4 The Economics of HIV/AIDS

> "A reliable AIDS vaccine would be a public good and so would be subsidizing the use of condoms, through sex education and through making condoms readily available at zero price."
>
> *Tomas J. Philipson and Richard A. Posner (1992) In: The Optimal Regulation of AIDS*

Economics is inextricably linked with HIV/AIDS. Economic conditions affect HIV/AIDS and, in turn, HIV/AIDS affects an economy at both the macro and micro levels. Thus, the link works in both directions. In this chapter, we examine the relationships between HIV/AIDS and poverty, inequality and social capital, and consider whether economic differences between countries explain differences in HIV prevalence. As we have noted in Chap. 3, HIV/AIDS disproportionately affects people of working age. In this chapter, we examine the potential economic impact of HIV/AIDS, using a macroeconomic model. This is followed by a review of microeconomic and epidemiological models that try to answer questions about the behavioral response of people who are either at risk of or actually living with HIV/AIDS. Such studies provide a useful mechanism for determining the effectiveness of HIV/AIDS prevention strategies (a topic we explore further in Chap. 9). Economics plays a significant role in the propagation of HIV/AIDS in high incidence countries. The economics of HIV/AIDS also shows us the likely economic returns on different strategies to prevent HIV infections.

4.1 Sexually Transmitted Infections and HIV/AIDS

The link between economic conditions (as measured by per capita income) and HIV/AIDS is very different from common sexually transmitted diseases (although HIV/AIDS is not exclusively a sexually transmitted disease, it is largely so). In Table 4.1, we show the correlation between per capita income in each state in the United States (excluding Washington DC) and HIV/AIDS, Chlamydia, Gonorrhea and Syphilis. It turns out that HIV/AIDS is strongly linked to gonorrhea and syphilis but not with chlamydia (Bleakley 2003). Income per capita, however, is not directly correlated with any of these diseases (Bleakley and Lange, 2005).

To see the importance of the correlations between HIV/AIDS and other sexually transmitted infections, we discuss a pioneering study by Oster (2005). She concentrated on two facts. (1) There is little difference between the sexual behavior of Americans and sub-Saharan Africans. (2) The transmission rate of HIV from men to women is three times as high in sub-Saharan Africa as it is in the United States. She builds a model that uses sexual behavior as an input, along with transmission of HIV as another input, which produces HIV prevalence as an output. Her model produces results that match the actual outcomes in terms of HIV prevalence in the United States and sub-Saharan Africa.

Table 4.1 Correlation between per capita income and HIV/AIDS, chlamydia, gonorrhea and syphilis by state, United States, 2003

	Chlamydia	Gonorrhea	HIV/AIDS	Syphilis	Income
Chlamydia	1.00	0.67[a]	0.29	0.41[a]	–0.16
Gonorrhea		1.00	0.53[a]	0.58[a]	–0.16
HIV/AIDS			1.00	0.70[a]	0.36[a]
Syphilis				1.00	0.04
Income					1.00

Source: Own calculations. [a]Significant at 1% level of significance

What is the cause of the substantial difference in the transmission rates between the United States and sub-Saharan Africa? Oster argues that it comes from other untreated sexually transmitted infections. Untreated, open sores from chlamydia, syphilis and gonorrhea are the main reasons for the vast difference in HIV transmission. Her results indicate that treating bacterial sexually transmitted infections could prevent as many as 24% of new infections over a decade, at a cost of less than USD 80 per infection. This has clear policy implications for HIV/AIDS. The most cost effective way to deal with HIV/AIDS may not lie in tackling HIV/AIDS directly. It may lie in the treatment of other sexually transmitted infections.

4.2 Social Capital and HIV/AIDS

There are three different types of capital: (1) human; (2) physical; and (3) social. We would expect human and physical capital to have strong relationships with HIV/AIDS (Cohen, 1998 and 2002). Human capital gets eroded due to HIV/AIDS because HIV/AIDS affects disproportionately people at a productive age. However, we never directly observe human capital. We use different proxies to measure it. Per capita income (or the level of schooling) is sometimes used as a proxy (Papageorgiou and Stoyetcheva, 2004). Table 4.1 shows that, at least with state level data in the United States, per capita income is not related to any of the sexually transmitted diseases.

Given that per capita income is not related to HIV/AIDS, researchers have investigated whether other types of capital are related to HIV/AIDS. Holtgrave and Crosby (2003) found that social capital is indeed strongly related to the prevalence of HIV/AIDS across the states in the United States (see Table 4.2).

The idea of social capital has been around for quite some time. Robert D. Putnam has pioneered quantitative measures to capture social capital. Putnam (2000) produced a composite index to measure it over time. He explained that " ….the core idea of social capital theory is that social networks have value". The central factors include trust, reciprocity and cooperation among members of a social network that aims to achieve common goals. Muntaner and Lynch (2002)

discuss Putnam's use of the term social capital. Since sexually transmitted diseases result from social interactions, any relation between social capital and such diseases are of interest. It is important to note that social capital is different from human capital as well as physical capital.

Table 4.2 shows that, for a developed country, poverty is not correlated with HIV, gonorrhea or syphilis. Income inequality, on the other hand, is correlated with HIV. However, social capital is strongly correlated with all four diseases.

Table 4.2 Correlation between poverty, social capital, income inequality and HIV/AIDS, Chlamydia, Gonorrhea and Syphilis

	Gonorrhea	Syphilis	Chlamydia	HIV/AIDS
Poverty	0.204	0.232	0.358[a]	0.099
Social capital	–0.671[a]	–0.591[a]	–0.532[a]	–0.498[a]
Income inequality	0.203	0.133	0.395[a]	0.469[a]

Source: Holtgrave and Crosby (2003). [a] Significant at 1% level of significance

4.3 Relationships Between HIV/AIDS and Poverty, Inequality and Social Capital Using Global Data

David (2007) undertook a more ambitious study of the relationship between HIV/AIDS and social capital, at the international level. Using data from 80 countries around the world, and using the World Value Survey at the national level for each country as a proxy for social capital, he finds that, under most specifications, HIV/AIDS is related to social capital. His interpretation of the data was to claim that HIV/AIDS causes a decline in social capital at the national level. However, given that his data is cross-sectional, there is no way of proving the causality he claims. We can just as easily envision a decline of social capital leading to an increase in HIV/AIDS.

There is a significant negative correlation between social capital and income inequality, on the one hand, and HIV/AIDS, on the other hand. However, it is not clear what policy prescription should flow from these findings. Changing income inequality in a country is not a simple matter. It involves social engineering on a large scale. A policy of reducing income inequality by taxation and redistribution of wealth can backfire because it can negatively affect individual incentives. Policies to increase social capital are even less obvious.

