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AIDS & Economics

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Introduction

More than 22 million people have now died of AIDS, including 3 million in 2000 alone. Thirty-six million people are currently infected with the virus and, although infection rates are stabilizing in Sub-Saharan Africa (albeit at a very high level), the epidemic is still growing in Asia and Eastern Europe. The lack of an imminent vaccine or cure means that many more deaths are inevitable.

The seriousness of the AIDS epidemic raises questions about the potential impact of the epidemic on national and regional economies. AIDS disproportionately affects people of working age, and is also creating a huge burden of AIDS orphans. Many political leaders have expressed alarm in light of studies showing the potential devastation of their economies, but relatively few business have spoken out decisively.

This paper provides an overview of the links between AIDS and economics. Part 1 assesses economic correlates of HIV transmission, using macro, micro and household data. Part 2 examines the effect of AIDS on economies, both directly and as a cause of demographic change. Part 3 explores the likely economic returns to actions that prevent HIV infections.

Part 1 – Economic determinants of HIV transmission

This section reviews existing studies of the association between HIV/AIDS and economic status, at both the macro and micro levels, and assesses the impact of development on AIDS.

The macro level

The link between income levels and AIDS prevalence is complex and poorly understood. Data from the 1980s and early 1990s, mainly from sub-Saharan Africa, show that the wealthy were at highest risk from the epidemic. Two of Africa's richest nations, Botswana and South Africa, are among the most affected nations in the world. Figure 1, based on data from 1997, shows a continuing disproportionate impact on Africa's richer countries, reflecting the role that better infrastructure and more mobile populations seem to play in the spread of the disease. Within all other continents, there is neither a positive nor a negative statistical association between income levels and AIDS. On an intra-continental level, therefore, HIV is either affecting the rich more than the poor or is income neutral.

Between continents, however, the picture looks different. 95 percent of those infected with HIV live in less developed countries, home to 80 percent of the world's population. As figures 2 and 3 show, at a global level there is a statistically significant relationship between low income and HIV prevalence rates; that is, the poorer the country the greater the HIV prevalence. There is a similar relation between income distribution and HIV prevalence, with countries with greater income inequality facing a more serious epidemic. Absolute poverty rates, defined as income below $1 a day, are strongly associated with HIV prevalence rates (figure 4), as are low rankings on the United Nations Development Programme (UNDP) Human Poverty Index, which takes into account mortality, literacy, malnutrition and access to water, sanitation and health services (figure 5).

Existing data provide some indication that the relationship between poverty and HIV is growing stronger over time, both between and within continents. But it is not possible to infer causality from these data. That is, it is difficult to tell whether poverty causes AIDS or vice versa – or whether another variable, such as war, inadequate health, or poor education, explains the relationship.

The micro level

Compared to existing macro data, micro-studies appear to be better equipped to highlight links between economic status and AIDS. Thus, the intuitive link between knowledge and HIV transmission is supported by several studies. School enrolment rates and illiteracy rates in the majority of the developing world, and particularly in Africa, are substantially lower than those in richer countries, and the poor within countries are least likely to receive education.[2] The poor are therefore less likely to be aware of the dangers of HIV/AIDS than the rich.

– Analysis of household data from Cambodia, Vietnam, Nicaragua and Tanzania (see Appendix 1) shows a strong correlation between both wealth and education and: knowledge that condoms prevent AIDS; knowledge of where condoms can be obtained; and self-reported usage of condoms.[3]

– Recent research in Cambodia, the country with the most advanced epidemic in Asia, demonstrates that the poorest segments of society have much less knowledge of how AIDS is transmitted and prevented; are more likely to have sex at a younger age; use condoms less frequently; and, in the case of young women, are more likely to turn to sex work as a means of supporting themselves and their families.[4]

– A study in Brazil showed that three-quarters of people newly diagnosed with HIV in the early 1980s had a secondary or university education, but by the early 1990s this share had fallen to one third.[5]

– A study in rural Uganda, on the other hand, found that in a cohort of almost 20,000 adults aged 15-59 years followed over 3 and one-half years, HIV-associated mortality was highest among the better educated[6]. However, there is evidence that this pattern may be changing over time. Another study in Uganda (see figure 6) shows that the better educated were hit hardest in the early stages of the epidemic, but that HIV infection rates are now falling quickest among those with more education.[7]

Education is not the only factor highlighted by micro data. There is evidence that poverty forces many people to work in the commercial sex industry, thereby putting them at risk of HIV infection. A series of small-scale studies from sub-Saharan Africa, Haiti and Brazil,[8] show how poor women can be forced into sex work, or into providing sexual favors in return

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[2] See Third World Institute (1997): The World Guide 1997/98 – A View from the South. New Internationalist Publications Ltd.
[3] Demographic & Health Survey Data, Macro International. 2001. Analysis conducted by the authors.
[4] David Bloom, River Path Associates and Jaypee Sevilla (2001): "Health, wealth, AIDS and poverty – the case of Cambodia. ADB/UNAIDS." Forthcoming.
[5] Parker,R.G.1998."Historic Overview of Brazil 's AIDS Programmes and Review of the World Bank AIDS Project".Family Health International/AIDSCAP.Processed; Ainsworth,M.,and Semali,I."Who is most likely to die of AIDS? Socioeconomic correlates of adult deaths in Kagera Region,Tanzania." Cited in Ainsworth, M.,Fransen, L,Over,M.(Eds).1997 ibid.
[6] Sewankambo NK. Gray RH. Ahmad S. Serwadda D. Wabwire-Mangen F. Nalugoda
F. Kiwanuka N. Lutalo T. Kigozi G. Li C. Meehan MP. Brahmbatt H. Wawer
MJ. (2000). "Mortality associated with HIV infection in rural Rakai District, Uganda." AIDS. 14(15):2391-400, 2000 Oct 20.
[7] UNAIDS (2000) ibid
[8] Fitzgerald DW. Behets F. Caliendo A. Roberfroid D. Lucet C. Fitzgerald JW. Kuykens L. (2000). Economic hardship and sexually transmitted diseases in Haiti's rural Artibonite Valley. American Journal of Tropical Medicine & Hygiene. 62(4):496-501Meekers D. Calves AE. (1997) 'Main' girlfriends, girlfriends, marriage, and money: the social context of HIV risk behavior in sub-Saharan Africa. Health Transition Review. 7 Suppl:361-75, 1997; Ryan KA. Roddy RE. Zekeng L. Weir SS. Tamoufe U. (1998). Characteristics associated with prevalent HIV infection among a cohort of sex workers in Cameroon. Sexually Transmitted Infections. 74(2):131-5, 1998 Apr; Lurie P. Fernandes ME. Hughes V. Arevalo EI. Hudes ES. Reingold A. Hearst N. (1995). Socioeconomic status and risk of HIV-1, syphilis and hepatitis B infection among sex workers in Sao Paulo State, Brazil. AIDS. 9 Suppl 1:S31-7, 1995 Jul.

for money. They are also shown to be less able to insist on condom use than their wealthier clients.

While the micro data is suggestive of a link between poverty and AIDS, many small scale studies are based on non-representative samples in the hardest hit areas, and some larger scale research, such as that conducted in Uganda, shows a negative correlation between HIV and poverty. As with the macro data, there remain many unanswered questions.

The impact of development

While poverty reduction might be thought to reduce HIV/AIDS rates, in some cases the development process may itself strengthen epidemics. Development is associated with infrastructure development, urbanization, increases in disposable income, the growing importance of cash in agriculture, and growing mobility. Furthermore, inequality often grows in the early stages of an epidemic, [9] creating increased internal migration (as workers migrate to centers of wealth and employment), a significant risk factor as men travel away to work, but occasionally return to their families in their village of origin. Development is likely to bring greater opportunities for multiple partnering and a growth in the commercial sex industry. [10] Finally, inequality can create changes in gender relations that may facilitate the spread of sexually transmitted diseases. [11]

There is currently little evidence to quantify the extent of the HIV risks caused by the unintended consequences of development efforts. However, a strong case is building for making HIV impact assessment a routine part of programs designed to promote development and poverty reduction.

Poverty to AIDS

In sum, the link between economic status and AIDS is complex. While many micro level studies point to a significant link between poverty and HIV prevalence rates, macro data is unconvincing, particularly in terms of the causality of the link. Some risk factors for HIV, such as a high level of disposable income, are more prevalent amongst the rich than the poor. Others, such as lack of education, are more prevalent among the poor than the rich. Both groups exhibit the kind of mobility that appears to be associated with HIV transmission.

