What Is the Impact of AIDS on Cross-Country Income So Far? Evidence from Newly Reported AIDS Cases*

Chris Papageorgiou
Research Department
International Monetary Fund
Washington, DC 20431
E–mail: cpapageorgiou@imf.org

Petia Stoytcheva
Department of Economics and Finance
Salisbury University
Salisbury, MD 21801
E–mail: psstoytcheva@salisbury.edu

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Abstract

This paper sheds new light on the impact of AIDS on cross-country income levels. We consider new UNAIDS/WHO data on officially reported AIDS cases for a panel of 89 countries over a 15 year period from 1986-2000 during which AIDS has spread across the world. These data are used to estimate cross-country level regressions employing panel data techniques. Our findings are as follows: First, when using the entire sample of countries we find that AIDS has a negative albeit marginally significant effect on the level of income. Second, when we control for regional effects we show that this negative effect is primarily driven by the sub-Sahara Africa and Latin America subsamples. Third, using AIDS data by age group, we find that the disease has a significantly negative impact on income only via infected people between the ages 16 and 34. Finally, while the economic impact of AIDS is negative and statistically significant, its economic significance measured by the estimated size of the AIDS coefficient is quite small.

Keywords: Health, economic development, reported AIDS cases, AIDS by age group, cross-country income levels.

JEL Classification: O30, O40, O47

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1 Introduction

The World Heath Organization (WHO) reported that as of November 2006, 32 million people were living with the human immunodeficiency virus (HIV) or the acquired immune deficiency syndrome (AIDS). According to the latest figures new cases of HIV in 2006 totaled 4.3 million with 2.8 million (65%) occurring in sub-Saharan Africa. AIDS related deaths in 2006 were estimated to be around 2.9 million. HIV/AIDS now ranks as the world's fourth largest cause of death, after heart disease, strokes and acute lower respiratory infections (Dixon, McDonald, Roberts (2002)). AIDS has surpassed tuberculosis (1.6 million deaths in 2002) and malaria (1.3 million deaths in 2002) as the top single agent/disease killer. While the number of deaths due to nearly every disease has decreased, deaths due to HIV/AIDS have increased fourfold.

AIDS' alarming infection rate coupled with no known cure has very important social, political, demographic and certainly economic implications. A central point of analysis for economists is to evaluate the impact of AIDS on economic welfare and, in particular, on per capita income. The main goal of this paper is to provide new evidence on the potential effect of AIDS on income in a panel of countries using aggregate AIDS data. Our dataset is compiled from the UNAIDS/WHO *Epidemiological Fact Sheets* (2003) and represents the number of newly reported infections occurring each year for the period 1979-2000 across 115 countries. This novel dataset permits us to analyze a repeated cross-section and to instrument for AIDS with past AIDS in order to estimate the economic impact of AIDS.

Our main findings are as follows: AIDS, as proxied by the number of officially reported cases per 100,000 people, has a negative and marginally statistically significant effect on per capita income across a panel of countries. However, in terms of *economic significance* the effect is shown to be small. When we incorporate regional interactions with AIDS, we find that only sub-Saharan Africa is negatively affected by the disease whereas Latin America and OECD subsamples obtain insignificant coefficient estimates. Finally, using more disaggregated (but less detailed) AIDS data by age group, we find that the disease may be most disruptive via its negative effects in productive people between the ages 16 and 34.

There is a small but rapidly expanding literature related to the economic effects of AIDS. Several theoretical papers suggest large negative economic consequences of the pandemic. For example, Cuddington (1993), simulating a modified Solow model, conclude that AIDS, via its impact on morbidity and mortality rates, will reduce GDP in Tanzania in 2010 by 15 to 20 percent relative to a counterfactual of no-AIDS scenario. Similarly, Cuddington and Hancock (1994) using a similar methodology simulate the impact of AIDS on the Malawian economy and find that the average annual real per capita GDP growth over the 1985-2010 period is projected to be 0.2-0.3 percentage points lower compared to the alternative no-AIDS scenario. More recently, Ferreira and Pessoa (2003) have proposed a model in which AIDS impacts negatively on income by affecting the incentives for schooling attainment due to shorter expected longevity. Based on their model, the most affected countries in sub-Saharan Africa are predicted to become about 25 percent poorer than they would have been without AIDS, with schooling declining by about 50 percent. Finally, Corrigan, Glomm, and Mendez (2005) show that their model exhibits substantial negative growth effects of the AIDS epidemic through the detrimental impact of lower life expectancy on investment combined with a sizable number of orphans created by the epidemic. Perhaps the most notable and controversial paper on AIDS is Young (2005) that, through simulations, arrives at the conclusion that as a result of a significant decrease in population AIDS will increase the welfare of the future generations in South Africa by increasing their per capita income. Other recent notable theoretical papers include Levy (2002), Auld (2003), Clark and Vencatachellum (2003) and Young (2007). Largely owing to data constraints, these studies calibrate the impact of HIV/AIDS, but do not provide a meaningful empirical analysis.

At the empirical side, the literature on AIDS and development has recently picked up due to the emergence of new datasets on AIDS. The first notable empirical contribution using cross-country data is Bloom and Mahal (1997). These authors use standard epidemiological models to estimate the number of reported AIDS cases from information on HIV prevalence at a point in time. Utilizing a rather scarce set of cross-country estimates on reported AIDS cases and using novel econometric techniques they arrive at the conclusion that the AIDS epidemic has had an insignificant effect on the growth rate of per capita income. Bonell (2000) and McDonald and Roberts (2006) also contact a cross-country empirical investigation and find a negative relationship between growth and AIDS whereas Lorentzen, McMillan and Wacziarg (2008) test the hypothesis that high adult mortality reduces economic growth by shortening time horizons and find substantial long-run economic costs of the ongoing AIDS epidemic.[1]

[1]McDonand and Roberts (2006) investigate the effect of AIDS on economic growth in a system of two equations, a structural growth equation based on the augmented Solow model and a reduced form health equation used to

More recently, a series of papers use macro data on AIDS but primarily focusing on sub-Saharan Africa. These papers include, Dixon, McDonald and Roberts (2001), Oster (2005, 2007a,b), Kalemli-Ozcan (2006), and Werker, Ahuja and Wendell (2006). Oster's papers primarily focus on the response of sexual behavior to HIV in sub-Saharan Africa whereas Kalemli-Ozcan's paper explores the effect of AIDS epidemic on demographic transition. Werker, Ahuja and Wendell (2006) use male circumcision to instrument for AIDS in growth regression for sub-Saharan Africa and find no effect of AIDS on economic output.

Our paper is more closely related to Bloom and Mahal (1997) but departs from it in two important ways: First, in order to address the economic implications of the disease on welfare, our framework focuses on levels rather than growth of per capita income.[2] Second, we use an alternative more comprehensive dataset. Although broader in scope, our paper also relates to the papers focusing on Africa in that we explicitly control for regional effects and show that sub-Saharan Africa is the only region that is negatively and significantly affected economically from the disease.