Using data from over 110 countries, we can also see the relationship between poverty and HIV prevalence. Figure 4.1 shows a strongly positive relationship between HIV prevalence and poverty, as measured by the proportion of the population living under USD 2 per day. This association does not mean that HIV/AIDS is the root cause of poverty, nor vice versa. For example, poverty and education go hand

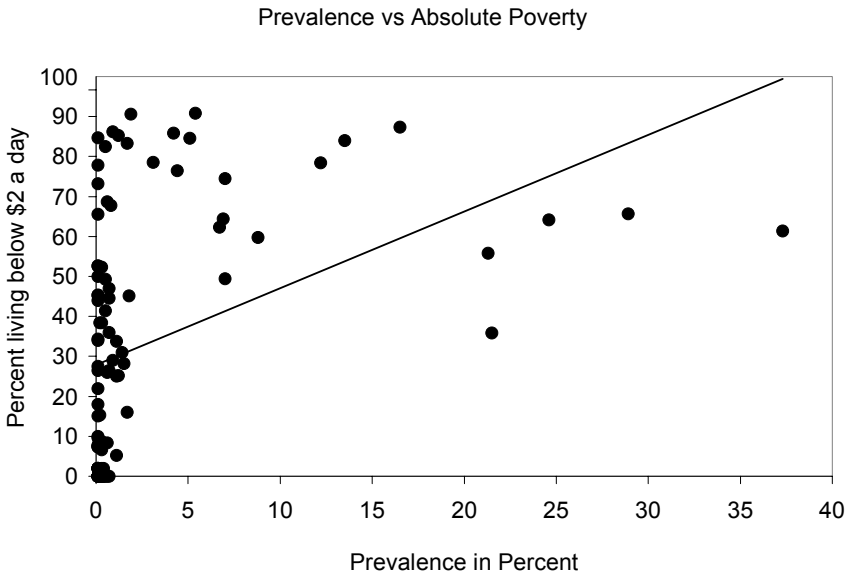

Fig. 4.1 HIV prevalence and absolute poverty. *Source*: Own calculations

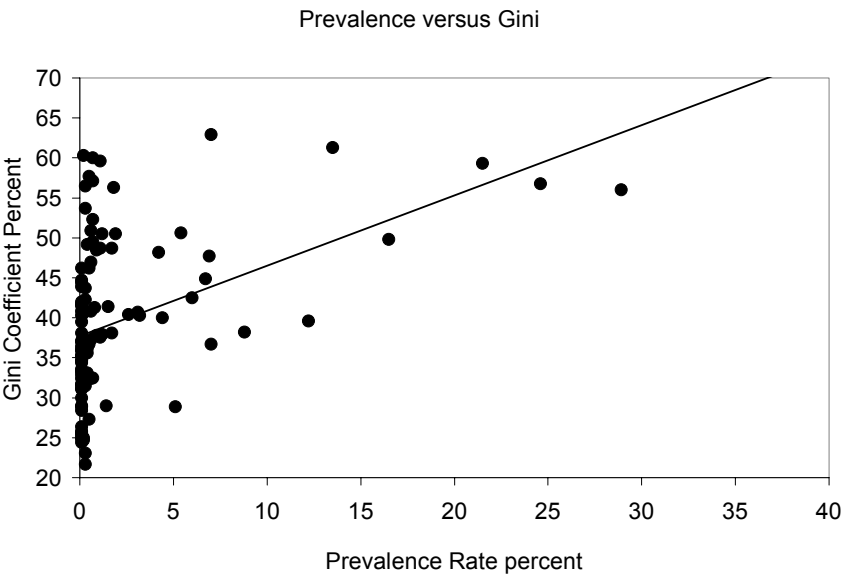

Fig. 4.2 Prevalence of HIV/AIDS and relative income inequality. *Source*: Own calculations

in hand. Thus, a high incidence of absolute poverty might cause a high incidence of HIV/AIDS. To put it differently, it is impossible to tell whether absolute poverty causes HIV/AIDS or vice versa – or whether another variable, such as war, inadequate health or poor education, explains the relationship.

We can also see the relationship between (relative) income inequality, as measured by the Gini coefficient, and the prevalence of HIV/AIDS, using data from over 110 countries. Figure 4.2 shows that higher inequality is associated with higher prevalence of HIV/AIDS. Once again, such an association cannot be interpreted as evidence of causality.

Bloom and Mahal (2001) have also noted relationships between poverty and income inequality and the prevalence of HIV/AIDS. However, in terms of policy implications, such studies do not offer much in the way of concrete proposals. Poverty reduction is too broad a goal to constitute what might be termed an HIV/AIDS prevention strategy. Moreover, there is no clear evidence that reducing poverty and income inequality will necessarily reduce HIV/AIDS prevalence. In Chap. 9 we examine HIV/AIDS prevention strategies in greater detail.

4.4 The Economic Impact of HIV/AIDS in a Macroeconomic Growth Model

The economic impact of HIV/AIDS takes place over many years and many generations. Therefore, the long-term economic impact of HIV/AIDS is very different from the short-term impact. Moreover, in any given economy, there are many evolving variables affecting the economy at the same time. Therefore, we use economic modeling to isolate the economic effect of one variable (HIV/AIDS).

We first use a standard one-sector macroeconomic model as a framework for exploring the macroeconomic impact of HIV/AIDS. The total output (Y) is a function of capital (K) and labor (L): $Y = F(K, L)$. Y is assumed to be an increasing function in both K and L. In addition, we make a distinction between labor (or workforce) (L) and the population (N). Thus, we can express the production function in per capita terms as $Y/N = F(K, L)/N$. Under the assumption that F is a homogeneous function of degree one, we can write the equation as $Y/N = F(K/N, L/N)$. Growth theory tells us that output per capita (Y/N) will rise or fall depending on capital per capita (K/L) and labor per capita or the labor participation rate (L/N). Economic growth comes from three different sources in this model: (1) a higher labor participation rate (rising L/N); (2) a higher capital labor ratio (K/N); and (3) technology (that causes the function F to shift upwards).

In theory, rising HIV/AIDS prevalence could cause the labor participation rate (L/N) to rise, to fall or to remain the same. Rising rates of HIV/AIDS would reduce the supply of labor (L). It would also reduce the population (N). If HIV/AIDS were to reduce the supply of labor and the population to the same degree,

then labor per capita would remain the same. However, HIV/AIDS strikes the population at a productive age. If HIV/AIDS reduces the labor force (L) more than the entire population (N), then the labor participation rate (L/N) would fall. However, a decline in the supply of labor would lead to a rise in capital per labor unit (K/L) in the short run. Thus, in the short run, the total impact of HIV/AIDS is ambiguous in this model. However, in the long run, the supply of capital (K) may fall if rising HIV/AIDS leads to less saving and investment.