On balance, it seems plausible that the rich are more at risk in the early stages of an epidemic, and that a combination of factors, including lack of education and other economic exigencies, put the poor at increasing risk as an epidemic progresses. One might therefore suspect HIV epidemics to become increasingly embedded in poor communities. Although not proven, this hypothesis is broadly consistent with patterns of HIV transmission seen in Africa and other regions, including wealthy industrial countries such as the US.

Part 2: The impact of AIDS on economies

The humanitarian case for taking action to prevent HIV/AIDS is clear. However, there is also value in exploring the economic case for action. With many problems competing for public sector budgets, governments need guidance on where to devote its resources.

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[9] Francois Nielson (1994): Income inequality and industrial development: dualism revisited. American Sociological Review, 59. October.
[10] Studies have found that the probability of having a non-regular sexual partner is higher in urban than rural areas; commercial sex is more common in urban areas; and STD rates are higher. Deon Filmer (1997): The socio-economic correlates of sexual behavior. In World Bank (1998): Confronting AIDS: Evidence from the developing world. European Commission 1998; Jean-Claude Deheneffe, Michel Carael, Amadou Noumbissi (1998): Socioeconomic determinants of sexual behavior and condom use. In World Bank (1998) ibid.
[11] Paul Farmer, 1999: Infections and inequalities. University of California Press

Businesses may also need to adjust their strategies to respond to the epidemic. This section therefore explores the epidemic's economic impact.

Macro evidence

A lack of reliable time series data on poverty rates and AIDS makes drawing macro level conclusions about the impact of AIDS on economies difficult. Inter-continental poverty differences predate the AIDS epidemic, and the hardest hit continent – Africa – is mired in too complex and deep a development trap to make disaggregating the effects of the epidemic feasible or persuasive.

There are many mechanisms through which AIDS may have a *potential* impact on the economy. Unlike most other deadly illnesses, HIV's prime target is people of working-age.[12] The result is a potential reduction in savings rates and disposable income, which may have an economic impact.[13] New staff must be trained and recruited, a cost that would not otherwise have been borne. Firms may also suffer a loss of valuable know-how. Moreover, AIDS is debilitating, particularly in the final two years before death,[14] and absenteeism for both those infected and those caring for them may have an impact on businesses and other work organizations. Increases in health spending could mean cuts in investment in other growth-enhancing areas, education and infrastructure, for example. The impact on productivity may also decrease an economy's attractiveness to foreign investors, and diminish tax revenue.

However, there are other influences that may counter these effects. Workers who die of AIDS may be replaced by people who were previously unemployed and a smaller labor force may even lead to a rise in output per capita. Although HIV/AIDS mortality can reduce overall output, it also reduces population, so per capita productivity may not be reduced.[15] Even in the hardest hit areas, therefore, it is possible that GDP *per capita* may not decline.

Macro evidence from the early phases of the epidemic failed to substantiate the hypothesis that AIDS would have a detrimental effect on growth rates of per capita income. From 1980 to 1992, AIDS had no statistically significant impact on per capita income growth.[16] However, the epidemic has since grown rapidly and has begun to have a significant effect on life expectancy and other human development indicators.[17] In South Africa, for example, life expectancy is expected to fall 25 years below its pre-AIDS level.[18] Recent studies show some evidence of growing macroeconomic impact:

– In the Caribbean, one study has argued that, if infections increase according to current trends, the loss to GDP will reach 4.2 percent per year by 2005.[19]

– Another study claims that AIDS will cut the government budget in Botswana by 20 percent by 2010, although population levels may fall by a similar rate.[20]

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[12] Most AIDS-related deaths are likely to hit the 25-45 year age group. ING Barings (1999): The demographic impact of HIV/AIDS on the South African economy. Johannesburg. December.
[13] Daly, Kieren. 2000. The Response of Business to AIDS: Impacts and Lessons Learnt. London: UNAIDS, The Prince of Wales Business Leaders Forum, and The Global Business Council on HIV & AIDS.
[14] C Arndt and JD Lewis (2000): "The Macro Implications of HIV/AIDS in South Africa: A Preliminary Assessment." *The South African Journal of Economics*. Special Edition: Vol 68: 5 December
[15] C Arndt and JD Lewis (2000) ibid.
[16] Bloom, David, and Ajay Mahal. 1997. "Does the AIDS epidemic threaten economic growth?" *Journal of Econometrics* 77(1):105-24.
[17] Bloom, David, Neil Bennett, Ajay Mahal, and Waseem Noor. 1996. "The Impact of AIDS on Human Development." Draft. New York: Columbia University, Department of Economics
[18] C Arndt and JD Lewis (2000) ibid.
[19] Karl Theodore, 2000.
[20] UNAIDS (2000) ibid.

– An early World Bank study, of 30 sub-Saharan African countries, concludes that the net effect of AIDS will be a reduction in GDP growth of between 0.8 and 1.4 percentage points per year.[21]

Conversely, however, a recent assessment of AIDS in Asia concluded that the region's low prevalence rates are likely to mean that the impact of the virus on Asian economies remains minimal.[22]

Data are far from adequate, but calculations made for Thailand may be instructive for understanding the potential economic effect of AIDS in Sub-Saharan Africa. Thailand's ratio of working-age to total population is projected to be 0.70 in 2015.[23] We estimate that cumulative AIDS deaths by that year will be about 1 million, a relatively small number because risky behaviors have declined as a result of Thailand's highly successful anti-HIV policies. Yet if we simulate cumulative AIDS deaths in the absence of these substantial behavioral improvements, they could be as high as 10 million. Add to this an estimate of the number of children that would not have been born because of these deaths and the population could be about 11.6 million smaller than it otherwise would have been. AIDS mortality is disproportionately selective of adults, and we project that of the 10 million deaths, 92% or 9.2 million would be among adults. To this number, we add the .75 million children these adults would have had, and who would have had the chance to reach working age by 2015, and we find that this high risk scenario causes the working age population to be smaller by about 9.95 million.[24] This combined effect on the total and working age population would result in a decline in the working-age share of the population to 0.67. This difference could reduce the growth in per capita GDP by about .65 percentage points every year from a projected rate of 3.46 to 2.81. As a result, the level of GDP per capita in 2015 would be $1272 lower than its projected $8500. At Thailand's current prevalence rates, still among the highest outside Africa at an adult rate of 2.15 percent, the impact on GDP is minimal. Nevertheless, the example demonstrates that an unchecked AIDS epidemic – as some African countries are experiencing – can have a substantial effect on the growth of income per capita because it is so highly concentrated in working-age individuals.[25]

In reviewing all the available evidence, UNAIDS states that, "despite incomplete data, there is growing evidence that as HIV prevalence rates rise, both total and growth in national income – GDP – fall significantly."[26] It is important to emphasize, however, that the data *are* incomplete; many of the studies forecast rather than report impacts; and the methodology of some studies can be questioned. On balance, it appears likely that countries that keep

[21] Over, Mead, 1992. "The Macroeconomic impact of AIDS in Sub-Saharan Africa," The World Bank, Technical Working Paper No. 3., 1992.

[22] David E Bloom, River Path Associates and Jaypee Sevilla (2001): "Health, wealth, AIDS and poverty. ADB/UNAIDS. Forthcoming."

[23] United Nations, World Population Prospects: The 2000 Revision

[24] Given an estimated cumulative number of females dead in 2015, we estimate the number of children these females would have had by assuming that over the 25 year period from 1990 to 2015 over which we are performing the projections, each female who dies from AIDS loses an average of 12.5 years of child-bearing life (the midpoint of the 25-year interval). We divide the 1995 Thai total fertility rate of 1.94 (UNPOP 2000) by 35, the number of child-bearing years (from 15 to 50 years of age), to obtain the average number of children born to a woman each year, about .06. We multiply this by 12.5, the number of child-bearing years lost to AIDS, to obtain the number of children lost to an AIDS death, about .75. We then calculate the total number of children lost by multiplying this number by the cumulative number of female deaths. Given this total number of children who were not born because of AIDS deaths, we (again roughly) compute the fraction of these children who would have reached working age by the year 2015 by simply assuming that the same number of children would have been born every year, and that those born by 2000 would reach working age by the year 2015.]

[25] See David Bloom, David Canning, and Jaypee Sevilla, "Economic Growth and the Demographic Transition", November 2001.

[26] UNAIDS (2000) ibid.

prevalence rates below threshold levels will see limited economic impacts. Above the threshold, more dramatic effects are possible and, in some cases, these may be very serious indeed.