The remainder of the paper is organized as follows. Section 2 takes a first look at the AIDS data used in our empirical analysis. Section 3 presents our panel estimation results for the full sample of countries. In addition, this section present results using age-specific AIDS data. Section 4 discusses of our main results in relation to the existing literature and section 5 concludes.

2 A Look at the AIDS Dataset

We begin by describing the AIDS data used in our estimation. Later on, we explain how we obtain the rest of the data needed for our analysis.

Our AIDS dataset is constructed using UNAIDS/WHO *Epidemiological Fact Sheets on HIV/AIDS and Sexually Transmitted Infections* (2002).[3,4] These are the number of officially reported AIDS

estimate the effect of HIV on some measure of health capital.

[2]For this and other arguments in favor of using levels rather than growth regressions, see Hall and Jones (1999, pp. 85-86). Other papers that use level regressions include Frankel and Romer (1999), Acemoglu, Johnson and Robinson (2001), and Caselli and Wilson (2004), just to name a few.

[3]We were able to update the reported AIDS cases using UNAIDS/WHO Epidemiological Fact Sheets-2004 Update for the following countries: Canada, Chile, Columbia, El Salvador, Iran Israel, Thailand, Turkey, Austria, Belgium, Czech Republic, Denmark, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland, U.K. of Great Britain, Fiji.

[4]Of note is the exclusion of South Africa from our dataset due to the gross under-reporting observed and documented by many field researchers. We thank participants at the North East Universities Development Consortium (NEUDC) 2004 conference and in particular Mark Gersovitz, Damien de Walque, Désiré Vencatachellum, for their insights on the substantial measurement errors present in the South African AIDS dataset.

Table 1: Regional descriptive statistic

Regions	Variable	Mean	Stand. Dev.	Min.	Max.
Africa	GDP per worker ($)	3626.9	3353.1	895.6	15515.0
	AIDS cases per 100,000	23.418	38.146	0.021	173.043
Americas	GDP per worker ($)	10632.5	8772.2	2179.4	39872.0
	AIDS cases per 100,000	7.335	7.647	0.244	30.103
Asia	GDP per worker ($)	12610.3	10636.1	2096.1	31888.1
	AIDS cases per 100,000	1.269	4.282	0.001	19.809
Europe	GDP per worker ($)	24076.3	8984.3	6649.7	44509.2
	AIDS cases per 100,000	2.416	2.629	0.022	10.471
Oceania	GDP per worker ($)	16966.5	12093.4	5635.9	30342.0
	AIDS cases per 100,000	1.094	0.401	0.729	1.527
World	GDP per worker ($)	11499.5	10838.1	895.7	44509.3
	AIDS cases per 100,000	10.576	24.660	0.001	173.043

Notes: The mean, standard deviation, minimum and maximum values presented above are computed for 41 countries in Africa, 25 countries in the Americas, 21 countries in Asia, 24 countries in Europe, and 4 countries in Oceania. Mean levels of GDP per worker and AIDS reported cases are for the period 1986-2000.

cases for each country in each year (when available). Our entire dataset includes 115 countries for the period 1979-2000. AIDS case reporting is carried out in most countries. Data from individual AIDS cases are aggregated at the national level and sent to WHO. However, case reports come from surveillance systems of varying quality. Reporting rates vary substantially from country to country and low reporting rates are common in developing countries due to weaknesses in the health care and epidemiological systems. In addition, AIDS case reporting provides information on transmission patterns and levels of infection approximately 5-10 years in the past, limiting its usefulness for monitoring recent HIV infections. Despite these caveats, this dataset is novel in that it contains a time dimension (the main advantage over the HIV/AIDS incidents dataset) thus providing with a unique opportunity to estimate the effect of AIDS on per capita income using a repeated cross-section of countries.

We multiply the number of reported AIDS cases by 100,000 and divide by total population in each year (data on population is from the *World Development Indicators* (2002)) to obtain reported AIDS cases per 100,000 per country per year. Thus, we obtain AIDS reported cases, which is a flow measure. Due to data constraints associated with explanatory variables necessary for our empirical analysis other than AIDS, our country coverage is reduced from 115 countries to 89. In addition, to eliminate major measurement error at the beginning of the epidemic we start our time coverage from 1986 rather than 1979. Therefore the sample used in our empirical investigation is further reduced to a panel of 89 countries for the time period 1986-2000. To explore the panel dimension of the data, we average them into 5 year periods and produce three non-overlapping five-year time intervals 1986-1990, 1991-1995 and 1996-2000.[5]

Next, we take a first look at the AIDS dataset by presenting correlations and descriptive statistics at the regional and country levels. In addition, we exploit a nice feature of our dataset and disaggregate our data into AIDS cases by four age groups (0-4, 5-15, 16-34, 35-60+).[6] We present examples from this disaggregated dataset for selected countries.

Table 1 presents the mean, standard deviation, minimum and maximum of AIDS and mean GDP per worker for five regions and the world.[7] The main reason for grouping countries into regions is to examine whether geographical location matters. We note that the mean for AIDS in Africa (23.418) is much higher than in all other regions/continents. Another interesting observation is the quite high number of AIDS cases in the Americas (with mean 7.335). It is much higher than in Europe, where the mean AIDS cases is 2.416. Finally, it is readily seen that Asia and Oceania are experiencing considerably lower AIDS cases than Africa, the Americas and Europe even though, as the standard deviation reveals, there also exists substantial variation between countries in these regions. The world mean AIDS cases is quite large at 10.576 but obviously upward biased by the African subsample.

Figure 1 adds a dynamic element to the descriptive statistics of Table 1 by illustrating the

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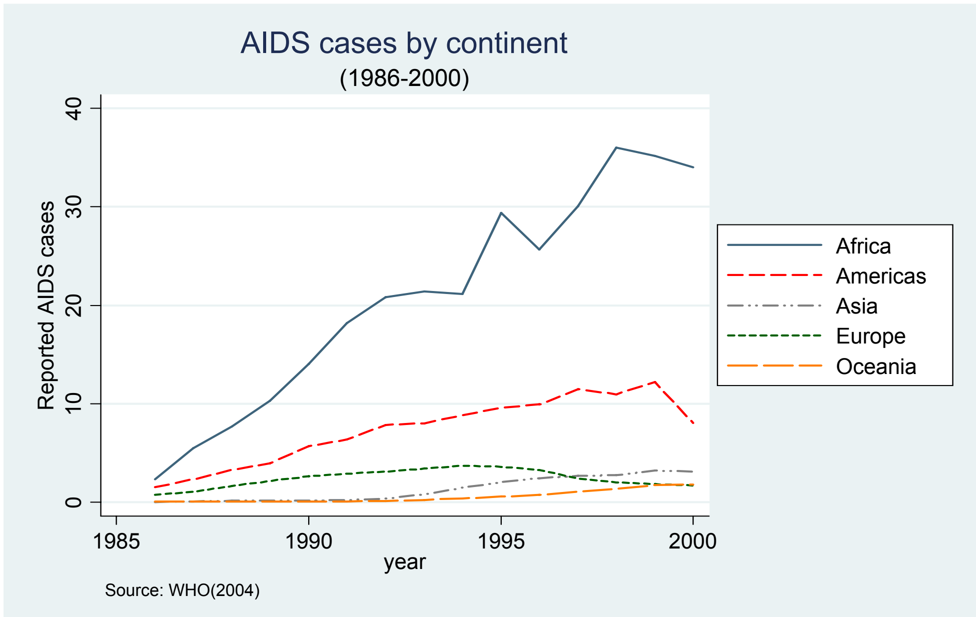
[5]For more information about the sample of countries and relevant variables used in the estimation, see Appendix A, Table A1. For detailed discussion on our definition of AIDS see Appendix B.

