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Welfare Implications of HIV/AIDS

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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. In Botswana, one of the worst-affected countries, with an adult HIV prevalence rate of 37.3 percent, mortality among the working-age population had increased to 3.8 percent a year (of which 3.7 percentage points, or 96 percent, is HIV/AIDS related) by 2004. Correspondingly, life expectancy has decreased substantially, frequently wiping out gains achieved over several decades. For example, life expectancy at birth is now estimated at less than 40 years for Botswana and Zambia (declines of 41 and 17 years, respectively, compared with a no-AIDS scenario).[1]

A considerable number of studies have addressed the impact of HIV/AIDS on GDP per capita.[2] Some have used a neoclassical growth framework to estimate the impact on aggregate output or income, whereas others have used a general equilibrium model with a larger number of sectors. Studies also 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. Although most studies project a

[1]Unless stated otherwise, all estimates of HIV prevalence rates quoted in this paper are from Joint United Nations Programme on HIV/AIDS (UNAIDS, 2004), and estimates of the impact of HIV/AIDS on mortality and life expectancy were provided by the International Programs Center at the U.S. Census Bureau (see Epstein, Chapter 1, this volume).

[2]See Haacker (Chapter 2, this volume) for a discussion of the literature.

small negative impact of HIV/AIDS on output per capita, 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 (2000) projects that GDP per capita will *increase* by about 9 percent by 2010 compared with a no-AIDS scenario. Arndt and Lewis (2001), using similar demographic assumptions, estimate that GDP per capita will be 8 percent lower in 2010, again compared with a no-AIDS scenario.[3]

Estimates of the impact of HIV/AIDS on GDP are useful, even essential, in many contexts, for example as a key indicator of living standards and as a summary measure of the broad economic repercussions of the epidemic. Because the various components of the government's tax base (such as corporate profits, individual incomes, or imports) are closely linked to the level of economic activity, changes in economic growth also have direct fiscal implications.

However, changes in GDP or in income per capita give a very crude picture of the economic impact of HIV/AIDS, in several ways. First, the impact differs across individuals and households, mainly depending on whether or not a given household has a member who becomes infected. Changes in the distribution of income result, which aggregate economic indicators, such as GDP, fail to capture (see Greener, Chapter 5, this volume). Second, poor households, which account for a small share of GDP, are less able to accommodate adverse shocks to income or expenditure (such as health expenditure) and are therefore more vulnerable to HIV/AIDS. More broadly, changes in income do not capture the 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.

Some of these shortcomings of aggregate indicators have been recognized in the literature and practice of economic development (see, for example, Sen, 1999). Most prominently, the United Nations' Millennium Development Goals not only constitute a political and economic agenda, but also define a comprehensive set of economic development indicators. The United Nations Development Programme assigns equal weights to measures of income per capita, educational attainment, and life

[3]The differences between the two studies arise mainly 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), and that this impact accumulates over time.

expectancy in calculating its Human Development Index (HDI; UNDP, 2001; see also Crafts, 2002). Most of the gains in the HDI over the past century resulted from gains in life expectancy, which in many countries will be largely lost as a consequence of HIV/AIDS. As noted by Haacker in Chapter 2 of this volume, although countries like Botswana, South Africa, and Swaziland would have attained living standards comparable to those in Brazil or Russia by 2001 (which have HDIs around 0.77) had the HIV/AIDS epidemic never occurred, their HDIs instead compare with countries like Bolivia (for South Africa) or India and Cambodia (for Botswana and Swaziland).

To sum up, the most direct welfare effects of HIV/AIDS are associated with increased mortality. For example, the losses in life expectancy in the worst-affected countries are reversing all the health gains achieved over the past 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.

Against this background, the purpose of this chapter is twofold. The first is to develop and present new quantitative indicators of the welfare effects of HIV/AIDS by evaluating the welfare cost of increased mortality. The second, given that this approach yields estimates of the welfare cost of HIV/AIDS as a percentage of GDP, is to provide some perspective on the earlier impact studies that focused on output and income.

The approach uses 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 differences in wages between employment categories to differences in mortality risks (see Miller, 2000, and Viscusi and Aldy, 2003). Provided that these observed wage differentials accurately reflect willingness to pay for a decrease in mortality, these estimates of the VSL can then be used to assess the costs and benefits of certain policy interventions.

