percent)

Source: International Programs Center, U.S. Bureau of the Census

IV. The Impact of HIV/AIDS on Welfare

The focus of our analysis is on the countries worst affected by HIV/AIDS. Empirical studies on the value of statistical life for these countries or countries with similar levels of per capita income are barely available. We therefore proceed by (1) discussing the available literature, particularly cross-country "meta" studies including low- or medium-income countries in the sample; and (2) applying the most suitable specifications to the analysis of the impact of the HIV/AIDS epidemic.

Miller (2000) uses 68 studies from 13 different countries, finding income elasticities of the VSL between 0.95 and 1.00. Projecting beyond the range of his sample, he estimates the VSL at about US$40,000 for Nigeria in 1997, with GDP per capita at about US$250 (both numbers are in 1995 U.S. dollars).

Bowland and Beghin (2001) attempt to address the problem of out-of sample prediction by focusing on specifications that, according to several criteria, perform well for the lower-income countries in their sample. For their preferred specification, they find an income elasticity of 1.52. The willingness to pay for a reduction in mortality is positively related to the education level; the availability of insurance has a strong negative effect.

Viscusi and Aldy (2003), the most comprehensive study available at present, discusses, among other issues, data problems, the role of unionization, and the effects of age. Using estimates of the value of statistical life from 46 studies (about two-thirds from the United States), they find income elasticities of 0.51–0.53.

A recent study by Mrozek and Taylor (2002) finds an elasticity of the VSL with respect to earnings of 0.46–0.49 when observations from outside the U.S. are included in the sample. Importantly, they also find evidence that the VSL declines with risk. However, as their sample features mortality rates much lower than the ones considered here and they use a complex specification including variables not available for the countries of interest here, it is not possible to adapt their findings to the present context.

The most useful starting point for our investigation is the study by Miller (2000), as he conditions the value of statistical life on GDP per capita, rather than wages. The specification for the value of statistical life that we adopt thus is

$$VSL = 136.7 * \frac{GDP}{capita}, \tag{15}$$

which is based on regression (4) in Miller (2000). It means that the value of statistical life is equal to about 137 times the level of GDP per capita, and that the elasticity of the VSL with respect to income is equal to one. For example, for a country with a level of GDP per capita of US$ 28,800 (the mean of Miller's sample), the VSL is equal to US$3.9 million.[8]

In the studies discussed above, the estimated income elasticities of the VSL range from about 0.5 to 1.5. Using the sample average of Miller (2000) as a starting point, it is possible to accommodate different elasticities ε using the following equation:

$$VSL_1 = 136.7\left(\frac{GDP/capita}{US\$28,800}\right)^{\varepsilon}\frac{GDP}{capita}.^{9} \tag{16}$$

[8] While Miller uses GDP data in terms of 1995 dollars, we use data at 2001 prices, which are 16 percent higher.

[9] In U.S. dollars at 2001 prices.

In light of the substantial differences in GDP per capita among the countries considered here, the choice of the income elasticity of the VSL function obviously has a large impact on the estimates of the VSL. In a country with a level of per-capita income of US$1,000, for instance, the VSL would be equal to to US$137,000 for an income elasticity of one, but it could range from US$25,500 to US$733,600 for income elasticities between 1.5 and 0.5. Alternatively, this would imply that, with an income elasticity of 1.5, the relative valuation of life (in terms of GDP per capita) is only about 19 percent in a country with GDP per capita of US$1,000, compared to a country with per-capita income of US$28,800 (or over 500 percent with an income elasticity of 0.5). While we would expect an income elasticity somewhat larger than one, as we do not explicitly account for variations in human capital,[10] these large variations in the relative valuation of life seem implausible. Overall, an income elasticity of one, as proposed by Miller (2000), thus appears to be a good approximation.

Using Eqs. (14) and (15), we provide two measures of the welfare losses, assuming an income elasticity of unity. In Tables (2), (3), and (4), columns 5 and 6 show the impact of HIV/AIDS on welfare based on the change in life expectancy (column 5) or discounted life expectancy (column 6), using a discount rate of 2 percent (column 6).[11] The average mortality rates reported in column 2 are derived from mortality rates projected by age group for 2003, weighted by the survival rates implied by these mortality rates. This means that, unlike the population averages reported in Table 1, they do not depend on other demographic trends, such as changes in birth rates. As the impact of HIV/AIDS on mortality and life expectancy depends on an agent's age, we provide estimates of welfare losses evaluated at age 0 (Table 2) and age 15 (Table (3), as well as estimates of the average welfare loss, obtained as a weighted average of welfare losses by age group, with age groups weighted by the respective survival rates (Table 4, see also Appendix Table 1 for estimates for a larger number of countries.).