[6]We were able to assemble data on reported AIDS cases for different age groups from UNAIDS/WHO Global Surveillance fact sheets (2002).

[7]**Africa:** Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, C. African Rep., Chad, Comoros, Congo, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bis., Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe. **Americas:** Argentina, Barbados, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Rep., Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Tri.&Tobago, USA, Uruguay, Venezuela. **Asia:** Bangladesh, China, Hong Kong, India, Indonesia, Iran, Israel, Japan, Jordan, Korea, Malaysia, Oman, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Syria, Thailand, Turkey, Yemen. **Europe:** Austria, Belgium, Czech Republic, Denmark, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Malta, Norway, Poland, Portugal, Romania, Russian Fed., Slovakia, Spain, Sweden, Switzerland, UK. **Oceania:** Australia, Fiji, New Zealand, Papua N.G..

Figure 1: AIDS cases by continent



Notes: This plot illustrates the evolution of AIDS in 5 regions over the period 1986-2000.

rate by which the infectious disease spread in each region. Three features stand out in Figure 1. First, is the rapid spread of the disease in Africa. This is a concern that is well-documented in the literature and echoed loudly in the public media. Second, a reversal of the AIDS spread rate is observed in Africa and Latin America after 1997, and after 1995 in Europe. A possible explanation for this slowdown is the combination of substantial increases in funding, increases in global political leadership (which is key to international development planning), and the beginning of pay off from policies and educational programs for promoting AIDS awareness that was initiated by many local, national and international agencies. Third, is the recent increase in reported AIDS cases in Asia. This is a major concern because AIDS cases in particular South Asian countries (i.e. Thailand and China) have increased at an alarming rate over the last few years.

Next, we present AIDS cases for individual countries to highlight the great variation that exists among them. Table 2 presents the top and bottom 25 countries in our sample of 115 countries. Among the countries with highest reported AIDS cases 20 are located in sub-Saharan Africa. This speaks directly to the major concerns raised by international organizations, such as the World Bank, WHO and UN, and governments of advanced nations like the U.K., France and the U.S.

Table 2: Countries with highest and lowest AIDS cases

Top 25

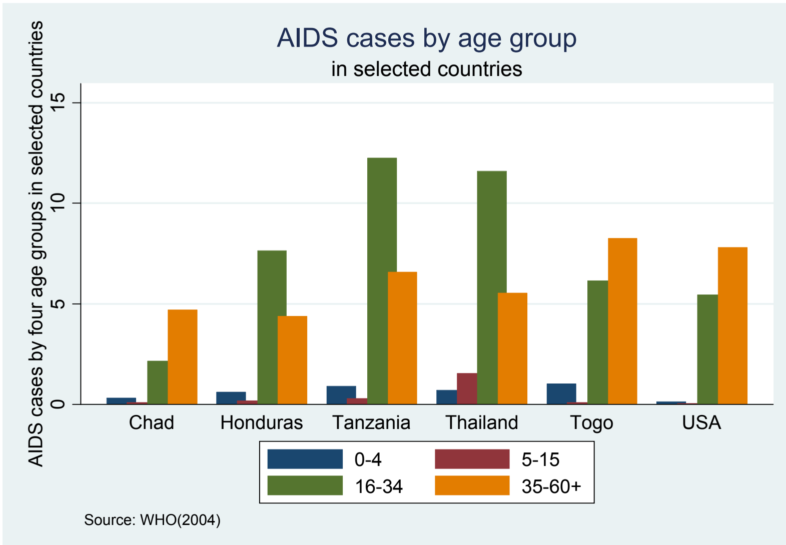
Country	Rank	Mean AIDS cases
Namibia*	1	173.043
Congo	2	168.600
Botswana	3	57.084
Zimbabwe	4	55.472
Lesotho*	5	49.333
Zambia	6	46.390
Malawi	7	40.971
Swaziland*	8	38.525
Tanzania	9	31.148
Barbados*	10	30.103
Burundi	11	27.484
Gabon*	12	26.618
Kenya	13	24.953
Uganda	14	22.979
Rwanda	15	22.221
Togo	16	21.910
C. African Rep.	17	20.396
USA	18	20.079
Thailand	19	19.809
Tri. &Tobago	20	18.936
Guyana	21	17.806
Ghana	22	16.679
Honduras	23	14.134
Jamaica	24	13.321
Chad	25	12.770

Bottom 25

Country	Rank	Mean AIDS cases
Hungary*	91	0.246
Bolivia	92	0.244
Morocco	93	0.207
Poland*	94	0.178
S. Arabia*	95	0.158
Jordan	96	0.147
Algeria	97	0.116
Yemen*	98	0.109
Japan	99	0.101
Czech Rep.*	100	0.096
India	101	0.073
Philippines	102	0.047
Sri Lanka	103	0.047
Turkey	104	0.041
Syria	105	0.036
Korea	106	0.031
Egypt	107	0.029
Slovakia	108	0.029
Iran*	109	0.024
Russian Fed.*	110	0.022
Madagascar	111	0.021
Indonesia	112	0.016
Pakistan	113	0.011
China*	114	0.005
Bangladesh	115	0.001

Notes: Mean AIDS cases is the average of reported AIDS cases during the period 1986-2000.
* countries not in our estimation sample.

Figure 2: AIDS cases by age



Notes: This figure illustrates AIDS cases by age group. We were able to assemble a dataset with 63 countries for which AIDS cases could be dissagregated into four age groups. For details see Appendix C.

It is interesting to notice, however, that the U.S. and Thailand are also part of the top 25 list. This suggests that AIDS may be different from other determinants of economic development that typically are inherently dependent on per worker income. This argument is reinforced by looking at the list with the bottom 25 countries as many developing and less developed countries experience very low AIDS cases. A notable feature of the low-AIDS-cases list is that the primary religion in 12 out of the 25 countries is Islam. This is consistent with the hypothesis that religion may be influential to the culture of these countries keeping AIDS cases very low.