The impact on business

The effects of HIV/AIDS on a business are likely to be felt in three areas: a firm's labor force, its customer base, and the reputation of the company.

There have been a number of studies on the impact of HIV/AIDS on the workforce. In the early stages of the epidemic in Africa, the spread of the epidemic appeared to correlate with wealth, and firms therefore seemed to be losing their most skilled, productive, and expensive-to-replace workers. More recently, however, a study has suggested that overall infection rates will peak at nearly three times the rate for highly skilled workers.[27] Generally, turnover in Africa was minimally affected in the early stages of the epidemic,[28] but as the epidemic has matured, companies in hard hit areas have begun to feel an impact.[29] Some multinational organizations in South Africa, for example, claim to have hired 3 workers for each position to replace those who die.[30] Outside Africa, there is as yet no evidence that the epidemic is disproportionately targeting the skilled. Companies in certain sectors may suffer – trucking companies in India, for example[31] – but large-scale decimation of workforces is unlikely.

There are other potential effects that are even more difficult to quantify. Studies in Kenya and Thailand, for example, have shown that some business leaders believe that motivation and productivity are adversely affected by AIDS-related illnesses and death, for example.[32] In the future, it is also possible that the quality of available workers will deteriorate, as AIDS orphans (of whom there are currently 13 million) receive less education and are poorly socialized.[33] Studies are not yet able to show the likely economic impact of these effects.

The impacts on the customer base will be felt most keenly in Africa, although countries that trade extensively with African countries (as well as multinationals with franchises in Africa) may feel a ripple effect. Young working-age adults have considerable spending power as consumers and, while industries such as health care are likely to see an increase in demand as a result of the virus, most others are likely to suffer as their customers redirect spending towards the costs of caring. Studies in Cote d'Ivoire and Rwanda have shown how health expenditure significantly reduces the household consumption of families living with AIDS.[34] A study of the epidemic in Thailand claims that it may cost Japan as much as 1.2 percent of its gross national product (GNP) due to the weakening of this important market for Japanese exports.[35] The methodological basis of this and similar studies is questionable however.

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[27] ING Barings (1999) ibid.
[28] Biggs, Tyler and Manju Shah. 1997. "The impact of the AIDS epidemic on African firms." RPED Discussion Paper #72. Washington, D.C.: The World Bank, Africa Region.
[29] See Bloom et al (2001) ibid for detailed list of examples.
[30] Economist. 2001. "The worst way to lose talent." 8 February.
[31] Harvard University (1995): Harvard AIDS Review, Fall 1995
[32] Rugalema, Gabriel. 1999. HIV/AIDS and the commercial agricultural sector of Kenya: Impact, vulnerability, susceptibility and coping strategies. Sustainable Development Department. Rome: Food and Agriculture Organization of the United Nations (FAO); ILO. 1999b. Study of the impact of HIV/AIDS in small businesses: Case studies of Suba and Isiolu districts in Kenya. November 1999, Geneva. www.ilo.org/public/english/protection/trav/aids/initiatives.htm; UNAIDS 1999a. "Mechai Viravaidya appointed UNAIDS ambassador." Press Release, Kuala Lumpur, 24 October.
[33] UNAIDS (2000): Report on the global HIV/AIDS epidemic. June 2000. UNAIDS
[34] UNAIDS (1998). Putting HIV/AIDS on the Business Agenda. Geneva: UNAIDS; Nandakumar, A.K., Pia Schneider and Damascene Butera. 2000. "Use of and expenditures on outpatient health care by a group of HIV-positive individuals in Rwanda." Partnerships for Health Reform Project. Bethesda, MD: Abt Associates.
[35] UNAIDS (1998) ibid

Even without proof that the virus will devastate labor forces and markets, however, there are reasons for firms to take action against the disease. Pharmaceutical companies have profited from the disease in terms of sales, but many have suffered harmful effects to their reputations as protesters have attacked AIDS drug patents.[36] Other companies, such as Levi Strauss and MTV, have been widely praised for their prompt action to educate their workers and their customers as to the dangers of the disease. As a recent study on corporate responsibility and HIV/AIDS for the American Foundation for AIDS Research suggested, there are both positive and negative motivations for companies to intervene in the public good sphere (see model at figure 7). "Negative" interventions will be a response to demands from employees, customers or shareholders, whereas "positive" actions will be driven by a desire to stand out above competitors and search out new business opportunities. As the paper says, "boosting employee morale, raising corporate profile and contributing to society are powerful drivers for many of today's most innovative companies."[37] The high profile of the AIDS virus, particularly among the young generation that has grown up with the disease, presents a powerful opportunity for corporate action.

The effect on households

The effect of AIDS on affected households is substantial. AIDS is an expensive illness to treat, and caring costs are high. Savings rates in affected households are likely to suffer as a result.[38] A series of micro level studies shows the impact of AIDS on households:

– A large-scale World Bank survey of households in Tanzania, Cote d'Ivoire and Thailand found that household expenditures on AIDS care were much higher than on other illnesses.[39]

– Household income in the poorest quarter of households in Botswana is projected to fall by 13 percent as a result of the disease.[40]

– A study in Cambodia shows the poor are forced to sell limited family assets to pay for the cost of caring for a family member with AIDS. They are also likely to borrow, at high rates of interest.[41]

Again, however, the literature is patchy. Many of the micro studies are carried out in extremely hard hit areas using non-representative samples and none gives a wholly reliable picture of the effect of the virus.[42]

AIDS and economics

The lack of conclusive evidence on the economic impact of the AIDS epidemic reflects the lack of investment in research by governments and donors and a failing in the academic community. Further studies will therefore be needed to provide conclusive evidence of the size and nature of any effects.

Part 3: The Economic Return on HIV Prevention Programs

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[36] Bloom et al (2001) ibid
[37] Bloom et al (2001) ibid

[38] C Arndt and JD Lewis (2000) ibid
[39] World Bank, 1997. Confronting AIDS: Public Priorities in a Global Epidemic. New York: Oxford University Press. See David E Bloom, Ajay Mahal and River Path Associates (2001): HIV/AIDS and the Private Sector – A Literature Review. American Foundation for AIDS Research (AmfAR), 2001, forthcoming for details of further micro studies showing economic impact.
[40] UNAIDS (2000) ibid
[41] Bloom et al (2001) ibid
[42] David E Bloom et al (2001) ibid

Irrespective of whether one can (or cannot) measure all of the economic impacts of HIV/AIDS epidemic, it can nonetheless be demonstrated that investments in HIV/AIDS prevention have the potential of yielding high rates of economic return. This is because independent of any other consideration – increased numbers of AIDS cases and deaths require medical expenditures for treatment; and impose a clear loss to society in the form of lost output. In this section we provide rough estimates of the rate of return to HIV prevention and compare it to returns to other investments, in the health sector and elsewhere.

Rate of return

Without reliable data, it is difficult for governments to set investment priorities. The standard approach adopted by economists advising governments is to calculate the rate of return (ROR) on competing demands for resources and direct the funds to investments that yield the highest return, followed by the second highest, and so on, until the budget is exhausted. If an activity offers higher rates of return than alternative uses, the case for investing in that activity is strengthened. Benefits from HIV prevention accrue from both the medical costs averted (by both private and public sectors) and the value of lives saved on account of the intervention.[43] Research conducted for this paper provides an attempt at assessing the ROR from HIV prevention efforts based on data from Thailand, whose efforts in the 1990s were successful in reducing the number of annual AIDS cases, which had doubled to 26,000 from 1994 to 1997, back to 1994 levels in just two years (see Appendix 2 for full details).[44]

The time period from 1990, when Thailand's prevention activities began, to 2020, when the full effects will be measurable, was chosen for the analysis. Public sector and donor expenditures on HIV/AIDS jumped from US$0.68 million in 1998 to nearly US$10 million in 1991 and $82 million by 1997. It is estimated that roughly 15 percent of these expenditures were on prevention activity.[45] The private sector spent US$80 million on prevention messages in 1991.[46] Data on changes in behavior suggests that if behaviors had remained unchanged at 1990 levels, there would have been more than 12 million extra deaths due to AIDS in Thailand, cumulatively, by the year 2020 compared to current behavioral patterns.

Even with conservative estimates of the impact of the prevention campaigns on the changes in behavior, ROR is calculated at between 12 percent and 380 percent, depending on the scenario posited:

– If we focus only on benefits in terms of medical expenditures avoided, the rates of return range from 12 percent to 33 percent over a 30-year period (the lower bound is an outcome of assuming growth of medical expenditures in tune with per capita income).