Empirical evidence on the loss of labor force due to HIV/AIDS is very clear in sub-Saharan African countries, as Table 4.3 shows. Over the next several decades, there could be a massive decline in the labor force in these countries. Such spectacular falls in the labor force have not been seen anywhere in the world since the Black Death in Europe during 1348–1350, when some 30–50% of the population died due to bubonic and pneumonic plague.

Table 4.3 Percentage of labor force lost due to HIV/AIDS

Year	Botswana	Lesotho	Malawi	Moz	SA	Namibia	Tanz	Zimb
2005	–17.2	–4.8	–10.6	–9.0	–12.8	–10.8	–9.1	–19.7
2020	–30.6	–10.6	–16.0	–24.9	–35.1	–24.9	–14.6	–29.4

Source: Husain and Badcock-Walters (2002). *Notes*: *Moz* Mozambique; *SA* South Africa; *Tanz* Tanzania; *Zimb* Zimbabwe

In conclusion, a classical model of economic growth does not give us any definite conclusion about the macroeconomic impact of HIV/AIDS. The impact depends critically on the specification of the model based on facts. Unfortunately, most facts are not unambiguous. They also vary between countries.

4.5 Macroeconomic Models: HIV/AIDS and Economic Growth

The literature on HIV/AIDS and economic growth provides a mixed picture. A large number of studies show a negative effect of HIV/AIDS on long run economic growth: Over (1992); Bonnel (2000); Bell et al. (2004); and Corrigan, Glomm, and Mendez (2005). However, in one of the first direct macroeconomic studies, Bloom and Mahal (1997) found that there is no relationship between HIV and economic growth in the long run. Werker et al. (2006) reaffirmed this result with the additional use of the variable of circumcision across countries (Poulin and Muula, 2007). In addition, two studies by Young (2005, 2006) show that HIV/AIDS actually will have a positive impact on the welfare of the surviving population over the next 100 years. We will discuss some of these studies in detail.

4.5.1 The Impact of HIV/AIDS on Per Capita Income

Bloom and Mahal (1997) published one of the earliest empirical studies of the impact of HIV/AIDS on the per capita income growth. They gathered data on 51 developing countries for the years 1980–1992. Their conclusion was startling: "HIV/AIDS has no statistical impact on per capita income growth". Their reasoning was fortified by a number of reasonable arguments. (1) In many developing countries, there is surplus labor. This surplus could be absorbed without much visible impact on GDP per capita. (2) Since the poor use less medical services, the drain on resources would be relatively minor in developing countries. (3) Community-based and family-based networks will deal with medical requirements. (4) Projections of the number of people with HIV/AIDS tend to be overstated. However, their paper relied heavily on the model of evolution of HIV/AIDS called EPIMODEL, developed by Chin (1994). The model was very sensitive to the specifications of initial conditions. It turned out that the expansion of HIV/AIDS was far more severe in many countries than were addressed in the model. The scale of the rise in mortality had not reached the proportions that were to be reached over the next decade. Hence, the macroeconomic impact that did not appear in their study was to show up in later studies (see below).

Bloom and Mahal also compared the current and forthcoming impact of HIV/AIDS with that of the Black Death in the 1300s. They argued that evidence shows that the Black Death actually caused an increase in the standard of living among the survivors. However, the same argument would not apply to HIV/AIDS today. In the 1300s, the main source income was agriculture that had very little input of human capital. Education hardly played any role in the (mostly agricultural) production process. Even the actual sowing season was not known with precision. Today, the agricultural production process is vastly different. Almost everywhere in the world, the use of artificial fertilizer and pesticides is commonplace. Thus, even in agriculture, human capital has become a factor in the production process. This was not relevant in the 14^{th} century. Therefore, it is critical to take into account in the model the impact of HIV/AIDS on human capital.

4.5.2 The Role of Human Capital

Bloom and Mahal downplayed two critical elements of HIV/AIDS. First, HIV/AIDS affects people who are sexually and economically active. This is in stark contrast with other important diseases like malaria. Therefore, the HIV/AIDS epidemic affects the size, growth rate, age and skill composition of the future labor force that feeds into the growth rates of potential output and of productivity. Second, unlike other killer diseases, like the bubonic plague or influenza, HIV/AIDS is slow-moving, both within society and within the human body. As a result, society must bear higher costs of treatment and palliative care relative to other comparable killer diseases (Moore and Viscusi, 1988). This affects the level and

composition of future consumption demand of households (as they have to incur additional private costs) and of governments (that provide public health services). These additional costs dampen savings and investment, thereby reducing the future GDP growth rate. The economics of HIV/AIDS is therefore quite distinct from other diseases with similar epidemiological and demographic characteristics.

A key factor for long-term accumulation of wealth in a given country is its human capital. Therefore, we modify the model to take into account human capital. We show that in the long run, HIV/AIDS can trap a country in poverty for many generations. To explain the human capital argument, we first document the fall in life expectancy due to HIV/AIDS in selected African countries (Acemaoglu and Johnson, 2005).

The impact of HIV/AIDS on life expectancy is large in many countries – especially in sub-Saharan Africa. As Table 4.4 demonstrates, the effect of HIV/AIDS on life expectancy at birth for males is staggering. In Mozambique, the life expectancy falls from 44.32 years in 1990 to 39.74 years in 2012, a drop of more than 10%. In Tanzania, the impact is somewhat smaller and it recovers over the 20-year period (Biswalo and Lie, 1995). The effects in South Africa and Namibia are far larger. In South Africa, life expectancy at birth for males falls by more than 25%. In Namibia, it falls by more than 30%. Botswana is the country hardest hit by this. Life expectancy males at birth falls by 36% in just 10 years (Botswana Sentinal Survey, 2001). Such a reduction in life expectancy over such a short period of time is without historical precedent (Ainsworth and Over, 2001).

What impact would a reduction of 5–20 years of life expectancy have on human capital? To answer that question, we turn to the evidence produced by Bils and Klenow (2000). Although their study was focused on the impact of schooling on economic growth, they also shed some light on the channels through which economic growth is caused by (and in turn, causes) schooling. They show that a 1-year rise in life expectancy at birth leads to 0.25- to 1-year rise in schooling on the average. Thus, a 5-year drop in life expectancy could lead to up to a 5-year drop in average schooling.

What are the microeconomic channels through which falling life expectancy can lead to lower future economic growth? Bonnel (2000) provides a list of microeconomic effects through two main channels: reduced income and increased costs. Reduced income results from the reduced working capacity of workers with HIV/AIDS and lower lifetime income due to lower life expectancy.