Finally, we take advantage of a nice feature of our dataset and present AIDS cases by four different age groups for selected countries. This disaggregation reveals that there is significant variability in the way AIDS affects different age groups across countries. For example, Figure 2 illustrates that for countries like the U.S., Togo and Chad the most affected age group is 35-60+ whereas for Tanzania, Thailand and Honduras the most affected age group is 16-34. This variability is explored further in our empirical analysis.

3 Estimation and Results

Our empirical estimation is based on the neoclassical growth model as in Mankiw, Romer and Weil (1992) (MRW). More precisely, MRW assumed a production function, $Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta}$, where Y is output, K is the stock of physical capital, H is a measure of human capital, A is a technological parameter that grows exponentially at rate γ, L is raw labor and α, β and $(1-\alpha-\beta)$ are the shares of physical capital, human capital and augmented labor, respectively. Following standard arguments, MRW (pp. 416-17) derived output per worker in country i, at period $T+r$ as[8]

$$\ln\left(\frac{Y}{L}\right)_{i,T+r} = \ln(A_0) + \gamma r + \frac{\alpha}{1-\alpha-\beta}\ln s_i^k - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n_i+\gamma+\delta) + \frac{\beta}{1-\alpha-\beta}\ln s_i^h, \tag{1}$$

where s^k, s^h are investment rates in physical and human capital, respectively, n is the average population growth of the working age population, γ is an exogenous technological progress parameter, and δ is a constant physical capital depreciation rate. Our empirical specification is motivated by equation (1) in which we consider AIDS as a productivity shock. To most efficiently use the information provided in our AIDS dataset, we follow recent contributions and employ panel data techniques over three 5-year periods (1986-1990, 1991-1995 and 1996-2000).[9] Specifically, we consider the following regression equation:

$$\ln\left(\frac{Y}{L}\right)_{it} = a_0 + a_1 Dum_t + a_2 Dum_j + a_3 \ln s_{it}^k + a_4 \ln(n_{it}+g+\delta) + a_5 \ln s_{it}^h + a_6 \mathrm{AIDS}_{it} + \varepsilon_{it}, \tag{2}$$

where Dum_t are time dummy variables for the three 5-year periods, and Dum_j are regional dummy variables for sub-Saharan Africa, Latin America and OECD countries. The use of time dummies to identify the time period over which the model is estimated is justified by equation (1). Regional dummies are used, as in most previous cross-country studies, to absorb idiosyncrasies in Africa, Latin America and OECD. Our measure for physical capital investment, s_{it}^k, is the ratio of average investment to GDP from Penn World Tables version 6.1, and s_{it}^h is the percentage of secondary

[8] See Kalaitzidakis, Mamuneas, Savvides and Stengos (2001) who also use this specification.

[9] In a longer version of this paper Papageorgiou and Stoytcheva (2007) (*chrispapageorgiou.com/papers/AIDSwp.pdf*) also present an extensive cross-country estimation analysis in Appendix D. Results from the cross-country estimation are consistent with the baseline panel estimation.

school attained in the total population from Barro and Lee (2001). n_{it} is the average population growth of the working age population from World Development Indicators (WDI-2002), and $g+\delta = 0.05$ as in MRW. Finally, AIDS_{it} is the reported AIDS cases per 100,000 people averaged for the periods considered.[10] Following much of the literature on cross-country panel estimation, we average the data in five-year time intervals; 1986-1990, 1991-1995 and 1996-2000. Due to data constraints our full sample of is now reduced from 115 to 89 countries with a maximum of three and a minimum of one time observations for each country.

Our empirical investigation is based on three sets of results. First, Table 3 presents results from the panel data analysis motivated by equation (2). Recognizing that AIDS is a potentially endogenous variable we extend this analysis to panel Instrumental Variable (IV) estimation using lagged AIDS as our instrumental variable. These results are presented in Table 4. Finally, we report coefficient estimates from a cross-country estimation in which we exploit disaggregated data on AIDS by age group.

Model 1 in Table 3 presents results without any regional dummies. Models 2, 3 and 4 present results from the same specification but now adding regional dummies starting with a Sub-Saharan Africa dummy (Dum_{SSA}), then including a Latin America dummy (Dum_{LATIN}), and finally including an OECD dummy (Dum_{OECD}), respectively. The coefficient estimate for AIDS from Model 1 is negative and strongly significant. When we move to our preferred specifications that include regional dummies (Models 2-4), the AIDS coefficient estimate drops to about half in magnitude (from -0.044 to -0.024) and but still negative and significant, albeit at the 10% level. It is interesting to note that the magnitude of the AIDS estimate is very stable in Models 2, 3 and 4 when we include additively the different regional dummies. In Model 5 we examine the possibility of parameter heterogeneity due to regional differences by interacting the regional dummies with the AIDS variable. Results reveal that the marginal effect of AIDS is negative and significant for the Africa region. It is important to note, however, that although the coefficient of the interaction with Latin America is negative and statistically insignificant, it is economically larger than the Africa interaction. This evidence is consistent with the view that the epidemic's negative effect on income is driven by the poor countries and especially those in sub-Saharan Africa and Latin America.

Consistent with the existing literature based on the neoclassical growth model, the estimated coefficients for the remaining estimates, $\ln(s_{itk})$, $\ln(n_{it} + g + \delta)$, and $\ln(s_{ith})$ have the expected

[10] Following Gallup and Sachs (2000) and McCarthy, Wolf and Wu (2002), AIDS_i enters the regressions in levels.

Table 3: Panel cross-country income regressions

Model Specification	Model 1 time dum.	Model 2 time dum. reg. dum. (SSA)	Model 3 time dum. reg. dum. (SSA LAT)	Model 4 time dum. reg. dum. (SSA LAT OECD)	Model 5 time dum. reg. dum. interactions
Constant	5.6594***	5.2965***	5.3876***	9.2590***	9.3524***
	(0.6708)	(0.6860)	(0.6993)	(0.9048)	(0.8897)
$\ln s_{it}^k$	0.5810***	0.5031***	0.4904***	0.4857***	0.4743***
	(0.0715)	(0.0760)	(0.0807)	(0.0805)	(0.0819)
$\ln(n_i + g + \delta)$	−1.9623***	−2.0235***	−1.9871***	−0.4370	−0.3941
	(0.2162)	(0.2162)	(0.2249)	(0.3219)	(0.3167)
$\ln s_{it}^h$	0.5377***	0.4716***	0.4673***	0.4655***	0.4826***
	(0.0548)	(0.0569)	(0.0577)	(0.0592)	(0.0608)
AIDS_{it}	−0.0044***	−0.0024*	−0.0023*	−0.0024*	0.0070
	(0.0016)	(0.0012)	(0.0013)	(0.0014)	(0.0051)
Dum_{86}	−0.1507**	−0.1362**	−0.1360**	−0.1628***	−0.1541**
	(0.0701)	(0.0702)	(0.0705)	(0.0654)	(0.0656)
Dum_{96}	0.0329	0.0306	0.0330	0.1285*	0.1410*
	(0.0783)	(0.0768)	(0.0765)	(0.0724)	(0.0733)
Dum_{SSA}		−0.3112***	−0.3551***	−0.2088	−0.1773
		(0.1096)	(0.1375)	(0.1396)	(0.1435)
Dum_{LATIN}			−0.0589	0.1667*	0.2222**
			(0.0859)	(0.0929)	(0.1040)
Dum_{OECD}				0.7604***	0.7024***
				(0.1255)	(0.1302)
AIDS*Dum_{SSA}					−0.0098*
					(0.0054)
AIDS*Dum_{LATIN}					−0.0167
					(0.0122)
AIDS*Dum_{OECD}					0.01246
					(.0075)
Adj. R^2	0.81	0.81	0.82	0.84	0.85
Obs.	241	241	241	241	241