– If we include averted income losses as additional benefits resulting from the reduced number of AIDS deaths (in addition to savings in medical expenditures), the rate of return jumps upwards very sharply – with the range now from 37 percent to 55 percent.

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[43] Measured either in terms of income losses as a result of death, or the value of a "statistical life" obtained from studies of the additional amounts people need as compensation to accept small increases in the risk of dying. We have calculated both effects.

[44] UNAIDS (2000): Thailand Epidemiological fact sheet. 2000 Update. UNAIDS. Geneva.

[45] Ainsworth, Martha, et al. 2001. "Thailand's response to AIDS: Building on success, confronting the future."   Bangkok, Thailand: The World Bank.

[46] Viravaidya, Mechai, Stasia Obremsky and Charles Myers. 1992. "The economic impact of AIDS on Thailand." In David Bloom and Joyce Lyons (eds.) Economic Implications of AIDS in Asia. New Delhi: United Nations Development Programme, HIV/AIDS Regional Project.

- If, however, instead of income losses, we consider the value of an averted AIDS death to be equal to the statistical value of a life, the rates of return of HIV prevention programs jump to upwards of 380 percent per year.

Estimates of the rate of return for some other health interventions are available. The rate of return (inclusive of income losses due to disability) of the global guinea-worm eradication program, for example, is roughly 29 percent, compared to 37-55 percent for Thailand for HIV prevention, calculated by an equivalent methodology. Our estimates for the rate of return on HIV prevention expenditures (inclusive of income losses) also exceed the range of rates of return from interventions for river blindness eradication in Africa (which the World Bank estimates at 6-17 percent[47]). The World Bank considers an annual rate of return of greater than 10 percent to be acceptable.[48]

Integrated action

It is clear, therefore, that intervention to prevent HIV/AIDS provides a potentially high rate of return on investment (even the lowest estimate is above World Bank criteria). However, there remains the need for further research in this area, to explore the rate of return in different countries, with different intensity of epidemic, at different stages in the development process, and with different intervention portfolios.

It is worth noting that one of the features of Thailand's success has been the reliability of its data on HIV/AIDS. This has enabled the nature of the virus to be tracked over time and spot emerging changes of profile in the epidemic.[49] In the absence of such surveillance, governments are unlikely to be able to keep up with HIV, and resource allocation will inevitably be inefficient.

Conclusion

The connection between AIDS and economics is complex, and drawing firm conclusions is complicated by the lack of concrete data in many areas. The poor appear to be most vulnerable to AIDS, but it is possible that this is not just because they are poor, but because of the interaction between poverty and other factors such as poor education, migration and weak health systems. Poverty reduction may decrease risk from the epidemic, but it is also possible that ill-planned development efforts will temporarily increase the risk that poor people face.

The impact of AIDS on economies is also hard to measure. It seems clear that there were limited effects early in the epidemic. Although some studies now project increasing impact, they are speculative, even if there is a strong intuition that very badly affected countries will see a significant economic deterioration. It is possible that this effect will only be felt when the prevalence of HIV/AIDS surpasses a certain threshold, however.

Finally, there is a need for better data to help track the development of the epidemic, to judge the most effective interventions, and to help decision-makers decide between competing priorities. Our preliminary estimates suggest a high potential return to investments in HIV prevention.

Our understanding of the epidemic seems to be somewhat weak, given the time since the discovery of HIV, the global nature of the epidemic, and its ferocity. At a time of huge political interest in health as a tool of development, it is clear that further work is badly needed.

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[47] World Bank, The. 2000. "Global Partnership to Eliminate River Blindness: African Program for Onchocerciasis Control." http://www.worldbank.org/gper/apocsuccess.htm
[48] http://www.worldbank.org/gper/guinea percent20worm.htm

Figure 1: HIV and Income, Africa

Source: UNAIDS 2001, WDI 1999

Figure 2: HIV and Income, World

Source: UNAIDS 2001, WDI 1999

Figure 3: HIV and the Gini Index, World

Source: UNAIDS 2001, Deininger and Squire 1999

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[49] World Bank (2001): Thailand's response to AIDS: Building on success, confronting the future. World Bank

Figure 4: HIV and the $1/Day Absolute Poverty Rate, World

Source: UNAIDS 2001, WDR 1998

Figure 5: HIV and the Human Poverty Index, World

Source: UNAIDS 2001, HDR 2000

Figure 6

HIV infection rate among pregnant women by level of education

Uganda, age 15-24

Source: UNAIDS (2999) ibid

Thailand Social Monitor V.

Figure 7

Source: Bloom et al (2001) ibid

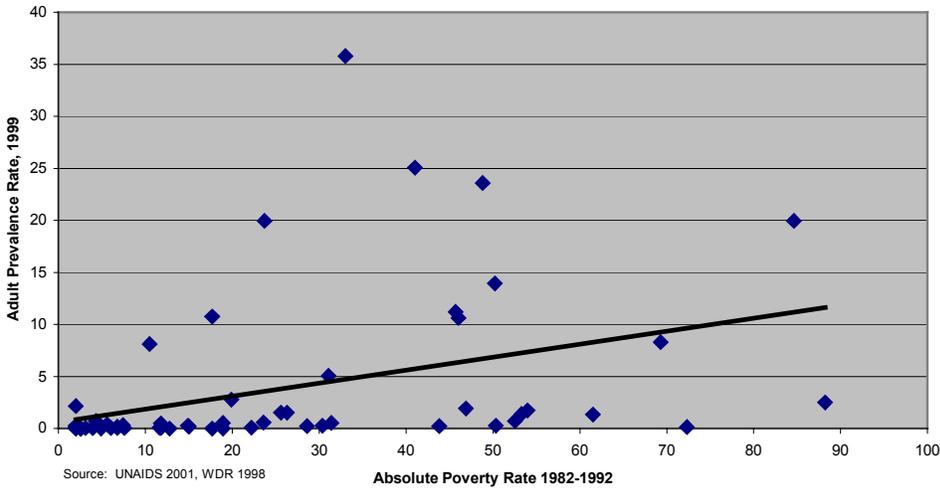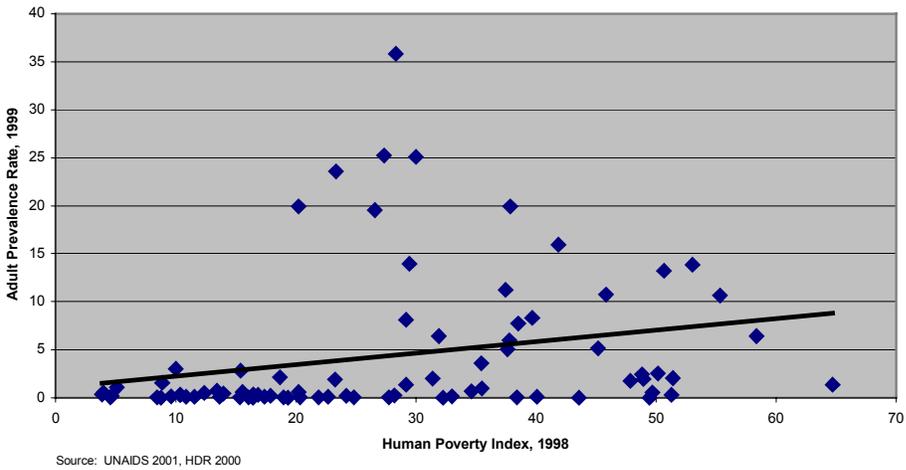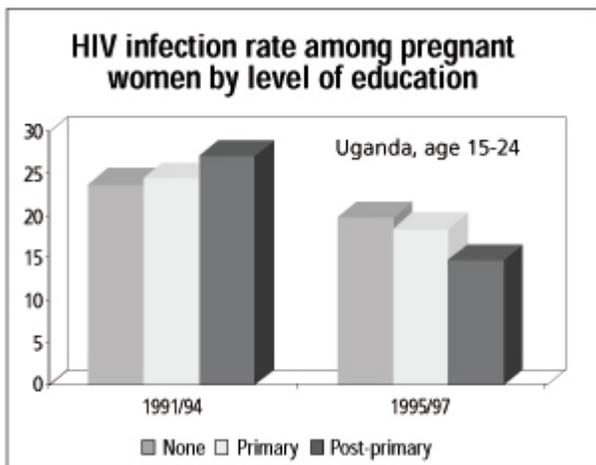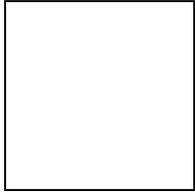# Appendix 1