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

This chapter adapts this method to the study of the economic impact of HIV/AIDS. Although the key concept translates very easily, certain limitations are important to bear in mind. One is that few empirical studies on the VSL are available for lower-income countries, and none are available for sub-Saharan Africa. Hence the usual shortcomings associated with out-of-sample predictions apply (see Bowland and Beghin, 2001, for a discussion of this point). In particular, 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; average educational attainment 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, the estimates presented here reflect the impact of increased mortality only, not of the deterioration in overall health.[4] Thus our point estimates are subject to considerable uncertainty; nevertheless, they do show that HIV/AIDS has a catastrophic welfare impact that dwarfs the economic assessments based on income per capita.[5]

The first section of the chapter outlines the methodology used. The second section then discusses the demographic data and projections used, and the third presents estimates of the impact of HIV/AIDS on welfare for selected countries. The final section concludes.

A Method of Accounting for Increased Mortality

The approach followed in this chapter is built on two simple premises. Individuals like higher income, and they like to live longer. The (somewhat simplified) outlook on life of these individuals can be illustrated by means of a utility function, which relates expected lifetime utility U to annual income Y and life expectancy LE:

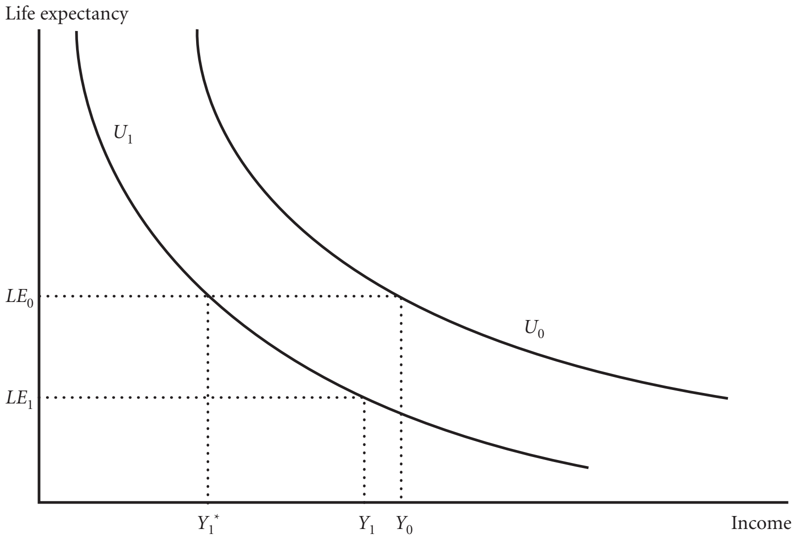
$$U = F(Y, LE). \tag{1}$$

Consider a situation with $Y = Y_0$ and $LE = LE_0$, and hence $U_0 = F(Y_0, LE_0)$, where subscripts index time periods or different states of nature. Assume

[4]A more refined measure of the impact of HIV/AIDS on life expectancy is the "disability-adjusted life expectancy" (DALE), used, for example, by the World Health Organization (see Mathers and others, 2000). This chapter does not follow this approach because sufficiently detailed demographic projections are not available, and because extending our method of accounting for the VSL to changes in DALE is not straightforward.

[5]Using a similar method, Jamison, Sachs, and Wang (2001) study the impact of HIV/AIDS on economic growth and "real income."

Figure 6.1. Impact of HIV/AIDS on Welfare Accounting for Changes in Life Expectancy



that, because of an HIV/AIDS epidemic, income falls to $Y = Y_1$, life expectancy declines to $LE = LE_1$, and utility becomes $U_1 = F(Y_1, LE_1)$, as illustrated in Figure 6.1. An economist focusing on the impact of HIV/AIDS on income per capita might find a very small effect $(Y_1 - Y_0)$, but this does not take into account the possibility that most of the welfare loss comes from the decline in life expectancy, not the decline in income. Instead, therefore, we measure the welfare loss associated with HIV/AIDS as the decline in income, $Y_1^* - Y_0$, that, for a given life expectancy, would yield the same level of welfare as the actual changes in income *and* life expectancy associated with HIV/AIDS. Formally, Y_1^* can be calculated as