Notes: Dependent variable is the log of per capital GDP in 2000. Robust standard errors are in parentheses. *** Significantly different from 0 at the 1% level. ** Significantly different from 0 at the 5% level. * Significantly different from 0 at the 10% level.

signs and are significant at the 1% level in Models 1-4 (an exception is the coefficients for human capital in Models 4-5 which are insignificant). In addition, also consistent with the vast majority of cross-country regressions, the OECD dummy coefficient is positive, large in magnitude and very significant (in Models 4-5), the Latin America dummy positive and marginally statistically significant (in Models 4-5) and the sub-Sahara African dummy negative but only significant in Models 2-3 (negative but insignificant in Models 4-5).

In summary, our panel estimation shows evidence of a negative impact of AIDS on per capita income. This result is shown to hold robust to the inclusion of the sub-Saharan Africa dummy and also the Latin and OECD dummies. Finally, our results indicate that the negative impact of AIDS is primarily due to the sub-Saharan Africa and Latin America samples.

A potential concern about the empirical strategy used thus far is that it does not consider the potential endogeneity of the AIDS variable. To check the robustness of the results we use an instrumental variable strategy where the first lag of AIDS (for the period 1986-1990) is our instrument.[11,12] As a consequence our sample is now reduced from 241 to 159 observations

The first stage regression (not shown) indicates a significant and positive relationship between the past and current AIDS cases (in all specifications considered, coefficient estimates are around 2 with standard error around 0.16). The results of the second stage instrumental variable regressions are presented in Table 4. We consider Models 1-4 as in Table 3 but not Model 5 as it is impossible to justify an acceptable set of instruments under the interactions specification. For Model 1 (without regional dummies) the coefficient estimate for AIDS -0.0074 and significant at the 5% level. When we add a sub-Saharan Africa dummy the coefficient estimate remains negative but its magnitude declines to -0.0056 and becomes only significant at the 10% level. These results are robust to adding the Latin America and OECD dummies (Models 3 and 4, respectively) with the magnitude of the AIDS coefficient taking the values of -0.0052 and -0.0064, respectively. Comparing the IV results for AIDS in Table 4 with the panel results in Table 3 we note that they share a similar decrease in the magnitude and significance when we add the sub-Saharan Africa dummy (and the other two regional dummies). In addition, it is worth noting that although significance in

[11]We have also instrumented AIDS with initial AIDS (i.e. as far back as we could get data for each country) with results being very similar. A potential concern with using lagged explanatory variable as instrument is that if the dependent variable is correlated over time, then the instrument may not be exogenous. This concern would be more severe if we were using annual data on AIDS.

[12]Werker, Ahuja and Wendell (2006) are using an alternative instrument for AIDS, namely male circumcision. Unfortunately, we could not use this instrument in our estimation as Werker et al.'s data cover only African countries.

Table 4: Panel IV cross-country income regressions

Model Specification	Model 1 time dum.	Model 2 time dum. reg. dum. (SSA)	Model 3 time dum. reg. dum. (SSA LAT)	Model 4 time dum. reg. dum. (SSA LAT OECD)
Constant	5.2993***	5.0133***	5.2078***	9.2876***
	(0.8158)	(0.8530)	(0.8673)	(1.1489)
$\ln s_{it}^k$	0.5387***	0.4881***	0.4707***	0.4903***
	(0.0881)	(0.0931)	(0.0961)	(0.0981)
$\ln(n_{it} + g + \delta)$	−2.0906***	−2.1471***	−2.0732***	−0.4713
	(0.2669)	(0.2726)	(0.2825)	(0.4096)
$\ln s_{it}^h$	0.5606***	0.5176***	0.5082***	0.5218***
	(0.0679)	(0.0707)	(0.0728)	(0.0756)
AIDS_{it}	−0.0074**	−0.0056*	−0.0052*	−0.0064*
	(0.0032)	(0.0031)	(0.0031)	(0.0034)
Dum_{96}	0.0187	0.0171	0.0220	0.1191
	(0.0798)	(.0783)	(0.0774)	(0.0751)
Dum_{SSA}		−0.2088	−0.2901*	−0.0840
		(0.1445)	(0.1790)	(0.1330)
Dum_{LATIN}			−0.1048	0.1330
			(0.1020)	(0.1330)
Dum_{OECD}				0.7500***
				(0.1487)
Hausman (p-values)	0.94	0.95	0.95	0.76
Obs.	159	159	159	159

Notes: Dependent variable is the log of per capital GDP in 2000. Robust standard errors are in parentheses. *** Significantly different from 0 at the 1% level. ** Significantly different from 0 at the 5% level. * Significantly different from 0 at the 10% level.

the IV results stays only marginal the magnitude more than doubles. This may be caused by the change in our sample (from 241 to 159) due to the use of lagged AIDS in the IV estimation. Finally, in all specifications, the coefficients on $\ln(s_{itk}), \ln(s_{ith})$ and $\ln(n_{it}+g+\delta)$, as well as those of all three regional dummies are qualitatively similar to those obtained in the panel estimation without instrumental variables (with the exception of the coefficient on $\ln(n_{it}+g+\delta)$ in Model 4 that becomes insignificant). To summarize, the instrumental variable regression results support a negative but marginally statistically significant effect of AIDS on per capita income.