We ran binary logits on each of the following outcome variables:

1. knowledge of the HIV-preventive benefits of condom use

2. knowledge of the HIV-preventive benefits of having just one sexual partner

3. knowledge of the HIV-preventive benefits of avoiding sex with prostitutes

4. knowing of a source for condoms

5. knowing about condoms

6. ever having used a condom

Each logit contained dummy variables for wealth quintile, highest level of education achieved, and 5-year age cohort. We report odds ratios for the effect of being in the wealthiest quintile and having the highest level of education. In all countries but Tanzania, the highest education level is higher education. In Tanzania, the highest education level is secondary education.

v754c byte   percent18.0g V754C AIDS: use condoms during sex

Country	Wealthiest quintile	Highest Education
Cambodia n=15,351	2.139 (0.259)***	1.953 (1.142)
Vietnam n=1658	2.684 (1.157)**	6.455 (4.284)**
Nicaragua n=1334	1.970 (0.377)***	1.876 (0.723)
Tanzania n=1675	3.031 (0.894)***	3.771 (1.355)***

v754d byte   percent20.0g V754D AIDS: only one sex partner

Country	Wealthiest quintile	Highest Education
Cambodia n=15,351	1.127 (0.095)	1.109 (0.291)
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Nicaragua	1.084	3.206

n=1334	(0.283)	(1.300)***
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Country	Wealthiest quintile	Highest Education
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Country	Wealthiest quintile	Highest Education
Vietnam n=1867	2.175 (0.771)**	34.132 (36.592)***
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v764   byte   percent18.0g V764   Knowledge of condom

Country	Wealthiest quintile	Highest Education
Vietnam	2.504	26.720

n=1832	(0.970)**	(15.523)***
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Nicaragua n=1419	1.766 (0.424)**	2.046 (0.916)*
Tanzania n=1698	2.779 (1.834)	3.457 (2.529)*

Summary of results:

1. Knowledge of HIV preventive benefits of condom use

Education and wealth both produce better knowledge everywhere.

2. Knowledge of HIV preventive benefits of having just one sexual partner

Education and wealth seem to produce better knowledge everywhere but results are statistically significant only in Vietnam and Nicaragua for education, and Tanzania for wealth.

3. Knowledge of HIV preventive benefits of avoiding sex with prostitutes

Education doesn't produce better knowledge anywhere.

Wealth has a mixed effect. It produces better knowledge in Vietnam and Nicaragua, less knowledge in Cambodia, and the same knowledge in Tanzania

4. Knowing of a source for condoms

Education and wealth both have very powerful beneficial effect on knowing a source for condoms everywhere. (Note, there is no Cambodia data on this)

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6. Ever use of condoms

Education and wealth have a beneficial effect everywhere, though it is not significant in Tanzania. (Note, there is no Cambodia data on this)

Appendix 2

What is the rate of return to investments in HIV prevention?

The average annual returns from HIV prevention expenditures over a 30-year period are:

1. If benefits include only averted medical expenditures (12-33 percent)

2. If averted income losses and medical expenditures (37-55 percent)

3. If averted value of statistical lives and medical expenditures (>380 percent)

A. Relevance

The importance of an answer to this question stems from the fact that ministries of health and finance in developing countries are resource constrained, and face competing demands for their resources. For instance, Ministries of Health are often faced with the policy challenge of whether to spend the marginal dollar on diarrhea and/or malaria prevention, or HIV prevention? At other times a policy choice may have to be made between investments on treating the elderly versus HIV prevention. The often unenviable nature of these choices may make it desirable to seek additional funds from ministries of finance, that in turn, also face competing demands for funds.

The standard approach economists' think about for allocating scarce resources in an efficient way is to assess the rate of return on competing demands for resources and direct the funds to investments that yield the highest return, following by the second highest, and so on, till the budget is fully exhausted. An economist advising a government whose objective function includes not just allocative efficiency, but also equity and environmental protection (for example), would modify the analysis so that the rate of return as referred to here is evaluated after including the value of these additional objectives. Whether governments do this in practice is another matter. What does matter is that if an activity offers higher rates of return in comparison to alternative uses, the case for investing in that activity will likely be strengthened.

Although it is often asserted that investments in HIV prevention yield relatively high rates of return, these assertions appear not to be empirically grounded.[50] In the absence of such grounding, it is difficult to argue (against competing claims) that governments ought to spend more on HIV. This note is a first attempt in the direction of providing a rate of return on investments in HIV prevention.

B. Approach

The technique that we use to estimate the rate of return is a classic one used in the cost-benefit analysis literature. Specifically, we seek to estimate the "internal rate of return" to investments in HIV infection.

If I_t are the investments in HIV prevention in year 't' and B_t are a money value of the benefits in terms of avoided HIV infections and AIDS cases that <u>can be attributed</u> to those investments, then the rate of return to HIV prevention is the 'r' that solves the following equation, where the summation is over the time horizon of interest.

$$\Sigma_t(B_t - I_t)/(1+r)^t = \quad 0$$

Expenditures on HIV prevention (I_t) in any given year 't' are the *sum*, after taking account of inter-institutional flows, of public sector expenditures, private sector expenditures (for-profit, non-profit, and households), and expenditures incurred by the international donor community.

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[50]The only study that we are aware of and that does, in fact, report rates of return for HIV prevention expenditures relies on *assumed* rates of change in behavior on account of such expenditures (Dayton 1998).

Benefits (B_t) from HIV prevention occur in two main ways – the first being the medical care expenditures incurred (by the public and private sectors) in the treatment of AIDS cases. This can be estimated to be the number of AIDS cases for each year (in year-equivalent terms) *times* the cost of treating an AIDS case for that year. A second benefit is the monetary value of lives that are "saved" on account of the intervention. This can be measured as the reduction the number of AIDS deaths due to the HIV prevention program *times* the value of a "life." One approach to estimating the value of a life is to look at the income losses that result from the death. Another is to estimate the value of a "statistical life" obtained from studies of the additional amounts people need (as compensation) to accept small increases in the risk of dying.

Calculation of benefits from a specific HIV prevention program requires AIDS-related data of the following type for the relevant time horizon: (a) the number of AIDS cases averted on account of the intervention in each year; (b) the medical cost of treating a single case of AIDS in each year; (c) the number of AIDS deaths (annual and cumulative) for each year; (d) the value of a statistical life in any given year; and/or (e) income "lost" for each future year on account on an AIDS death in any given year.

C. Data and Rationale

To calculate the rate of return from interventions in HIV prevention, we used data from Thailand that, since the early 1990s put in a tremendous effort in HIV prevention activity. We chose the time period 1990-2020 as the horizon over which to make calculations of the rate of return. This way, we could inquire how much Thailand is likely to have "earned" for the investments in HIV prevention that it undertook starting 1990.

As one illustration of Thailand's efforts towards HIV control, public sector and donor HIV/AIDS expenditures (not all on prevention) jumped from a level of US$0.68 million in 1988 to nearly US$10 million in 1991 and to a level of US$82 million by 1997 (Ainsworth et al. 2001). We estimate that roughly 15 percent of these expenditures in any given year were on prevention activity (Ainsworth et al. 1997). By contrast the private corporate sector spent about US$80 million on HIV prevention messages in 1991 (Viravaidya, Myers and Obremsky 1992). There were additional small amounts spent by non-governmental organizations, but we assume these were mostly funds obtained from international donors and the government. No data were available about HIV prevention spending by the private corporate sector for years other than 1991, so we estimated the rate of return under many different assumptions about its time profile.[51]

There are good data in Thailand on changes in behavior that put people at high risk for HIV infection, and that has helped permit reliable calculations of AIDS cases and deaths with the help of sophisticated epidemiological models. In particular, these models can help predict the profile of HIV and AIDS cases, and deaths linked to AIDS, over time. As a consequence we can construct a profile of AIDS cases and deaths over time had behaviors remained unchanged at their 1990 levels, and compare them with the profile that actually emerged following 1990. Comparing the two series yields startling numbers. For instance, unchanged behaviors at their 1990 levels would have led to more than 12 million extra deaths due to AIDS in Thailand, cumulatively, by the year 2020 compared to current behavioral patterns.

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[51]We had no data on private household expenditures on HIV prevention (for example, through condom purchase). Given that condom distribution was done at highly subsidized rates during the 1990s in Thailand, the expenditures were probably not significant. Not including these expenditures will lead to overestimating the rate of return on HIV prevention programs. On the other hand, to the extent that unprotected sex (as one component of behavior leading to HIV infection) yields a benefit to participants, not including a measure for these foregone benefits following behavior change (and we do not) would lead to *underestimating* the rate of return on HIV prevention – and thus lessen any upward bias in the estimated rate of return.