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

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

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

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

$$\int_s^\infty c_t e^{-\int_s^t r_v dv} dt = \int_s^\infty y_t e^{-\int_s^t r_v dv} dt, \tag{4}$$

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 (that is, $y_t = y^*$) and that the real interest rate equals 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

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

or $V(\{\mu_{s,t}\}, y^*, \rho, s) = u(y^*) LE(\{\mu_{s,t}\}, \rho, s)$,

with $LE(\{\mu_{s,t}\}, \rho, s) = \int_s^\infty e^{-\int_s^t (\rho+\mu_{s,v}) dv} dt.$ (6)

In other words, lifetime utility is 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 equation (5), lifetime utility becomes $V = u(y^*)/\delta + \mu$, 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 on which most empirical studies are based. Once the coefficient of $d\mu$ is estimated based on equation (8), the VSL can be obtained as

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

which is the implied compensation for one statistical death. As an illustration, suppose that an empirical study finds that a professional mortality risk of 0.1 percent annually is associated with a salary that is 10 percent higher than for a comparator group. This would mean that the VSL is 100 times the applicable income level.

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 appropriate to focus on the induced change in (discounted) life expectancy rather than the changes in mortality rates. Using equation (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:

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

What we are interested in is the change in income that is as bad (or good) as some change in life expectancy. This can be obtained, using equation (10), as –1 times the change in income that would leave welfare V unchanged, following a change in life expectancy. Thus the incremental change in income that is "equivalent" to an incremental change in life expectancy is given by

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

Equation (11) directly relates to the empirical estimates of the VSL from equation (9), as

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

Although most studies, which focus on small changes in mortality rates, use a linear framework, this approach seems inappropriate in the present context of comparatively large changes in mortality rates or life expectancy. Although equation (11) or equation (12) can be used for any utility function of the general form used above to calculate the welfare losses associated with declining life expectancy in a piecemeal fashion, assuming a constant-elasticity utility function allows us to integrate equations (11) and (12), which yields

$$y^* = constant \cdot LE^{u(y^*)/y^* u'(y^*)} = constant \cdot LE^{VSL/y^* LE}, \tag{13}$$

where the coefficients $u(y^*)/y^* u'(y^*)$ and VSL/y^*LE are constant by assumption. The discrete percentage change in income that would restore the previous level of utility following a change in life expectancy is

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

Table 6.1. Impact of HIV/AIDS on Mortality and Life Expectancy in Selected Countries
(Percent except where stated otherwise)

Country	HIV Prevalence Rate, Ages 15–49, End of 2003[1]	Mortality, All Ages, 2004		Mortality, Ages 15–49, 2004		Mortality, Ages 15–49, Projected 2010		Life Expectancy at Birth, 2004 (years)	
		Total	From AIDS	Total	From AIDS	Total	From AIDS	Actual	Without AIDS
Botswana	37.3	2.9	2.5	3.8	3.7	3.6	3.5	34.2	75.7
Côte d'Ivoire	7.0	1.5	0.4	1.1	0.6	1.1	0.7	48.4	55.7
Ethiopia	4.4	1.5	0.2	1.0	0.4	1.0	0.4	48.7	53.1
Haiti	5.6	1.3	0.3	0.9	0.5	0.9	0.5	52.6	60.2
South Africa	21.5	2.9	2.5	2.3	2.0	2.1	1.9	44.1	66.7
Vietnam	0.4	0.6	0.02	0.2	0.03	0.2	0.04	70.4	70.9
Zambia	16.5	2.1	1.0	1.9	1.4	1.9	1.4	39.4	56.2

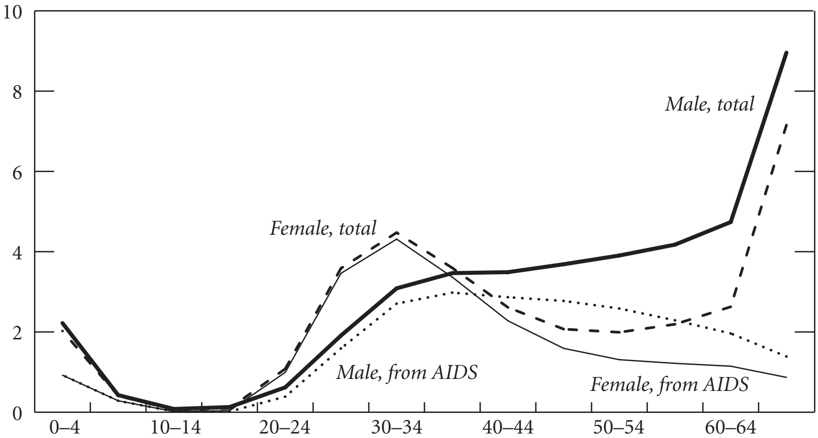
Source: UNAIDS (2004); U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.
[1]Data refer to the population aged 15–49.