In addition to obtaining data on annual AIDS cases, we were also able to assemble data on the officially reported AIDS cases for the period of study on different age groups. In particular we were able to disaggregate our original AIDS dataset into four age-group samples as follows: AIDS[0-4] (*infancy period*), AIDS[5-15] (*schooling period*), AIDS[16-34] (*productive period*) and AIDS[35-60+] (*less productive period*). A caveat of this dataset is that AIDS cases by age is quite incomplete and these breakdowns exists only for selected years. Due to these data constraints our original sample was further reduced to 63 countries and were limited to applying OLS to Models 1-4 (without regional or time dummies).[13]

Table 5 presents regression results using AIDS cases by three age groups.[14] The main result from this exercise is that only the coefficient on AIDS[16-34] is statistically significant (albeit marginally in Models 2-4) with a negative sign. It is also important to notice that the magnitude of the AIDS[16-34] coefficient estimate (-0.09) is quite stable across the different models and substantially larger compared to respective cross-sectional estimate. The other two groups with ages 5-15 and 35-60+ do not obtain significant coefficient estimates. The estimates on $\ln(s_{ik})$, $\ln(s_{ih})$ and $\ln(n_i+g+\delta)$, remain significant at the 1% level of significance with the expected sign. This finding is quite intriguing suggesting that the negative impact of AIDS on income may be primarily due to the most productive age group, AIDS[16-34], being affected by AIDS. We note however that this analysis is quite preliminary and should be interpreted with caution.[15]

[13] These countries are marked with an asterisk in Table A1 in Appendix A. A detailed explanation of how we construct AIDS cases by age group appears in Appendix C.

[14] Due to the high correlation between AIDS[0-4] and AIDS[16-34], 0.825 we decided to exclude AIDS[0-4] from our regression to reduce the possibility of multicollinearity. This high correlation is present because infants till the age of 4 are infected almost exclusively by their parents who are HIV positive or they are already infected by AIDS.

[15] For example we recognize the potential for reverse causality, and that the 16-34 age group is hardly the most productive in developed countries relative to the age group 35-60+ taking salaries as an indicator of productivity.

Table 5: Cross-country income regressions using AIDS by age group

Model Specification	Model 1 Cross-section	Model 2 Cross-section reg. dum (SSA)	Model 3 Cross-section reg. dum (SSA LAT)	Model 4 Cross-section reg. dum (SSA LAT OECD)
Constant	5.2621***	5.2060***	5.4003***	6.5420***
	(1.0457)	(1.1049)	(1.1126)	(1.5849)
$\ln s_{ik}$	0.7231***	0.7122***	0.6671***	0.6540***
	(0.1461)	(0.1599)	(0.1609)	(0.1675)
$\ln(n_i + g + \delta)$	−2.5612***	−2.5603***	−2.4758***	−1.9900***
	(0.3184)	(0.3238)	(0.3363)	(0.6285)
$\ln s_{ih}$	0.4986***	0.4815***	0.4845***	0.4768***
	(0.0880)	(0.1010)	(0.1020)	(0.1062)
AIDS[5-15]	−0.0230	−0.0278	−0.0874	0.0436
	(0.2010)	(0.2009)	(0.2215)	(0.2687)
AIDS[16-34]	−0.0961***	−0.0973*	−0.0878*	−0.0918*
	(0.0030)	(0.0528)	(0.0531)	(0.0526)
AIDS[35-60+]	0.0584	0.0619	0.0584	0.0536
	(0.0782)	(0.0777)	(0.0768)	(0.0756)
Dum_{SSA}		−0.0625	−0.1612	−0.1002
		(0.2271)	(0.2701)	(0.2804)
Dum_{LATIN}			−0.1190	−0.0184
			(0.1524)	(0.1987)
Dum_{OECD}				0.2677
				(0.3056)
Adj. R^2	0.85	0.85	0.85	0.86
Obs.	63	63	63	63

Notes: Standard errors are in parentheses. White's heteroskedasticity correction was used. *** Significantly different from 0 at the 1% level. ** Significantly different from 0 at the 5% level. * Significantly different from 0 at the 10% level. AIDS[X1-X2] = AIDS for people within ages X1-X2.

4 Discussion

Beyond the negative impact of AIDS on cross-country income that emerges from our estimation results it is interesting to examine the magnitude of this impact. AIDS coefficient estimates are quite robust across the models that include regional dummies within the panel, panel-IV and cross-section-group estimations, respectively. However, they more than double in absolute magnitude when we compare panel to panel-IV estimation (i.e. -0.0024 to about -0.0056 in Model 2). Taking an estimate of about -0.003 as a conservative lower bound would imply that for the period 1979-2000 each additional AIDS incident per 100,000 people per year was associated with a 0.003 percentage point reduction in income per worker.

To better understand what these numbers mean we use the estimate of -0.003 to back out "lower-bound" direct cost estimates for the epidemic for selected countries with different AIDS severity. For example, we calculate that total cost to GDP ratio was about 0.2% for Botswana with the second highest AIDS rate in our sample. This is a really small effect especially when we take into account that the annual per capita GDP growth rate of Botswana was 5.3% during the period of our study. These calculations reveal that while the impact of AIDS is negative and significant from a statistical perspective, the estimated size of the effect is economically very small.

How do our results compare with those in the existing literature? Our work is closely related to the influential paper by Bloom and Mahal (1997) that also uses cross-country regressions but instead finds no significant impact of AIDS on growth. The difference between the Bloom-Mahal and our papers may well be explained by the central question asked; on the one hand, we are interested in the effect of AIDS on *income*, considering income as a good proxy for welfare. On the other hand Bloom and Mahal are interested in the effect of AIDS on *growth*, considering growth as a good proxy for the development process. Another possibility for the different results is the more extensive coverage of countries and years we have for the AIDS series (Bloom and Mahal's sample is for 51 countries and ends in 1992). In our working paper version (Papageorgiou and Stoytcheva (2007)), we report cross-sectional estimates of regressions with income growth per worker as the dependent variable in the spirit of Bloom and Mahal (1997). Consistent with these authors' results we find that there is an insignificant effect of AIDS on growth. Our analysis therefore suggest that AIDS has a different effect in level versus growth regressions (as indicated in e.g., Hall and Jones (1999, p.85)).

Another influential paper in the AIDS-development literature is the contribution by Young (2005). Young shows that as a result of a significant decrease in population, AIDS will increase the welfare of the future generations in South Africa by increasing their per capita income. Young argues that in South Africa infection lowers fertility both through a reduction in the willingness to engage in unprotected sexual activity and by increasing the scarcity of labor. He argues that the fertility effect dominates, thus his quite controversial result. A more recent contribution by Kalemli-Ozcan (2006), however, finds that extending the sample to a panel of 44 African countries, AIDS positively affects fertility rates and negatively affects enrollment rates (although in some specification there is no effects). Our result, that after controlling for various regional interactions only sub-Saharan Africa's income is negatively and significantly affected by AIDS, is broadly consistent with the finding of Kalemli-Ozcan. As argued in Kalemli-Ozcan, extending the careful analysis of Young on South Africa to a panel of African countries (and in our case a world sample) may be the reason for the difference between the two results.

Albeit statistically significant, our results show that the negative impact of AIDS on per capita income is very small. This is a result that has recently been emerging in the broader health-growth literature. For example, in cross-country studies of this relationship by Acemoglu and Johnson (2007) and Weil (2007) there seems to be either no significant relationship or a negative but small effect of health on growth.