Whether the difference in the time profile of AIDS cases and deaths (with and without the behavior change following 1990) was due solely to HIV prevention interventions is another matter. In particular, faced with high risks of HIV infection, individuals might seek on their own to acquire the knowledge and adopt some of the steps necessary to prevent HIV infection to themselves and people they care about, without any public intervention. If only a portion of the difference in the two profiles (with and without behavior change) can be attributed to HIV prevention expenditures, then our method of calculating the rate of return must account for that fact. It is also possible that some of the reductions in HIV/AIDS infections arise out of increased expenditures on AIDS treatment. This might occur, if individuals when infected individuals come into contact with the formal health system, counseling and the like and adopt protective measures that lead to a reduction of secondary infections. Exactly, how much of the averted cases arise from treatment-related expenditures is uncertain, but not insignificant.

The approach that we use in this note relies on the reasonable premise that compared to a public campaign, individuals acting alone or in small groups will take longer to adopt preventive measures and in less intensive ways than would result from the sort of all-out public campaign so characteristic of Thailand. Specifically, we assume that during the period 1990-2000 all of the reduction in AIDS cases and deaths were due to HIV prevention expenditures of the public and private corporate sectors. During the period 2000-2020, however, we attributed only half of the averted AIDS cases and deaths to prevention expenditures.

Calculating benefits requires assigning money values to the averted AIDS cases and deaths. Consider first medical expenditures due to AIDS. Data on the annual cost of treatment of an AIDS case (about 25,700 Baht at 1995 prices – US$837) was obtained from a 1991 study of Thailand (Viravaidya, Obremsky and Myers 1992) and forecasted forward (and backward) in two ways: (a) based on regression analysis linking the log of the annual costs of AIDS treatment to the log of per capita income using cross-country data for 9 Asian countries (authors' calculations); and (b) from the rate of growth of the annual costs of AIDS cases in the United States over the period 1992-1997 (slightly higher than the growth rate based on per capita income changes) (Hellinger 1998). This scenario was considered necessary since costs of treating AIDS will likely increase over time as AZT (and various combination therapies) are used with greater frequency in Thailand.[52]

To forecast the cost of AIDS cases, we needed to know the expected rate of growth of real GDP per capita. The rate of growth of real GDP per capita in Thailand during 1999-2020 was forecasted to be its average annual rate of growth during 1989-1998 – about 3.6 percent per year. This is somewhat lower than forecasts reported in a recent IMF report and so leads to conservative estimates of benefits in terms of the amounts of medical expenditures avoided through HIV prevention programs.

Next, there were benefits from averted AIDS deaths as the money values of lives saved. Benefits in terms of lost incomes averted from a person dying of AIDS in a specific year were calculated to be the per capita GDP for that year; and for subsequent years, the forecasted levels of real per capita GDP until the year 2020. In the year, 1995, for instance, the per capita GDP (at 1995 prices) was about Baht 71 thousand, rising to Baht 138 thousand by the year 2020.

On the other hand, the gains in terms of the value of a statistical life (estimated to be Baht 38.73 million in 1993 at 1995 prices) were directly allocated in the year in which the AIDS death occurred and assumed to grow at 3.6 percent per year in line with the rate of growth of real GDP per capita. This estimate of the value of a statistical life was based on US numbers but multiplied by the ratio of Thailand's income per capita to the US income per capita in PPP terms (UNDP 1996, Moore and Viscusi 1998). Estimates of the rate of return based on benefits measured in terms of the value of statistical lives saved turned out to be very high.

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[52]Jos Pierrens estimated medical expenditures per AIDS case per year for Thailand in 1996 to be roughly US$1,335 (the mid-point of his estimated range, communication with Stefano Bertozzi). These are very similar to projected estimates that we obtain for Thailand for that year based on the methodologies described above.

We did not have any data on forecasted HIV prevention expenditures during the period 2000-2020 and on private corporate prevention expenditures for years other than 1991, so we considered two scenarios. Both assumed that for the period 2000-2020 annual HIV prevention expenditures would remain the same (in real terms) as the mean of expenditures during the period 1990-2000. However, one scenario assumed that private corporate expenditures would be fixed at their 1991 levels for the period 1990-2000. Another assumed that the ratio of private corporate prevention expenditures to public sector (and donor) prevention expenditures would remain constant during 1990-2000.

D. Results

The estimates of the rates of return were obtained under three main benefit profile scenarios, and four main time profiles for prevention expenditures:

1. Benefits evaluated in terms of medical expenditures averted only (with two possibilities – growth at US levels, or based on per capita income growth);

2. Benefits evaluated in terms of medical expenditures averted plus income losses averted;

3. Benefits evaluated in terms of medical expenditures averted plus losses in the value of a statistical life averted;

4. Private prevention expenditures were fixed at their 1991 levels; and during 2001-2020, prevention expenditures (public and private) were the mean of all prevention expenditures during the period 1990-2000.

5. Private prevention expenditures were fixed at a constant proportion of public (and donor spending) based on their 1991 levels; and for 2001-2020 prevention expenditures (public and private) were the mean of all prevention expenditures during the period 1990-2000.

In total, 12 cases were considered and are summarized in the 6 scenarios reported below. The main findings are reported below.

Scenario I:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels; NO income losses, or value of statistical lives lost on account of AIDS deaths

Rate of return on HIV prevention expenditures 31.5 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 32.6 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario II:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are a ratio of public expenditures; NO income losses, or value of statistical lives lost on account of AIDS deaths.

Rate of return on HIV prevention expenditures 12.3 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 14.0 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario III:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels; Losses on account of AIDS deaths included and measured in terms of per capita income losses for each year subsequent to an AIDS death.

Rate of return on HIV prevention expenditures 55.0 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 55.1 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario IV:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are a ratio of public expenditures; Losses on account of AIDS deaths included and measured in terms of per capita income losses for each year subsequent to an AIDS death.

Rate of return on HIV prevention expenditures 37.0 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 37.2 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenarios V and VI:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels/Taken as a fixed proportion of public expenditures; Include value of statistical lives lost on account of AIDS deaths

Rate of return on HIV prevention expenditures was in the range of 385-415 percent.

In sum: If we focus only on benefits in terms of medical expenditures avoided, the rates of return range from 12.0 percent to 33.0 percent over a 30-year period. The lower bound of our numbers is an outcome of assuming growth of medical expenditures in tune with per capita income.

If we include averted income losses as additional benefits resulting from the reduced number of AIDS deaths (in addition to savings in medical expenditures), the rate of return jumps upwards very sharply – with the range now from 37 percent to 55 percent.

If instead of income losses, we consider the value of an averted AIDS death to be equal to the statistical value of a life, the rates of return of HIV prevention programs jump to upwards of 380 percent per year!

E. Cautionary Remarks

1. We are not fully confident about what proportion of the reduction in AIDS cases and deaths in Thailand can be attributed to HIV prevention programs. We do believe that we have been conservative about HIV risk reduction that can be attributed to prevention expenditures.

2. Even though returns from HIV prevention programs appear high, for a fair comparison with other heath interventions and programs, rates of return from the latter ought to be evaluated using the same methodology.

   It is interesting in this context that our estimates of the internal rate of return with only avoided medical expenditures as benefits (12 percent-33 percent) bracket the 26.7 percent estimate based on scenario prevention analyses carried out for India and reported in Dayton (1998).

   Estimates of the rate of return (inclusive of income losses due to disability) of the global guinea-worm eradication program are roughly 29 percent, which is below the range of estimates of the rate of return that we report for Thailand for HIV prevention (37-55

percent). Our estimates for the rate of return on HIV prevention expenditures (inclusive of income losses) also exceed the range of rates of return from interventions for Riverblind disease eraditication in Africa (6-17 percent, World Bank 2000).

3. We had to make several assumptions about the level of private corporate spending during the period 1990-2020 and beyond, with obvious implications for the estimates of the rate of return that we report here.

4. The fact that we observe high rates of return on HIV prevention does not imply that expenditures for much needed treatments for people with HIV and AIDS ought to be ignored or placed on a lower level of priority. Care for people living with HIV/AIDS, aside from being crucial from basic humanitarian and equity concerns is potentially important for HIV prevention (as noted earlier).