Data

All demographic estimates and projections used in this chapter were provided by the International Programs Center (IPC) of the U.S. Census Bureau (see Epstein, Chapter 1 of this volume for a more extensive discussion). These include annual data on population size and mortality, by age group (five-year cohorts) and sex, from the (estimated) onset of the epidemic in each country through 2050. Importantly for the purpose of this chapter, they also include a counterfactual scenario excluding the impact of HIV/AIDS. Whereas the IPC provides mortality rates by five-year cohort, we have derived mortality rates for each year of age through linear intrapolation.

Table 6.1 provides some demographic indicators for the impact of the HIV/AIDS epidemic. The countries have been chosen to include not only some of the worst-affected countries in southern Africa (such as Botswana, South Africa, and Zambia), but also some countries with relatively high HIV prevalence rates in other parts of Africa and elsewhere (Côte d'Ivoire, Ethiopia, Vietnam, and Haiti). The impact of HIV/AIDS on mortality rates and life expectancy is catastrophic in the worst-affected countries. In Botswana, the worst-affected country covered in Table 6.1, for example, life expectancy has dropped to 34 years, compared with 76 years in a no-AIDS scenario; overall mortality has risen about almost eightfold, to 2.9 percent; mortality in the working-age population (ages 15–49) has risen 27-fold, to 3.8 percent. Even in countries where the HIV/AIDS epidemic has not (or

Figure 6.2. Mortality Rates by Age and Sex in South Africa, 2004
(Percent)



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

not yet) escalated to such dimensions, the impact is severe. In Haiti, with an adult HIV prevalence rate of about 6 percent, overall mortality increases by one-third, and life expectancy decreases by about 8 years. In Vietnam, with an adult HIV prevalence rate of only 0.4 percent, life expectancy decreases by half a year, and mortality increases by 15 percent (not percentage points) among the working-age population and 4 percent among the total population.[6]

Complementing the aggregate data, Figure 6.2 shows the impact of HIV/AIDS on mortality by age and sex, using South Africa as an example. Because of HIV/AIDS, male mortality rates increase very substantially between ages 20 and 39 and reach 3.5 percent for the group aged 40–44, of which 86 percent is HIV-related; for older ages mortality increases more slowly, as HIV/AIDS-related mortality declines while mortality for other reasons increases with age. Female mortality rates rise even higher and peak somewhat earlier (because of higher rates of male-to-female viral transmission and because sexual activity tends to begin at an

[6]It is important to note that the adult HIV prevalence rate for Vietnam, in turn, is actually lower than for many countries for which comparable demographic estimates and projections of the impact of HIV/AIDS are not available, such as Brazil (0.7 percent), India (about 0.7 percent), Russia (1.1 percent), Spain (0.7 percent), and the United States (0.6 percent).

earlier age among females) at 4.5 percent for the group aged 30–34, of which 96 percent is HIV-related. In the present context, one lesson from Figure 6.2 is that mortality rates and thus remaining life expectancy vary quite substantially by age. This implies that average mortality rates, for different age distributions of the population or age profiles of mortality, can have different implications for life expectancy and thus for welfare. Below we therefore evaluate the impact of HIV/AIDS on welfare by age group.

Impact of HIV/AIDS on Welfare

The focus of our analysis is on the countries worst affected by HIV/AIDS. Very few empirical studies on the VSL for these countries, or countries with similar levels of income per capita, are available. We therefore proceed by discussing the available literature, particularly cross-country "meta" studies that include low- or medium-income countries in the sample; we then apply the most suitable specifications to the analysis of the impact of the HIV/AIDS epidemic.