Higher costs come from a variety of sources: (1) higher medical expenses due to HIV/AIDS; (2) the dissolution of households that leads to increased social costs; and (3) the cost of caring for orphans that falls either directly on the family or on the society. Higher costs also lead to less education for the children and less saving at the macro level. They all contribute to falling future levels of income through falling productivity (which is linked to education) of future generations.

In summary, HIV/AIDS destroys human capital through a number of mechanisms. (1) It weakens mechanisms for human capital formation. (2) When parents die, it weakens knowledge transmission between generations. (3) Children stay out

Table 4.4 Male life expectancy at birth: 1995–2015

Year	Botswana	Mozambique	Namibia	South Africa	Tanzania
1990	NA	44.32	62.05	59.67	48.34
1991	NA	44.35	62.58	59.81	48.20
1992	NA	44.34	62.95	59.83	47.94
1993	NA	44.43	63.13	59.66	47.59
1994	NA	44.50	63.03	59.13	47.20
1995	54.62	44.48	62.51	58.30	46.50
1996	50.75	44.37	61.28	57.15	45.79
1997	46.96	44.15	59.57	55.70	45.16
1998	43.65	43.87	57.52	54.04	44.66
1999	40.95	43.52	55.31	52.30	44.27
2000	38.85	43.12	53.19	50.58	44.00
2001	37.31	42.70	51.27	48.98	44.09
2002	36.22	42.27	49.53	47.58	44.26
2003	35.48	41.83	48.13	46.44	44.52
2004	35.04	41.41	47.10	45.57	44.83
2005	34.81	41.01	46.38	44.96	45.17
2006	34.73	40.65	45.94	44.59	45.55
2007	34.77	40.35	45.73	44.42	45.95
2008	34.88	40.09	45.72	44.42	46.35
2009	35.05	39.91	45.86	44.64	46.73
2010	35.22	39.78	46.1	44.96	47.11
2011	35.39	39.74	46.4	45.34	47.48
2012	35.54	39.74	46.72	45.75	47.83
2013	35.67	39.81	47.03	46.16	48.17
2014	35.77	39.93	47.31	46.55	48.49
2015	35.86	40.09	47.56	46.93	48.8

Source: US Census Bureau, International Programs Center, unpublished tables

of school due to lost labor and income. (4) Lower life expectancy reduces the payoff from education. (5) Teachers become sick and die due to HIV/AIDS. They are costly to replace.

The impact of HIV/AIDS on mortality during productive years is striking. This can be seen in the two following figures. Figures 4.3 and 4.4 show the precise nature of where AIDS strikes in terms of excess mortality. The figures are calculated from the mortality tables produced by the Actuarial Society of South Africa (ASSA). First, we normalize the mortality in South Africa to the year 1985. Thus, the mortality for every age group 15–19, 20–24, etc. are set to 1. The logic of choosing 1985 was that it would be last year in which the effect of deaths due to AIDS had not yet shown up in the mortality of the population. We then calculate

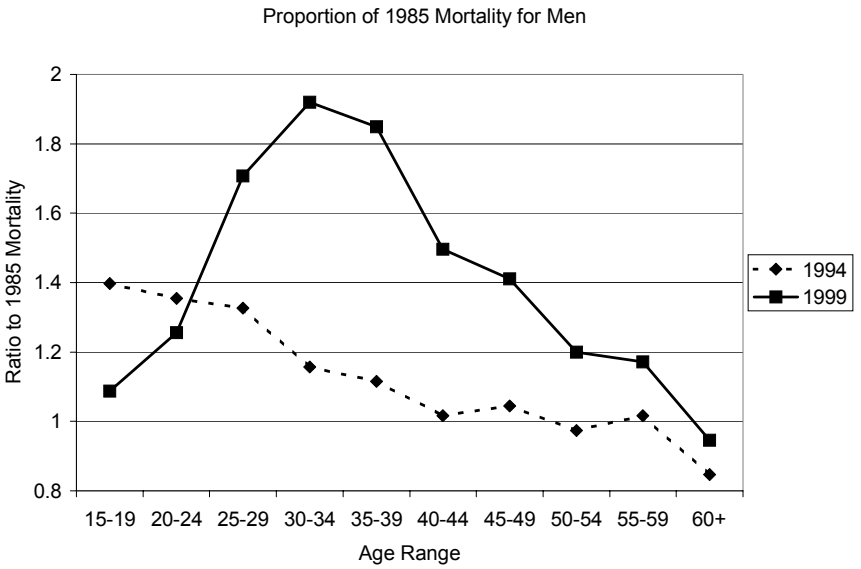

Fig. 4.3 Male mortality in 1994, 1999 as a proportion of male mortality in 1985. *Source*: South African Actuarial Society database

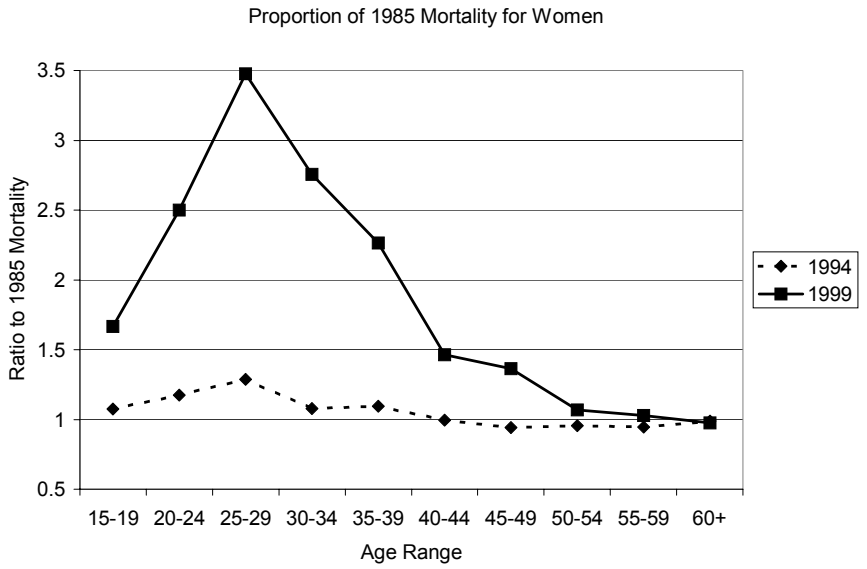

Fig. 4.4 Female mortality in 1994, 1999 as a proportion of female mortality in 1985. Source: South African Actuarial Society database

the mortality of males and females for every age group for the years 1994 and 1999 in relation to their corresponding rates for 1985. Thus, Fig. 3.5 for females of age group 25–29 for the year 1999 implies that the mortality for that age group was 3.5 times higher than their figure for the year 1985. These kinds of staggering reversals of longevity of prime-age people in such a short time have never been seen in any society in the past century.