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http://www.worldbank.org/gper/apocsuccess.htm

The impact of AIDS on economies is also hard to measure. It seems clear that there were limited effects early in the epidemic. Although some studies now project increasing impact, they are speculative, even if there is a strong intuition that very badly affected countries will see a significant economic deterioration. It is possible that this effect will only be felt when the prevalence of HIV/AIDS surpasses a certain threshold, however.

Finally, there is a need for better data to help track the development of the epidemic, to judge the most effective interventions, and to help decision-makers decide between competing priorities. Our preliminary estimates suggest a high potential return to investments in HIV prevention.

Our understanding of the epidemic seems to be somewhat weak, given the time since the discovery of HIV, the global nature of the epidemic, and its ferocity. At a time of huge political interest in health as a tool of development, it is clear that further work is badly needed.

Figure 1: HIV and Income, Africa
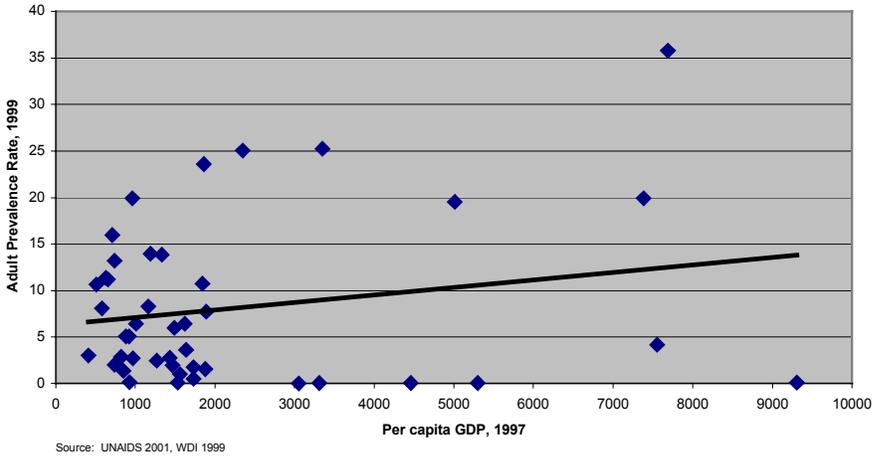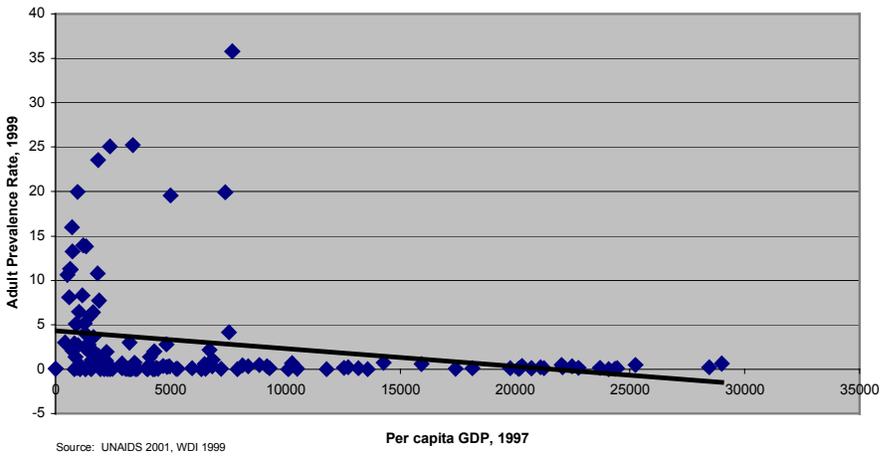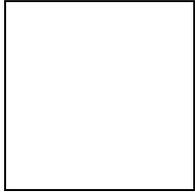
Figure 2: HIV and Income, World

Figure 3: HIV and the Gini Index, World

Figure 4: HIV and the $1/Day Absolute Poverty Rate, World

Figure 6

Source: UNAIDS (2999) ibid

Figure 7

Source: Bloom et al (2001) ibid

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We ran binary logits on each of the following outcome variables:

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2. knowledge of the HIV-preventive benefits of having just one sexual partner

3. knowledge of the HIV-preventive benefits of avoiding sex with prostitutes

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6. ever having used a condom

Each logit contained dummy variables for wealth quintile, highest level of education achieved, and 5-year age cohort. We report odds ratios for the effect of being in the wealthiest quintile and having the highest level of education. In all countries but Tanzania, the highest education level is higher education. In Tanzania, the highest education level is secondary education.

v754c byte   percent18.0g V754C AIDS: use condoms during sex

Country	Wealthiest quintile	Highest Education
Cambodia n=15,351	2.139 (0.259)***	1.953 (1.142)
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If I_t are the investments in HIV prevention in year 't' and B_t are a money value of the benefits in terms of avoided HIV infections and AIDS cases that <u>can be attributed</u> to those investments, then the rate of return to HIV prevention is the 'r' that solves the following equation, where the summation is over the time horizon of interest.

$$\Sigma_t(B_t - I_t)/(1+r)^t = \quad 0$$

Expenditures on HIV prevention (I_t) in any given year 't' are the *sum*, after taking account of inter-institutional flows, of public sector expenditures, private sector expenditures (for-profit, non-profit, and households), and expenditures incurred by the international donor community.

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[53]The only study that we are aware of and that does, in fact, report rates of return for HIV prevention expenditures relies on *assumed* rates of change in behavior on account of such expenditures (Dayton 1998).

Benefits (B_t) from HIV prevention occur in two main ways – the first being the medical care expenditures incurred (by the public and private sectors) in the treatment of AIDS cases. This can be estimated to be the number of AIDS cases for each year (in year-equivalent terms) *times* the cost of treating an AIDS case for that year. A second benefit is the monetary value of lives that are "saved" on account of the intervention. This can be measured as the reduction the number of AIDS deaths due to the HIV prevention program *times* the value of a "life." One approach to estimating the value of a life is to look at the income losses that result from the death. Another is to estimate the value of a "statistical life" obtained from studies of the additional amounts people need (as compensation) to accept small increases in the risk of dying.

Calculation of benefits from a specific HIV prevention program requires AIDS-related data of the following type for the relevant time horizon: (a) the number of AIDS cases averted on account of the intervention in each year; (b) the medical cost of treating a single case of AIDS in each year; (c) the number of AIDS deaths (annual and cumulative) for each year; (d) the value of a statistical life in any given year; and/or (e) income "lost" for each future year on account on an AIDS death in any given year.

C. Data and Rationale

To calculate the rate of return from interventions in HIV prevention, we used data from Thailand that, since the early 1990s put in a tremendous effort in HIV prevention activity. We chose the time period 1990-2020 as the horizon over which to make calculations of the rate of return. This way, we could inquire how much Thailand is likely to have "earned" for the investments in HIV prevention that it undertook starting 1990.

As one illustration of Thailand's efforts towards HIV control, public sector and donor HIV/AIDS expenditures (not all on prevention) jumped from a level of US$0.68 million in 1988 to nearly US$10 million in 1991 and to a level of US$82 million by 1997 (Ainsworth et al. 2001). We estimate that roughly 15 percent of these expenditures in any given year were on prevention activity (Ainsworth et al. 1997). By contrast the private corporate sector spent about US$80 million on HIV prevention messages in 1991 (Viravaidya, Myers and Obremsky 1992). There were additional small amounts spent by non-governmental organizations, but we assume these were mostly funds obtained from international donors and the government. No data were available about HIV prevention spending by the private corporate sector for years other than 1991, so we estimated the rate of return under many different assumptions about its time profile.[54]

There are good data in Thailand on changes in behavior that put people at high risk for HIV infection, and that has helped permit reliable calculations of AIDS cases and deaths with the help of sophisticated epidemiological models. In particular, these models can help predict the profile of HIV and AIDS cases, and deaths linked to AIDS, over time. As a consequence we can construct a profile of AIDS cases and deaths over time had behaviors remained unchanged at their 1990 levels, and compare them with the profile that actually emerged following 1990. Comparing the two series yields startling numbers. For instance, unchanged behaviors at their 1990 levels would have led to more than 12 million extra deaths due to AIDS in Thailand, cumulatively, by the year 2020 compared to current behavioral patterns.

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[54]We had no data on private household expenditures on HIV prevention (for example, through condom purchase). Given that condom distribution was done at highly subsidized rates during the 1990s in Thailand, the expenditures were probably not significant. Not including these expenditures will lead to overestimating the rate of return on HIV prevention programs. On the other hand, to the extent that unprotected sex (as one component of behavior leading to HIV infection) yields a benefit to participants, not including a measure for these foregone benefits following behavior change (and we do not) would lead to *underestimating* the rate of return on HIV prevention – and thus lessen any upward bias in the estimated rate of return.