Miller (2000) draws on 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 $40,000 for Nigeria in 1997, when GDP per capita was about $250 (both numbers are in 1995 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 education; 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 VSL from 46 studies (about two-thirds of which are from the United States), they find income elasticities of 0.51 to 0.53.

A recent study by Mrozek and Taylor (2002) finds an elasticity of the VSL with respect to earnings of 0.46 to 0.49 when observations from outside the United States are included in the sample. Importantly, they also find evidence that the VSL declines with risk. However, their sample features mortality rates much lower than those considered here, and they use a complex specification that includes variables for which data are not available for the countries of interest here. Thus 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), which conditions the VSL on GDP per capita rather than wages. Thus the specification for the VSL that we adopt is

$$VSL_1 = 136.7^* \frac{GDP}{capita}. \tag{15}$$

which is based on regression (4) in Miller (2000). This specification implies that the elasticity of the VSL with respect to income is equal to 1. For example, for a country with GDP per capita of \$28,800 (the mean of Miller's sample), the VSL is equal to \$3.9 million.[7]

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:

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

In light of the substantial differences in GDP per capita among the countries considered here, the choice of the income elasticity in the VSL function obviously has a large impact on the estimates of the VSL. In a country with income per capita of \$1,000, for instance, the VSL would be equal to \$137,000 for an income elasticity of 1, but it could range from \$25,500 to \$733,600 for income elasticities between 0.5 and 1.5. Alternatively, this would imply that, with an income elasticity of 1.5, the VSL (in terms of GDP per capita) in a country with GDP per capita of \$1,000 is only about 19 percent what it would be in a country with income per capita of \$28,800, but over 500 percent of the latter's income per capita if the income elasticity is 0.5. Although one would expect to observe an income elasticity somewhat larger than 1, since we do not explicitly account for variations in human capital,[8] these large variations in the relative valuation of life seem implausible when considering countries with large differences in income per capita. Overall, an income elasticity of around 1, as proposed by Miller (2000), appears to be a good approximation. Our estimates below

[7]Whereas Miller uses GDP data in 1995 dollars, we use data at 2001 prices, which are 16 percent higher.

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

Table 6.2. Estimated Welfare Effect of Increased Mortality in Selected Countries
(Percent except where stated otherwise)

	Change in:				
				Welfare	
Country	Mortality (in percentage points)	Life expectancy	Discounted life expectancy	Based on decline in life expectancy	Based on decline in discounted life expectancy
2004, evaluated at age 0					
Botswana	1.6	−55.1	−39.5	−76.7	−83.9
Côte d'Ivoire	0.3	−13.1	−8.8	−29.5	−34.5
Ethiopia	0.2	−8.4	−5.6	−20.5	−24.2
Haiti	0.2	−12.6	−8.4	−26.4	−31.4
South Africa	0.8	−34.0	−23.8	−57.6	−66.0
Vietnam	0.01	−0.8	−0.5	−1.6	−2.0
Zambia	0.8	−30.1	−20.5	−58.4	−64.8
2004, evaluated at age 15					
Botswana	2.6	−62.5	−50.0	−88.6	−93.6
Côte d'Ivoire	0.4	−14.8	−11.2	−35.8	−41.9
Ethiopia	0.2	−9.6	−7.2	−24.7	−29.5
Haiti	0.3	−14.2	−10.7	−33.0	−39.3
South Africa	1.1	−38.1	−29.8	−69.0	−77.4
Vietnam	0.02	−1.0	−0.7	−2.2	−2.9
Zambia	1.0	−34.5	−26.3	−67.9	−74.8
2004, aggregate[1]					
Botswana	3.1	−59.1	−49.2	−88.9	−92.9
Côte d'Ivoire	0.4	−13.3	−10.5	−37.3	−43.5
Ethiopia	0.2	−8.5	−6.6	−25.3	−30.0
Haiti	0.3	−12.7	−10.0	−33.9	−40.1
South Africa	1.1	−32.3	−26.6	−69.6	−76.9
Vietnam	0.02	−0.8	−0.6	−2.3	−2.9
Zambia	1.1	−32.3	−25.5	−68.8	−75.1
Projected 2010, aggregate[1]					
Botswana	3.3	−61.1	−51.1	−89.5	−93.4
Côte d'Ivoire	0.4	−14.9	−11.8	−40.2	−46.9
Ethiopia	0.3	−10.3	−8.1	−29.7	−35.1
Haiti	0.3	−12.9	−10.2	−33.7	−40.2
South Africa	1.4	−37.8	−30.5	−75.5	−82.0
Vietnam	0.03	−1.1	−0.9	−3.4	−4.3
Zambia	1.1	−31.8	−25.2	−67.3	−74.1

Sources: Authors' calculations based on the model described in the text and data from the International Programs Center, U.S. Census Bureau (see Epstein, Chapter 1 of this volume).