4.5.3 The Transmission of Human Capital

Bell et al. (2004) took a different tack. They proposed an overlapping generations model with a central role for human capital instead of a classical Solow growth model. They explicitly modeled the transmission of human capital between generations through costly education. They list all the channels through which a disease like HIV/AIDS strikes.

> We begin by listing what are arguably the primary effects of morbidity and mortality in the age groups that AIDS typically strikes, namely, young and prime-aged adults. It is useful to order such effects, whether due to AIDS or to other causes, in the following way: (a) Morbidity reduces productivity on the job or results in outright absenteeism. If the worker dies, his or her skills and experience are destroyed. (b) Firms and the government lose trained workers on both counts and must replace them. In particular, many teachers die prematurely of AIDS. (c) Substantial expenditure, public and private alike, may be required to treat and care for those who become sick. (d) Savings are also diverted out of net investment in physical and human capital into the treatment and replacement of workers who fall sick and die. (e) Lifetime family income is greatly reduced, and with it the family's means to invest. (f) Children lose the love, care, guidance, and knowledge of one or both parents, which plausibly weakens the transmission of knowledge and capacity from generation to generation. (g) The tax base shrinks. (h) Collateralization in credit markets becomes more difficult, and as a consequence credit markets function less well. (i) Social cohesion and social capital decline.

Their model explicitly takes into account the factors listed above in an overlapping generations model with human capital investment. They note some explicit facts about morbidity in South Africa (along with Zimbabwe). In 1990, 11% of 20-year-old males and 4% of 20-year-old females died before their fortieth birthday. By 2010, the proportions would be 36 and 54%. To put it differently, more than a third of all males aged 20 would die before 40 and more than half of females aged 20 would die before 40. To get an idea of the mortality impact of AIDS compared with other diseases, it is sufficient to remember that the number of death from AIDS would exceed the total number of deaths from all other diseases combined.

This rising mortality would imply that a third of the children in the country would have at least one parent die during their childhood and one in five would become an orphan. This would lead to a loss of human capital of unprecedented scale. The level of education would decline in the next generation.

Bell, Devarajan and Gersbach describe this process vividly:

> In the absence of support, [the children] do not attend school, and each will marry another uneducated individual. In the absence of support or compulsion, the offspring of these unions will also go uneducated, and so on. Observe that any premature adult mortality will produce a new crop of orphaned children in each period and that these lineages will fall into poverty and illiteracy, even if they were not in that condition before. Hence, as time progresses, a steadily increasing proportion of the whole population finds itself in poverty. Caring for orphans is not, of course, a new problem for humankind, and societies have devised various ways of dealing with it. Whether these arrangements can withstand the burden of an epidemic like AIDS, however, remains to be seen.

After calibrating the model to South African parameters, Bell, Devarajan and Gersbach proceed to work out the dynamics of the evolution of family income in the model under three scenarios. First, they calculate it for the case of "No AIDS". Then, they contrast it with two possible scenarios with different levels of human capital investment. In "AIDS (L)" case, they assume that human capital investment would taper off rapidly. In "AIDS (H)" case, they assume that human capital investment would taper off relatively slowly. These results are depicted in Figure 4.5.

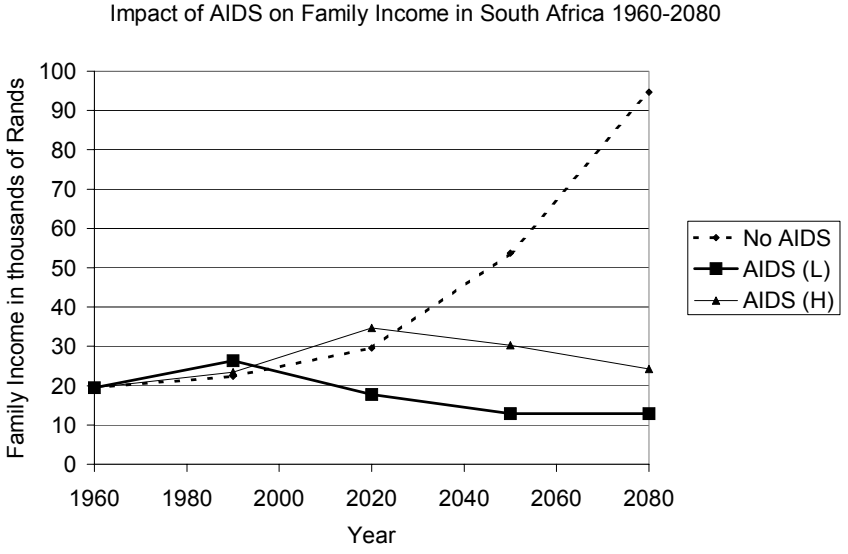

Fig. 4.5 Projection of family income in Bell, Devarajan and Gersbach model. Source: Bell et al. (2004)

Had there been no AIDS, the family income in real terms would have increased almost fivefold between 1960 and 2080. In the worst case scenario of AIDS (L), the family income declines by 40% by 2080. In the not-so-bad scenario of AIDS (H), the family income would show a modest rise of 20% by 2080.

4.5.4 Fertility, HIV/AIDS and Economic Growth

Young (2005) undertook a study to examine the impact of HIV/AIDS on the future welfare of the people who will survive it. The new element he introduced was the effect of HIV on fertility (see also Boldrin and Jones, 2002). He starts with the premise that this effect is strongly negative. Couples with one partner who is HIV-positive would have fewer children. He proceeds to generate projections of the South African population with and without the HIV epidemic (see also Doepke, 2005).

He first notes that, in the absence of the epidemic, the population would have grown to 110 million persons by 2050. With the epidemic, the combination of adult mortality, HIV infant mortality, the effects of HIV infection on fertility and the endogenous response of fertility to higher wages would keep the population below 50 million for almost 50 years (see also Chakraborty, 2004).

He argues that the positive effects of lower population growth are strong enough to counteract the most pessimistic forecasts of the human capital losses of orphaned children due to AIDS, thus implicitly endowing the economy with extra

Fig. 4.6 Wages for farm workers in England 1200–1840 AD. *Source*: Clark (2005)

resources that can be used to extend the lifespan of the afflicted and still leave reserves to raise the per capita welfare of future generations (Ehrlich and Lui, 1991).

The argument of high wages in the post HIV/AIDS societies in sub-Saharan Africa relies on the following observation (see Fig. 4.6): For several centuries after the Black Death, real wages stayed high, while the population was halved between 1300 and 1400 in England.