Whether the difference in the time profile of AIDS cases and deaths (with and without the behavior change following 1990) was due solely to HIV prevention interventions is another matter. In particular, faced with high risks of HIV infection, individuals might seek on their own to acquire the knowledge and adopt some of the steps necessary to prevent HIV infection to themselves and people they care about, without any public intervention.   If only a portion of the difference in the two profiles (with and without behavior change) can be attributed to HIV prevention expenditures, then our method of calculating the rate of return must account for that fact. It is also possible that some of the reductions in HIV/AIDS infections arise out of increased expenditures on AIDS treatment. This might occur, if individuals when infected individuals come into contact with the formal health system, counseling and the like and adopt protective measures that lead to a reduction of secondary infections. Exactly, how much of the averted cases arise from treatment-related expenditures is uncertain, but not insignificant.

The approach that we use in this note relies on the reasonable premise that compared to a public campaign, individuals acting alone or in small groups will take longer to adopt preventive measures and in less intensive ways than would result from the sort of all-out public campaign so characteristic of Thailand. Specifically, we assume that during the period 1990-2000 all of the reduction in AIDS cases and deaths were due to HIV prevention expenditures of the public and private corporate sectors. During the period 2000-2020, however, we attributed only half of the averted AIDS cases and deaths to prevention expenditures.

Calculating benefits requires assigning money values to the averted AIDS cases and deaths. Consider first medical expenditures due to AIDS. Data on the annual cost of treatment of an AIDS case (about 25,700 Baht at 1995 prices – US$837) was obtained from a 1991 study of Thailand (Viravaidya, Obremsky and Myers 1992) and forecasted forward (and backward) in two ways: (a) based on regression analysis linking the log of the annual costs of AIDS treatment to the log of per capita income using cross-country data for 9 Asian countries (authors' calculations); and (b) from the rate of growth of the annual costs of AIDS cases in the United States over the period 1992-1997 (slightly higher than the growth rate based on per capita income changes) (Hellinger 1998). This scenario was considered necessary since costs of treating AIDS will likely increase over time as AZT (and various combination therapies) are used with greater frequency in Thailand.[55]

To forecast the cost of AIDS cases, we needed to know the expected rate of growth of real GDP per capita. The rate of growth of real GDP per capita in Thailand during 1999-2020 was forecasted to be its average annual rate of growth during 1989-1998 – about 3.6 percent per year. This is somewhat lower than forecasts reported in a recent IMF report and so leads to conservative estimates of benefits in terms of the amounts of medical expenditures avoided through HIV prevention programs.

Next, there were benefits from averted AIDS deaths as the money values of lives saved. Benefits in terms of lost incomes averted from a person dying of AIDS in a specific year were calculated to be the per capita GDP for that year; and for subsequent years, the forecasted levels of real per capita GDP until the year 2020. In the year, 1995, for instance, the per capita GDP (at 1995 prices) was about Baht 71 thousand, rising to Baht 138 thousand by the year 2020.

On the other hand, the gains in terms of the value of a statistical life (estimated to be Baht 38.73 million in 1993 at 1995 prices) were directly allocated in the year in which the AIDS death occurred and assumed to grow at 3.6 percent per year in line with the rate of growth of real GDP per capita. This estimate of the value of a statistical life was based on US numbers but multiplied by the ratio of Thailand's income per capita to the US income per capita in PPP terms (UNDP 1996, Moore and Viscusi 1998). Estimates of the rate of return based on benefits measured in terms of the value of statistical lives saved turned out to be very high.

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[55]Jos Pierrens estimated medical expenditures per AIDS case per year for Thailand in 1996 to be roughly US$1,335 (the mid-point of his estimated range, communication with Stefano Bertozzi). These are very similar to projected estimates that we obtain for Thailand for that year based on the methodologies described above.

We did not have any data on forecasted HIV prevention expenditures during the period 2000-2020 and on private corporate prevention expenditures for years other than 1991, so we considered two scenarios. Both assumed that for the period 2000-2020 annual HIV prevention expenditures would remain the same (in real terms) as the mean of expenditures during the period 1990-2000. However, one scenario assumed that private corporate expenditures would be fixed at their 1991 levels for the period 1990-2000. Another assumed that the ratio of private corporate prevention expenditures to public sector (and donor) prevention expenditures would remain constant during 1990-2000.

D. Results

The estimates of the rates of return were obtained under three main benefit profile scenarios, and four main time profiles for prevention expenditures:

1. Benefits evaluated in terms of medical expenditures averted only (with two possibilities – growth at US levels, or based on per capita income growth);

2. Benefits evaluated in terms of medical expenditures averted plus income losses averted;

3. Benefits evaluated in terms of medical expenditures averted plus losses in the value of a statistical life averted;

4. Private prevention expenditures were fixed at their 1991 levels; and during 2001-2020, prevention expenditures (public and private) were the mean of all prevention expenditures during the period 1990-2000.

5. Private prevention expenditures were fixed at a constant proportion of public (and donor spending) based on their 1991 levels; and for 2001-2020 prevention expenditures (public and private) were the mean of all prevention expenditures during the period 1990-2000.

In total, 12 cases were considered and are summarized in the 6 scenarios reported below. The main findings are reported below.

Scenario I:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels; NO income losses, or value of statistical lives lost on account of AIDS deaths

Rate of return on HIV prevention expenditures 31.5 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 32.6 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario II:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are a ratio of public expenditures; NO income losses, or value of statistical lives lost on account of AIDS deaths.

Rate of return on HIV prevention expenditures 12.3 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 14.0 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario III:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels; Losses on account of AIDS deaths included and measured in terms of per capita income losses for each year subsequent to an AIDS death.

Rate of return on HIV prevention expenditures 55.0 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 55.1 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenario IV:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are a ratio of public expenditures; Losses on account of AIDS deaths included and measured in terms of per capita income losses for each year subsequent to an AIDS death.

Rate of return on HIV prevention expenditures 37.0 percent if rate of growth of per person AIDS expenditures was linked to per capita income growth in Thailand, but 37.2 percent if AIDS medical expenditures grow at the rate reported for the US.

Scenarios V and VI:

Medical Expenditures per AIDS case grow over time; Private corporate expenditures on HIV prevention are fixed at their 1991 levels/Taken as a fixed proportion of public expenditures; Include value of statistical lives lost on account of AIDS deaths

Rate of return on HIV prevention expenditures was in the range of 385-415 percent.

In sum: If we focus only on benefits in terms of medical expenditures avoided, the rates of return range from 12.0 percent to 33.0 percent over a 30-year period. The lower bound of our numbers is an outcome of assuming growth of medical expenditures in tune with per capita income.

If we include averted income losses as additional benefits resulting from the reduced number of AIDS deaths (in addition to savings in medical expenditures), the rate of return jumps upwards very sharply – with the range now from 37 percent to 55 percent.

If instead of income losses, we consider the value of an averted AIDS death to be equal to the statistical value of a life, the rates of return of HIV prevention programs jump to upwards of 380 percent per year!

E. Cautionary Remarks

5. We are not fully confident about what proportion of the reduction in AIDS cases and deaths in Thailand can be attributed to HIV prevention programs. We do believe that we have been conservative about HIV risk reduction that can be attributed to prevention expenditures.

6. Even though returns from HIV prevention programs appear high, for a fair comparison with other heath interventions and programs, rates of return from the latter ought to be evaluated using the same methodology.

   It is interesting in this context that our estimates of the internal rate of return with only avoided medical expenditures as benefits (12 percent-33 percent) bracket the 26.7 percent estimate based on scenario prevention analyses carried out for India and reported in Dayton (1998).

   Estimates of the rate of return (inclusive of income losses due to disability) of the global guinea-worm eradication program are roughly 29 percent, which is below the range of estimates of the rate of return that we report for Thailand for HIV prevention (37-55

percent). Our estimates for the rate of return on HIV prevention expenditures (inclusive of income losses) also exceed the range of rates of return from interventions for Riverblind disease eraditication in Africa (6-17 percent, World Bank 2000).

7. We had to make several assumptions about the level of private corporate spending during the period 1990-2020 and beyond, with obvious implications for the estimates of the rate of return that we report here.

8. The fact that we observe high rates of return on HIV prevention does not imply that expenditures for much needed treatments for people with HIV and AIDS ought to be ignored or placed on a lower level of priority. Care for people living with HIV/AIDS, aside from being crucial from basic humanitarian and equity concerns is potentially important for HIV prevention (as noted earlier).

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