A final point is worth noting. We suggest that cross-country regressions, regardless of whether testing for growth, health or other aggregate output, should incorporate AIDS as a key control variable to capture the effect of the disease, especially on the sub-Sahara African region. For example, Papageorgiou, Savvides and Zachariadis (2007) investigate a cross-country relationship between health output (life expectancy and infant mortality) and medical technology diffusion. They show that an important control variable is the AIDS that controls for the reversion of life expectancy in many sub-Sahara African countries in mid-1980s. Omission of the AIDS data would result in biased estimates as the authors note.

5 Conclusion

In this paper, we investigate the impact of AIDS on cross-country income levels. Our measure of AIDS comes from the officially reported AIDS cases compiled by UNAIDS/WHO on 89 countries for the period 1986-2000, during which the AIDS epidemic has spread across the globe. Our main results are as follows: First, using the full sample without controlling for regional effects, we find the coefficient estimate for AIDS to be negative albeit marginally statistically significant. Second, upon adding regional dummies we show that the negative effect is primarily due to the sub-Sahara African and Latin American countries in our sample. Third, using AIDS cases by age group reveals that only the coefficient on AIDS between the ages 16-34 is significant with a negative sign. In addition, the magnitude of the AIDS[16-34] coefficient estimate has more than doubled compared to that obtained when using the aggregated AIDS data. Last but not least, our results suggest that while the economic impact of AIDS is negative and statistically significant, its economic significance measured by the estimated size of the AIDS coefficient is quite small. This is consistent with resent results by Acemoglu and Johnson (2006) and Weil (2007) who find more broadly that the effects of health on income growth is small. A sensitivity analysis shows robustness of our results to various alternative specifications.

We note that our analysis is subject to three limitations. First, the AIDS data used in this study are likely to suffer from measurement and under-reporting errors. Second, lack of an ideal instrument for AIDS suggests that we can only make qualified statements about the causal effect of the relationship. Third, the AIDS epidemic is still an evolving phenomenon and therefore as newer data become available we can better capture its economic effects. Notwithstanding these limitations, it is shown that with some care this dataset can shed new light on the economic effects of AIDS.

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Appendix A

Table A1: Data

Country information			Summary values for relevant variables				
Name	PWT Code	Reg. Dummy	Y/L_{2000}	I/Y	SCHOOL	$n+g+\delta$	AIDS
Algeria*	DZA	SSA	10005.4	13.67	0.107	0.075	0.116
Angola	AGO	SSA	4360.1	6.27	0.029	0.074	3.776
Argentina*	ARG	Latin	18742.5	15.67	0.094	0.064	3.366
Australia	AUS	OECD	40452.0	24.00	0.111	0.060	0.777
Austria*	AUT	OECD	36615.7	25.60	0.108	0.053	1.687
Bangladesh	BGD	—	3046.7	10.47	0.038	0.069	0.001
Belgium*	BEL	OECD	38061.8	23.27	0.113	0.051	1.772
Benin	BEN	SSA	2406.2	7.53	0.031	0.077	5.776
Bolivia*	BOL	Latin	5205.1	9.47	0.071	0.070	0.243
Botswana	BWA	SSA	14769.7	17.00	0.082	0.073	57.084
Brazil*	BRA	Latin	11723.9	17.40	0.063	0.068	8.890
Burkina Faso*	BFA	SSA	2051.0	11.20	0.010	0.070	11.231
Burundi	BDI	SSA	1248.1	6.00	0.008	0.066	27.484
Cameroon	CMR	SSA	4321.1	6.60	0.044	0.073	10.862
Canada*	CAN	OECD	42080.2	25.20	0.112	0.058	4.080
C.African Rep.	CAF	SSA	2357.0	5.00	0.024	0.069	20.396
Chad*	TCD	SSA	1903.4	6.67	0.015	0.071	12.769
Chile*	CHL	Latin	16137.4	19.67	0.101	0.062	1.960
Colombia*	COL	Latin	9276.3	11.93	0.093	0.068	2.183
Congo	COG	SSA	5024.4	7.40	0.127	0.072	168.599
Costa Rica*	CRI	Latin	9391.8	16.60	0.082	0.074	4.055
Denmark*	DNK	OECD	42759.9	22.40	0.118	0.053	2.885
Dom. Rep.*	DOM	Latin	9089.1	13.80	0.091	0.069	5.074
Ecuador*	ECU	Latin	6051.4	15.93	0.107	0.072	0.882
Egypt*	EGY	—	7282.9	6.13	0.125	0.074	0.029
El Salvador*	SLU	Latin	7778.1	8.20	0.057	0.071	4.321
Ethiopia	ETH	SSA	1388.1	4.33	0.022	0.069	7.163
Finland*	FIN	OECD	36433.6	24.13	0.111	0.052	0.402
France*	FRA	OECD	36165.8	24.27	0.109	0.052	6.007
Ghana*	GHA	SSA	2464.5	6.20	0.079	0.077	16.679
Greece*	GRC	OECD	23087.6	21.40	0.103	0.052	1.396
Guatemala*	GTM	Latin	8202.7	7.47	0.044	0.075	2.513
Haiti	HTI	Latin	6235.0	4.77	0.034	0.074	9.346
Honduras*	HND	Latin	3947.2	14.67	0.068	0.078	14.133
Hong Kong*	HKG	—	38179.1	25.27	0.089	0.068	0.523
India	IND	—	4360.6	12.33	0.068	0.070	0.073
Indonesia*	IDN	—	6263.5	17.67	0.0770	0.0684	0.0159
Ireland*	IRL	OECD	40520.7	19.73	0.1553	0.0638	1.2876
Israel*	ISR	—	30942.5	26.33	0.1236	0.0753	0.9041
Italy*	ITA	OECD	33816.6	21.93	0.0882	0.0507	5.5837
Jamaica*	JAM	Latin	5648.5	17.80	0.1300	0.0627	13.3205
Japan*	JPN	OECD	38057.5	32.60	0.1040	0.0497	0.1010
Jordan*	JOR	—	7490.8	15.13	0.1741	0.0888	0.1469
Kenya	KEN	SSA	2451.1	8.13	0.0505	0.0817	24.9535
Korea*	KOR	—	20719.5	36.07	0.1404	0.0613	0.0306

Notes: The sources for these data are Barro and Lee (2001), UNAIDS/WHO and PWT 6.1.
Y/L_{2000} is GPD per worker in 2000. All other variables are averages for the period 1986-2000.
* denotes the 63 nations included in the sample used to carry out age-sepcific AIDS estimation.

Table A1: Data (cont.)