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[10] The accumulation of human capital implies a postponement of earnings. In countries with higher levels of human capital an increase in mortality would thus have a stronger impact on lifetime earnings, and thus on the VSL.

[11] To calculate the estimates based on actual life expectancy, the discount rate is set equal to zero.

Table 2. The Welfare Effect of Increased Mortality, 2003 (evaluated at age 0)

	Adult HIV Prevalence Rate, End of 2002	Change in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Botswana	38.8	1.7	-55.9	-41.3	-78.8	-86.4
Côte d'Ivoire	9.7	0.6	-26.4	-18.3	-52.5	-59.6
Ethiopia	6.4	0.6	-23.2	-16.0	-49.5	-56.3
Haiti	6.1	0.3	-12.6	-8.7	-27.0	-32.6
South Africa	20.1	0.7	-30.1	-21.6	-52.3	-61.9
Thailand	1.8	0.03	-2.3	-1.6	-4.3	-5.7
Zimbabwe	33.7	1.1	-44.1	-26.4	-68.5	-77.1

Sources: UNAIDS (2002) for column 1; author's calculations (based on data from the International Programs Center at the U.S. Bureau of the Census) for columns 2-7. Adult HIV prevalence rates (column 1) refer to the population aged 15-49.
1/ Based on decline in life expectancy. 2/ Based on decline in discounted life expectancy.

Table 2 shows that the welfare losses caused by the HIV/AIDS epidemic are substantial even for countries with relatively low prevalence rates, and that they are horrific for the worst-affected countries. For Thailand, with an adult HIV prevalence rate of 1.8 percent, welfare losses already exceed 4 percent of GDP. In South Africa (with an adult HIV prevalence rate of 20.1 percent), they amount to over 50 percent of GDP, and in Botswana (with an adult HIV prevalence rate of 38.8 percent), they reach around 80 percent of GDP.

Table 3. The Welfare Effect of Increased Mortality, 2003 (evaluated at age 15)

	Adult HIV Prevalence Rate, End of 2002	Change in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Botswana	38.8	2.8	-63.0	-51.8	-89.7	-94.8
Côte d'Ivoire	9.7	0.9	-30.0	-23.4	-62.1	-70.0
Ethiopia	6.4	0.7	-26.6	-20.7	-58.0	-65.9
Haiti	6.1	0.3	-14.1	-10.9	-33.0	-40.0
South Africa	20.1	0.9	-33.3	-26.7	-62.9	-73.0
Thailand	1.8	0.04	-2.6	-2.1	-5.8	-8.0
Zimbabwe	33.7	1.7	-49.0	-39.0	-79.7	-87.1

Sources: UNAIDS (2002) for column 1; authors' calculations (based on data from the International Programs Center at the U.S. Bureau of the Census) for columns 2-7. Adult HIV prevalence rates (column 1) refer to the population aged 15-49.
1/ Based on decline in life expectancy. 2/ Based on decline in discounted life expectancy.

Reflecting the age pattern of HIV/AIDS-related mortality (compare Figure 1), which (apart from an increase in infant mortality (age 0)) rises from about age 15 and peaks at about age 30-35, the decline in welfare for those at age 15 actually exceeds the change in welfare evaluated at age 0 (see Table 3). For older generations, the welfare loss eventually declines, as HIV/AIDS has a smaller impact on the remaining life expectancy.

Table 4. The Aggregate Welfare Effect of Increased Mortality, 2003

	Adult HIV prevalence rate, end-2002	Change in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Botswana	38.8	2.7	-55.3	-46.6	-84.1	-88.7
Côte d'Ivoire	9.7	0.9	-26.9	-21.5	-60.7	-67.9
Ethiopia	6.4	0.7	-23.2	-18.5	-56.0	-63.1
Haiti	6.1	0.3	-12.0	-9.5	-31.7	-38.2
South Africa	20.1	0.8	-25.7	-21.5	-56.6	-65.3
Thailand	1.8	0.03	-1.7	-1.4	-4.5	-6.2
Zimbabwe	33.7	1.6	-43.5	-35.9	-76.0	-82.3

Sources: UNAIDS (2002) for column 1; authors' calculations (based on data from the International Programs Center at the U.S. Bureau of the Census) for columns 2-7. Adult HIV prevalence rates (column 1) refer to the population aged 15-49.
1/ Based on decline in life expectancy. 2/ Based on decline in discounted life expectancy.