In summarizing the argument, Young (2005) noted: "Regardless of the precise mechanism, it is clear that the Black Death, in a purely economic sense, was a boon to the generations which survived and succeeded it, who, for a sustained period of time, experienced living standards which were not seen again until the late nineteenth century." The implication for the unfolding pandemic of HIV/AIDS is clear. A similar effect would be observed over the next decades in sub-Saharan Africa.

In a separate paper, Young (2006) also tackles the question of the negative relationship between HIV and fertility. Using a series of Demographic and Health Survey (DHS) data, he shows that the relationship is indeed negative.

4.5.5 Fertility and Human Capital Accumulation

The Kalemli-Ozcan (2006) study contradicts the results of Young (2006). She asks the following question: What is the effect of HIV/AIDS on fertility and human capital accumulation in the aggregate data? With a panel data set of two decades from Africa she shows that (1) the HIV/AIDS epidemic affects the total fertility rates positively and (2) it affects the school enrollment rates negatively. She provides empirical evidence on specific mechanisms through which demographic transition affects economic growth.

Kalemli-Ozcan provides evidence on the risk perception of people who are at risk. Consider Fig. 4.7. It has three elements. For a number African countries, it gives information about: (1) women in 15–19 age group who consider themselves not to be at risk from HIV/AIDS; (2) the percentage of HIV-positive pregnant women in the country; and (3) women in the child-bearing age group who know about the mother-to-child transmission risk of HIV/AIDS. She concludes from the evidence that: "The percentage of sexually active women (15–19) that perceive not to be at risk at all of getting AIDS is rather high, with a mean of 48% among the countries shown. The percentage of 15–49 year old women who know that HIV can be transmitted from mother to child is also plotted for the same countries, with a mean of 58%. It does not seem to be the case that higher HIV countries necessarily have better knowledge."

Among the people who do not know the risk they face or people who are not well informed about the risk they face, behavior would not change. How would parents react in the face of uncertainty about a child's survival? They would have more children and provide each of them with less education.

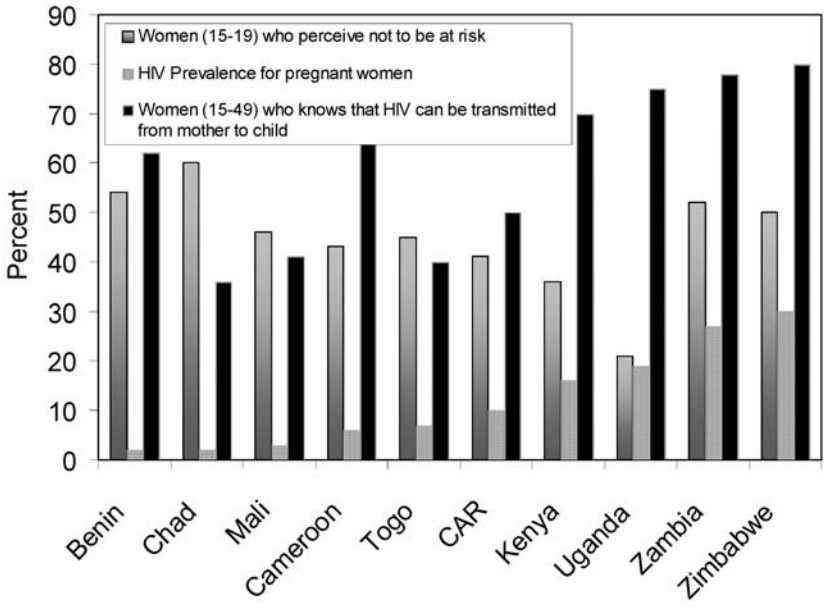

Fig. 4.7 Prevalence, risk perception and knowledge of women about HIV. *Source*: Kalemli-Ozcan (2006)

Figures 4.8 and 4.9 provide evidence of these two important relationships. Note that the two variables are not simply correlated by ignoring the effect of other factors. Rather, they exhibit the relationship after taking into account other factors.

How strong are these effects? Kalemli-Ozcan notes the following: "The empirical estimates predict that parents in a country with a high level of HIV/AIDS prevalence, such as Congo, have two more children compared to a country with a low level of HIV/AIDS prevalence, such as Madagascar. Botswana had a quadrupling of the prevalence of HIV/AIDS. It has had 1.5 more births per woman and 30% points lower primary school enrollment since 1985. The results imply lower economic growth and welfare for current and future African generations."

Juhn et al. (2007) followed up on Kalemli-Ozcan (2006) by examining directly the fertility response to HIV/AIDS. They used the latest rounds of the Demographic and Health Surveys linking an individual woman's fertility to her HIV-status based on testing. The data allows us to distinguish the effect of positive HIV status on fertility (which may be due to lower fecundity and other physiological reasons) from the behavioral response to higher mortality risk (measured by the local community's HIV prevalence). They found that the disease significantly lowered an infected woman's fertility. On the other hand, the local community's

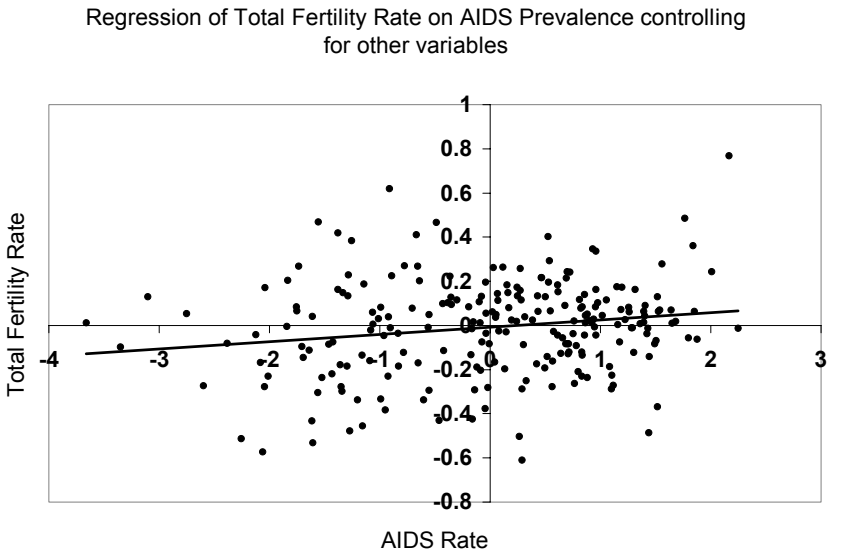

Fig. 4.8 Relation between total fertility rate and prevalence. Source: Kalemli-Ozcan (2006)