Country information			Summary values for relevant variables				
Name	PWT Code	Reg. Dum.	Y/L_{2000}	I/Y	SCHOOL	$n+g+\delta$	AIDS
Madagascar*	MDG	SSA	1677.6	3.13	0.047	0.075	0.021
Malawi	MWI	SSA	1591.9	7.67	0.018	0.069	43.880
Malaysia	MYS	—	15251.6	25.53	0.094	0.075	1.642
Mali	MLI	SSA	1995.9	8.13	0.018	0.070	3.970
Mauritania	MRT	SSA	2984.3	9.21	0.027	0.077	2.082
Mauritius*	MUS	SSA	21132.0	12.47	0.086	0.062	0.402
Mexico*	MEX	Latin	15629.6	18.20	0.112	0.069	3.508
Morocco*	MAR	—	7024.9	11.93	0.066	0.070	0.207
Mozambique	MOZ	SSA	2107.5	3.53	0.013	0.068	9.823
Netherlands*	NLD	OECD	37847.2	22.60	0.128	0.054	2.380
New Zealand*	NZL	OECD	30608.2	21.40	0.121	0.057	1.340
Nicaragua*	NIC	Latin	3584.3	12.27	0.093	0.078	0.431
Niger*	NER	SSA	1875.0	4.60	0.012	0.078	4.239
Nigeria	NGA	SSA	1592.5	9.47	0.047	0.075	3.148
Norway*	NOR	OECD	49423.1	28.27	0.116	0.055	1.054
Pakistan*	PAK	—	3956.5	11.07	0.039	0.073	0.011
Panama*	PAN	Latin	10528.0	19.80	0.115	0.069	8.795
Papua N.G.*	PNG	—	5778.8	10.36	0.023	0.073	1.527
Paraguay*	PRY	Latin	8423.9	12.67	0.063	0.077	0.694
Peru*	PER	Latin	7767.1	18.20	0.122	0.071	2.799
Philippines	PHL	—	6896.7	14.53	0.131	0.072	0.046
Portugal*	PRT	OECD	25241.1	23.47	0.086	0.052	5.594
Rwanda	RWA	SSA	1839.0	4.13	0.012	0.085	22.221
Senegal	SEN	SSA	3161.3	6.73	0.028	0.074	2.554
Sierra Leone	SLE	SSA	1388.0	4.69	0.030	0.068	0.595
Singapore*	SGP	—	40393.7	42.47	0.090	0.071	1.366
Spain*	ESP	OECD	27861.2	24.60	0.131	0.052	10.470
Sri Lanka*	LKA	—	5695.3	12.47	0.109	0.066	0.046
Sweden*	SWE	OECD	38254.8	21.00	0.101	0.051	1.316
Switzerland*	CHE	OECD	41885.1	27.73	0.098	0.051	6.890
Syria*	SYR	—	7742.7	9.20	0.112	0.084	0.036
Tanzania*	TZA	SSA	932.4	13.93	0.008	0.077	31.147
Thailand*	THA		9858.3	33.40	0.063	0.061	19.808
Togo*	TGO	SSA	1760.4	8.07	0.051	0.077	21.910
Tri.&Tobago*	TTO	Latin	20072.5	8.93	0.128	0.065	18.936
Tunisia	TUN	—	11064.1	13.27	0.080	0.070	0.442
Turkey*	TUR	OECD	11548.5	19.20	0.083	0.066	0.041
Uganda	UGA	SSA	2132.7	3.20	0.021	0.072	22.979
UK*	GBR	OECD	37153.1	18.93	0.105	0.053	1.975
Uruguay*	URY	Latin	16503.9	10.93	0.097	0.054	3.018
USA*	USA	OECD	53979.1	21.27	0.109	0.060	20.079
Venezuela	VEN	Latin	11757.8	14.33	0.062	0.074	2.825
Zambia	ZMB	SSA	1664.6	9.00	0.042	0.070	46.390
Zimbabwe	ZWE	SSA	5053.0	13.53	0.077	0.070	55.472

Notes: The sources for these data are Barro and Lee (2001), UNAIDS/WHO and PWT 6.1.
Y/L_{2000} is GPD per worker in 2000. All other variables are averages for the period 1986-2000.
* denotes the 63 nations included in the sample used to carry out age-specific AIDS estimation.

Appendix B

AIDS Definition

The 1985 World Health Organization AIDS surveillance case definition was developed in October 1985, at a conference in Bangui, Central African Republic (known as the "Bangui definition"). It was developed to provide surveilling case definition of AIDS for use in countries where testing for HIV antibodies was not available. The 1994 expanded World Health Organization AIDS case definition was introduced to incorporate the statement that HIV testing should be done. However, if testing was unavailable, then the Bangui definition should be used (Weekly Epidemiological Record, 1994, issue 69, pp. 273-280).

1985 WHO AIDS surveillance case definition

For the purposes of AIDS surveillance an adult or adolescent ($>$ 12 years of age) is considered to have AIDS if at least 2 of the following major signs are present in combination with at least 1 of the minor signs listed below, and if these signs are not known to be due to a condition unrelated to HIV infection.

Major signs

- weight loss $\geqq$ 10% of body weight
- chronic diarrhoea for more than 1 month
- prolonged fever for more than 1 month (intermittent or constant)

Minor signs

- persistent cough for more than 1 month
- generalized pruritic dermatitis
- history of herpes zoster
- oropharyngeal candidiasis
- chronic progressive or disseminated herpes simplex infection generalized lymphadenopathy

The presence of either generalized Kaposi sarcoma or cryptococcal meningitis is sufficient for the diagnosis of AIDS for surveillance purposes.

1994 extended WHO AIDS surveillance case definition

For the purposes of AIDS surveillance an adult or adolescent ($>$ 12 years of age) is considered to have AIDS if a test for HIV antibody gives a positive result, and 1 or more of the following conditions are present:

- $\geqq$ 10% body weight loss or cachexia, with diarrhoea or fever, or both, intermittent or constant, for at least 1 month, not known to be due to a condition unrelated to HIV infection
- cryptococcal meningitis
- pulmonary or extra-pulmonary tuberculoses
- Kaposi sarcoma
- neurological impairment that is sufficient to prevent independent daily activities, not known to be due to a condition unrelated to HIV infection (for example, trauma or cerebrovascular accident)
- candidiasis of the oesophagus (which may be presumptively diagnosed based on the presence of oral candidiasis accompanied by dysphagia)
- clinically diagnosed life-threatening or recurrent episodes of pneumonia, with or without etiological confirmation
- invasive cervical cancer

Appendix C

Constructing AIDS cases by age

- The officially reported AIDS cases for the different age groups are reported as a total before 1997 and annually for 1997, 1998, 1999 and 2000.

- In addition to the officially reported cases per age group, UNAIDS/WHO also reports "Not Specified" (NS) representing cases in which an age group was not specified along with AIDS reporting. We can not use NS cases in our calculation of the age groups and recognize that this is a source of measurement error due to aggregation.

- We chose aggregate AIDS cases into four age-group samples as follows: AIDS[0-4] (*infancy period*), AIDS[5-15] (*schooling period*), AIDS[16-34] (*productive period*) and AIDS[35-60+] (*less productive period*).

- We divide the total number of reported AIDS cases in each age group by the number of years cases are reported and multiply by 100,000 and divide by average population. This the mean AIDS cases reported per 100,000 people by each of the four age groups.

- Data on population are taken for the WDI (2002).