[1]Average of welfare losses by age group, with age groups weighted by survival rates.

are therefore based on the link between life expectancy and equivalent change in income as specified in equation (14), using the VSL estimate from equation (15).

Because the impact of HIV/AIDS on mortality and life expectancy depends on an individual's age, Table 6.2 provides estimates of welfare losses evaluated at age 0 (top panel) and age 15 (second panel), 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 their survival rates (third panel).[9] As a robustness check regarding the discount rate applied to life expectancy—see equations (3) and (6)—we provide estimates of the impact of HIV/AIDS on welfare based on the change in life expectancy or the change in the discounted life expectancy, using a discount rate of 2 percent. The average mortality rates reported in the first column are derived from estimated mortality rates by age group for 2004, weighted by the survival rates implied by these mortality rates. This means that, unlike the population averages reported in Table 6.1, they do not depend on other demographic trends, such as changes in birthrates.

Table 6.2 shows that the welfare losses caused by the HIV/AIDS epidemic are significant even for countries with relatively low prevalence rates, and horrific for the worst-affected countries. For Vietnam, with an adult HIV prevalence rate of 0.4 percent, welfare losses already exceed 2 percent of GDP (third panel of Table 6.2). In Zambia, with an adult HIV prevalence rate of 16.5 percent, they exceed two-thirds of GDP, and in Botswana, with an adult HIV prevalence rate of 37.3 percent, they are around 90 percent of GDP.[10]

Reflecting the age pattern of HIV/AIDS-related mortality (Figure 6.1), which (apart from an increase in infant mortality) rises from about age 15 and peaks at about ages 30–35, the decline in welfare for those at age 15 (second panel of Table 6.2) actually exceeds the change in welfare evaluated at age 0 (first panel of Table 6.2). For older generations the welfare loss eventually declines, as HIV/AIDS has a smaller impact on the remaining life expectancy.

The HIV/AIDS epidemic is evolving, and, for most countries, HIV/AIDS-related mortality rates are projected to increase over the next several years (see Table 6.1). The bottom panel of Table 6.2 therefore reports estimates of aggregate welfare changes for 2010. Reflecting changes

[9]We attach equal weight to the relative decline of lifetime utility for each individual, regardless of age. Alternatively, it is possible to assign larger weights to younger people, for example assigning a 50 percent loss in life expectancy for someone aged 15 a larger weight than for someone aged 50. Since HIV/AIDS-related mortality is concentrated among a relatively narrow, middle-aged group, the weights applied to each age group do not make a big difference.

[10]Crafts and Haacker (2002) provide estimates for a larger group of countries, based on demographic estimates and projections available at that time.

in mortality rates, welfare losses increase further for most countries. For South Africa, for example, the projected welfare losses rise by 5 percent of GDP, to about 75–82 percent of GDP.

Conclusions

This paper has attempted 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 drawing on existing studies on the value of statistical life, we estimate the welfare loss of HIV/AIDS as the loss in income per capita that would have the same effect on lifetime utility as the increase in mortality.

Although our point estimates of welfare losses are subject to a high degree of uncertainty, they are of a much higher magnitude (generally, more than 10 times larger) than the available estimates of the impact of HIV/AIDS on output and income per capita. For South Africa, for example, the available projections of the impact of HIV/AIDS on GDP per capita range from –8 percent to +9 percent by 2010. This paper, in contrast, evaluates South Africa's welfare loss associated with increased mortality at around 80 percent of GDP. Thus the estimated changes in GDP per capita, although valuable in some other regards, not only give an incomplete picture of the welfare effects of HIV/AIDS, but, as far as welfare is concerned, appear negligible compared with the direct effect of increased mortality.

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 VSL deal 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.[11] 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

[11]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.

on GDP per capita—is robust to alternative specifications or broader definitions of welfare.

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