Table 4 provides estimates of the impact of HIV/AIDS on aggregate welfare in 2003, obtained as a weighted average of the welfare losses calculated for each age group.[12] Reflecting the fact that the welfare loss is less pronounced for older generations, the aggregate estimates are somewhat lower than the estimates for those at age 0 or 15.

Table 5 The Aggregate Welfare Effect of Increased Mortality, 2010

	Adult HIV prevalence rate, end-2002	Projected change (for the year 2010) in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Botswana	38.8	4.7	-65.7	-56.7	-88.1	-91.0
Côte d'Ivoire	9.7	0.9	-29.4	-23.8	-63.2	-70.8
Ethiopia	6.4	1.0	-29.4	-23.7	-65.1	-72.1
Haiti	6.1	0.3	-13.0	-10.5	-33.3	-40.4
South Africa	20.1	1.8	-41.8	-35.7	-75.6	-81.4
Thailand	1.8	0.04	-1.8	-1.4	-4.8	-6.5
Zimbabwe	33.7	2.4	-52.1	-43.5	-81.7	-86.6

Sources: UNAIDS (2002) for column 1; authors' calculations (based on data from the International Programs Center at the U.S. Bureau of the Census) for columns 2-7. Adult HIV prevalence rates (column 1) refer to the population aged 15-49.
1/ Based on decline in life expectancy. 2/ Based on decline in discounted life expectancy.

The HIV/AIDS epidemic is evolving and, for most countries, mortality rates are projected to increase over the next year (see Table 1). Table 5 therefore reports estimates

[12] See Appendix Table A1 for estimates of aggregate welfare losses for a larger number of countries.

of aggregate welfare changes for 2010. Reflecting changes in mortality rates, welfare losses increase substantially for some countries. For South Africa, for example, the projected welfare losses rise from around 60 percent of GDP to about 75-80 percent of GDP, as mortality increases by a further percentage point.

V. Conclusions

Our study attempts to quantify the welfare effects of the HIV/AIDS epidemic. Using estimates and projections of the impact of HIV/AIDS on mortality rates and life expectancy and existing studies on the value of statistical life, we estimate the welfare loss of HIV/AIDS as the loss in per capita income which would have the same effect on lifetime utility as the increase in mortality.

While our point estimates of the welfare losses are subject to a high degree of uncertainty, they are of a much higher magnitude (generally, more than ten times larger) than the available estimates of the impact of HIV/AIDS on per capita output and income. For South Africa, for example, the available projections of the impact of HIV/AIDS on GDP per capita range from minus 8 percent to plus 9 percent by 2010. Our study evaluates the welfare losses associated with increased mortality at around 80 percent of GDP. Thus, the estimated changes in per capita GDP (while valuable in some other regards) not only give an incomplete picture of the welfare effects of HIV/AIDS; as far as welfare is concerned, they appear negligible compared with the direct effect of increased mortality.

At this stage, it is important to bear in mind certain limitations of our analysis. Our estimates are subject to the usual problems associated with out-of-sample projections: the bulk of studies on the value of statistical life deals with countries with higher GDP per capita than those considered here, and the available studies deal with changes in mortality that are smaller than those observed in the countries significantly affected by HIV/AIDS. Also, our measure of welfare is entirely based on changes in mortality and does not take into account the direct and indirect effects of HIV/AIDS on the health status of the population.[13] However, the magnitude of our estimates suggests that our key finding – that the direct welfare effects of HIV/AIDS through increased mortality substantially outweigh even the worst projections of the impact on GDP per capita – is robust to alternative specifications or broader definitions of welfare.

[13] HIV/AIDS directly affects the health status of those infected, but it also has indirect health effects, for example through an increase in infections like tuberculosis, or declines in the general quality of health services owing to overwhelming demand.