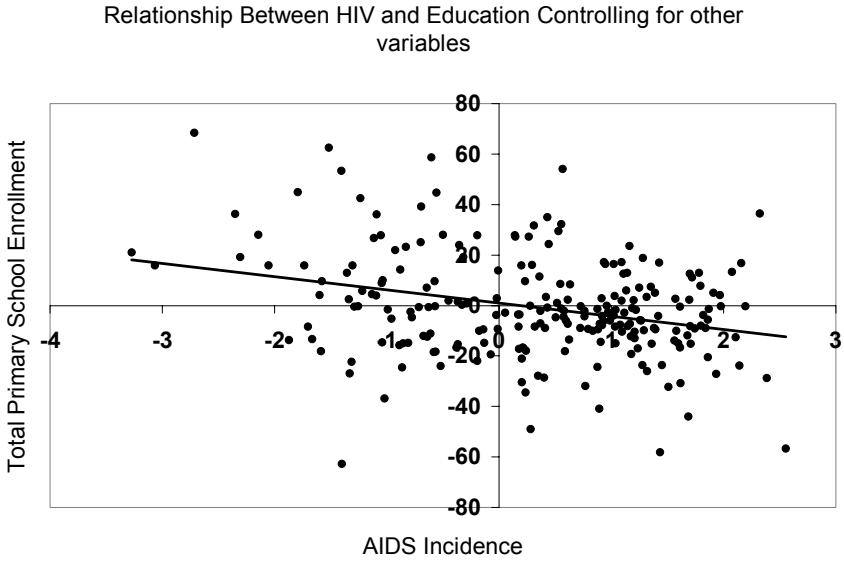

Fig. 4.9 Relation between education and prevalence. *Source*: Kalemli-Ozcan (2006)

HIV prevalence had no significant effect on non-infected women's fertility when they pooled all communities (see Table 4.5). However, HIV/AIDS had a significant positive effect on fertility in the sub-sample of communities with non-zero prevalence. This result kills the argument of a negative impact of HIV/AIDS posited by Young through empirical facts on the ground.

Table 4.5 Knowledge of status in Africa

Country	Year	Percent of men who knew status[a]	Percent of HIV+ men who knew status[b]	Percent of women who knew status[a]	Percent of HIV+ women who knew status[b]
Botswana	2005	10.3	17.4		
Cameroon	2004	9.7	25.1	13.9	23.6
Ethiopia	2005	3.8	4.9		
Ghana	2003	7.4	12.4	7.5	8.2
Kenya	2003	13.1	18.2	14.3	22.8
Lesotho	2004	12.0	16.8	9.1	16.2
Malawi	2004	12.9	15.0	15.1	20.0
Mozambique	2003	3.7	3.6		
Nigeria	2003	6.4	13.6		
Congo	2005	9.5	10.6		
Tanzania	2004	12.1	12.3		
Uganda	2004	12.7	23.5	10.8	15.0

Source: Demographic and Health Surveys, 2003−2005. Notes: [a]Percent distribution of men or women aged 15−49 years who were ever tested for HIV and received test results. [b]Percent distribution of HIV-positive men or women aged 15−49 years who were ever tested for HIV and received results of the last test before the survey

4.5.6 Summary of Reviewed Literature on Fertility and Human Capital

There are many channels of transmission of the impact of HIV/AIDS on macroeconomic variables. They do not necessarily move in the same direction. For example, theoretically speaking, a rising incidence of HIV/AIDS can lead to a rising or falling total fertility rate (Meltzer 1992). The empirical results depend on the strengths of each channel through which the fertility rate is affected. In sub-Saharan Africa, where even basic macroeconomic data can be spotty, it is not always possoble to get conclusive results. Thus, many economists have turned to microeconomic or sectoral studies, where conclusions are sharper but the results do not necessarily point to any macroeconomic outcomes (Lorentzen et al., 2004). Specifically, these studies do not give clear answers regarding the impact of HIV/AIDS on overall economic welfare in the form of changes in GDP.

4.6 Microeconomic and Epidemiological Models of Behavior

Microeconomic and epidemiological models try to answer questions about the behavioral response of people who are either at risk of or actually living with HIV/AIDS. For example, does the threat of HIV lead to less sex without condoms? What factors affect the behavior of people when they know about the risk of HIV/AIDS, given that there is no cure? Does the introduction of ARV drugs lead people to have more risky sex? Is it possible to set out policies that are aligned to the incentives of people to undertake activities to limit the propagation of HIV/AIDS? Answers to such behavioral questions are important. For example, the ABC policy (A for abstinence B for be faithful and C for condom), which is favored by the Bush Administration and implemented by PEPFAR in countries in Africa with high HIV/AIDS prevalence, emphasizes A and B and relies heavily on the behavioral response.

4.6.1 Do Ugandans Behave Differently?

Figure 4.10 provides a picture of the prevalence of HIV in the antenatal clinics in various African countries over a decade and a half. In Kenya, HIV/AIDS prevalence rose dramatically over this period. In the province of Kwazulu Natal, it rose

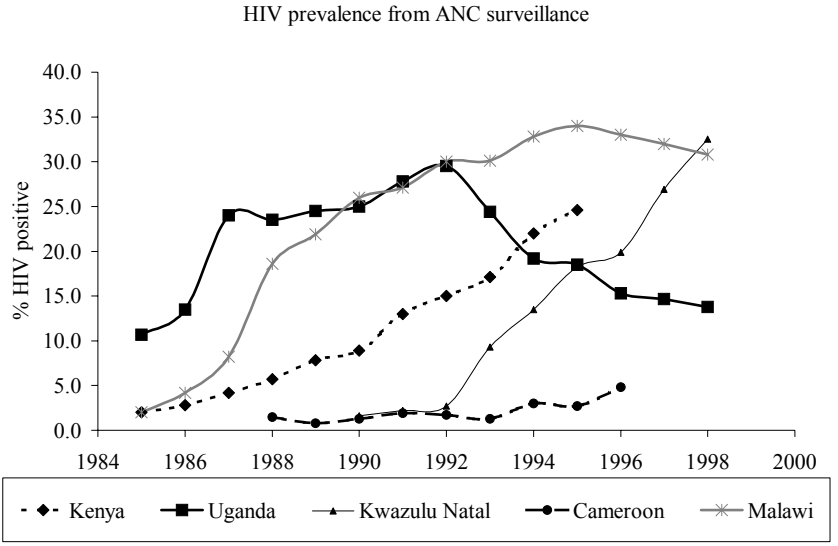

Fig. 4.10 HIV prevalence in antenatal clinics in Africa 1984–1999. *Source*: Mosley (2005)

spectacularly in 6 years, after starting from very low figures. The only country that stands out in this group is Uganda. Between 1985 and 1992, the figure rose, but then declined dramatically.

This effect is also clear for every site for which data on the HIV status of pregnant women are collected in various parts of Uganda, as Fig. 4.11 shows. All of the sites show a clear downward trend, without exception.