APPENDIX

Table A1. 51 Countries: Aggregate Welfare Effect of Increased Mortality, 2003

	Adult HIV Prevalence Rate, End of 2002	Change in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Angola	5.5	0.2	-5.2	-4.2	-18.4	-21.8
Bahamas	3.5	0.2	-9.7	-7.9	-24.4	-31.0
Barbados	1.2	0.06	-2.8	-2.4	-8.1	-10.7
Belize	2.0	0.1	-5.4	-4.3	-13.8	-17.9
Benin	3.6	0.1	-5.2	-4.1	-15.2	-18.9
Botswana	38.8	2.7	-55.3	-46.6	-84.1	-88.7
Burkina Faso	6.5	0.4	-15.3	-12.2	-39.3	-46.5
Burundi	8.3	0.8	-25.8	-20.6	-58.1	-65.7
Cambodia	2.7	0.15	-6.3	-5.1	-17.2	-21.8
Cameroon	11.8	0.5	-18.5	-14.8	-45.3	-53.0
Central African Republic	12.9	0.9	-28.2	-22.6	-62.4	-69.6
Chad	3.6	0.1	-5.8	-4.6	-16.7	-20.7
Congo, Dem. Rep. of	4.9	0.3	-11.9	-9.3	-31.8	-37.9
Congo, Rep. of	7.2	0.3	-13.4	-10.8	-34.9	-42.1
Côte d'Ivoire	9.7	0.9	-26.9	-21.5	-60.7	-67.9
Djibouti	n.a.	0.5	-17.0	-13.5	-45.0	-51.8
Dominican Republic	2.5	0.2	-7.4	-6.0	-18.0	-23.5
Eritrea	2.8	0.1	-5.9	-4.7	-16.6	-20.8
Ethiopia	6.4	0.7	-23.2	-18.5	-56.0	-63.1
Gabon	n.a.	0.2	-9.8	-7.8	-25.4	-31.5
Ghana	3.0	0.2	-9.3	-7.4	-24.4	-30.4
Guatemala	1.0	0.08	-3.9	-3.1	-10.2	-13.2
Guinea	n.a.	1.0	-4.1	-3.2	-12.2	-15.2
Guinea-Bissau	2.8	0.2	-6.0	-4.8	-18.1	-22.2
Guyana	2.7	0.2	-7.4	-6.1	-20.0	-25.5
Haiti	6.1	0.3	-12.0	-9.5	-31.7	-38.2
Honduras	1.6	0.1	-6.4	-5.1	-15.6	-20.3
Kenya	15.0	1.0	-31.9	-25.8	-64.3	-72.5
Lesotho	31.0	1.6	-41.7	-34.5	-73.5	-79.6
Liberia	n.a.	0.2	-7.2	-5.6	-20.1	-24.9
Malawi	15.0	1.1	-33.7	-27.2	-68.5	-75.5
Mali	1.7	0.1	-4.7	-3.7	-14.0	-17.4
Mozambique	13.0	0.8	-22.1	-17.9	-59.5	-65.9
Myanmar	n.a.	0.1	-4.7	-3.9	-14.8	-18.5
Namibia	22.5	1.1	-33.6	-27.5	-66.2	-74.1

Table A1. The Aggregate Welfare Effect of Increased Mortality, 51 countries, 2003 (concluded)

	Adult HIV prevalence rate, end-2002	Change in:				
		Mortality	Life expectancy	Discounted life expectancy	Welfare 1/	Welfare 2/
	(In percent)	(In % points)	(In percent)	(In percent)	(In percent)	(In percent)
Niger	n.a.	0.09	-3.5	-2.8	-11.3	-13.9
Nigeria	5.8	0.3	-11.5	-9.2	-30.6	-37.1
Panama	1.5	0.09	-4.2	-3.4	-10.5	-14.0
Rwanda	8.9	0.8	-24.9	-20.0	-58.9	-66.1
Senegal	0.5	0.1	-4.8	-3.8	-13.3	-16.8
Sierra Leone	7.0	0.2	-7.1	-5.6	-21.7	-26.2
South Africa	20.1	0.8	-25.7	-21.5	-56.6	-65.3
Suriname	1.2	0.07	-3.4	-2.8	-9.2	-12.1
Swaziland	33.4	1.6	-44.2	-36.6	-74.8	-82.2
Tanzania	7.8	0.5	-18.7	-14.9	-47.2	-54.6
Thailand	1.8	0.03	-1.7	-1.4	-4.5	-6.2
Togo	6.0	0.4	-14.6	-11.6	-34.9	-42.6
Trinidad and Tobago	2.5	0.05	-2.4	-2.0	-6.9	-9.1
Uganda	5.0	0.6	-20.7	-16.3	-48.6	-56.3
Zambia	21.5	1.4	-37.9	-30.8	-73.4	-79.6
Zimbabwe	33.7	1.6	-43.5	-35.9	-76.0	-82.3

Sources: UNAIDS (2002) for column 1; authors' calculations (based on data from the International Programs Center at the U.S. Bureau of the Census) for columns 2-7. Adult HIV prevalence rates (column 1) refer to the population aged 15-49.
1/ Based on decline in life expectancy. 2/ Based on decline in discounted life expectancy.

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