The Ugandan government has been using a three-pronged strategy: Abstinence (efforts to raise the age of sexual debut by young adults), Be Faithful (efforts to discourage more than one sexual partner) and Condom (efforts to increase the use of condoms) – the so-called ABC approach. The "success" of Uganda's ABC program attracted the attention of the US Agency for International Development (USAID) in 2001. It convened a group of policymakers from academia, various government bodies, such as the CDC, along with various charitable American organizations working in Africa. The point of this meeting was to hammer out the importance of different components of ABC.

When PEPFAR began planning its strategy, it clearly had Uganda in mind. For example, in testimony before Congress, Anne Peterson, Assistant Administrator for Global Health at USAID noted, "It is important that we highlight the successful interventions in Uganda so we can better apply them to other countries. The new Emergency Plan for AIDS Relief that President Bush announced in January in the State of the Union Address is based on one of these successful models" (Peterson 2003).

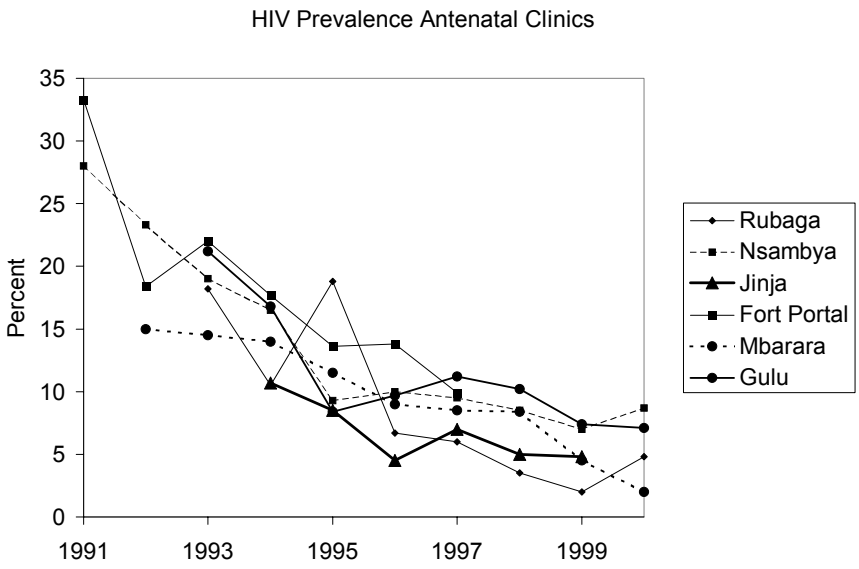

Fig. 4.11 Downward March of HIV prevalence in antenatal clinics in Uganda. *Source*: Mosley (2005)

One of the strongest ABC proponents was Dorothy Brewster Lee of Christian Connections for International Health. She noted that, in Cameroon, where faith-based organizations were marginalized because they would not support condoms, HIV infections among pregnant women continued to increase. She emphasized that interventions that have proven effective in Europe and North America should not be applied in African settings without consideration for indigenous culture, including views on recreational or casual sex. She noted that many African countries have higher rates than the United States of under-15-year-olds who have not had sex. She also argued that HIV prevention approaches have generally failed to provide fair and balanced recognition to abstinence and faithfulness. Instead, the reports and strategies of UNAIDS and other international organizations gave condoms much more attention and emphasis (USAID 2002).

It was clear from the outset that the policy prescription of PEPFAR would bring Uganda to the central stage. However, what was not clear at the time was that US policy would have, in turn, a big impact on the future course of Ugandan policy. Once the US government began spending large sums of money in Uganda, rewarding it as the role model, the official policy in Uganda changed considerably. It began to emphasize A and B and to downplay C, just as Dorothy Brewster Lee had proposed. Thus, we could characterize the new policy as ABc, rather than ABC, in which all three elements had played prominent roles.

In November 2004, Uganda claimed to have become the first country in the world to draft an official national policy on abstinence and fidelity. Titled the "Uganda National Abstinence and Being Faithful Policy and Strategy on Prevention of Transmission on HIV," the draft policy is described by its authors as a companion to the country's existing strategy on the promotion of condoms and a component of Uganda's larger "ABC" strategy. One of the coauthors of this strategy document (Edward Green) was also a founding member of PEPFAR (Kyomuhendo et al., 2004).

Gray (2005) noted a clear change in the Ugandan government position with respect to condom promotion. The government of Uganda has adopted an official stance that discourages condom promotion, for the following reasons: "(1) Condoms may promote promiscuity. (2) Promotion of condoms along with abstinence messages may confuse youth. In addition, there is a condom shortage in Uganda because the Government requires in-country quality control testing of imported condoms."

Human Rights Watch (2005) noted a curious coincidence. The new Ugandan policy to scale up abstinence-only programs is styled after those in use in the United States. The definition of "abstinence education" in the draft follows almost verbatim the eight-part definition of "abstinence education" in the US Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (Section 912). The Ugandan definition which reads: "Abstinence education means an educational or motivational approach which: (1) Has as its exclusive purpose, teaching, supporting and empowering the social, psychological, and health gains to be relized by abstaining from premarital sexual activity; (2) Teaches abstinence from sexual

activity outside marriage (or "faithfulness") as the expected standard; (3) Teaches that abstinence from sexual activity is the only certain way to avoid sexually transmitted diseases, and other associated health problems; (4) Teaches that a mutually faithful monogamous relationship in context of marriage is the expected standard of human sexual activity."

Dr. Alex Kamugisha, Uganda's minister of state for primary health care, was quoted in the newspaper saying, "We want to slowly move away from the condom. As a ministry, we have realized that abstinence and being faithful to one's partner are the only sure ways to curb AIDS. From next year, the ministry is going to be less involved in condom importation but more involved in awareness campaigns, abstinence and behavior change" (Kasyate 2005).

However, the policy of emphasizing abstinence and faithfulness was not based on hard research (Luke and Munshi, 2004). Regarding abstinence, longitudinal research results exist that use US data. Lipsitz et al. (2003) surveyed over 500 college students over period of time. They found that 16.3% had taken virginity pledges. The majority of pledgers (61%) broke their vows. Pledge-breaking virgins had their first sexual intercourse later but used condoms less. The results were consistent with earlier evidence found by Bearman and Brückner (2001). Abstinence, used as a policy instrument in Uganda, has had negative effects on the use of condoms in the United States.

On the issue of faithfulness, the data in Uganda itself is rather discouraging, as Figs. 4.12 and 4.13 show. In Fig. 4.12, we examine the number of non-marital partners 15–19 year old girls in Uganda had between 1995 and 2003. It shows an increasing trend.

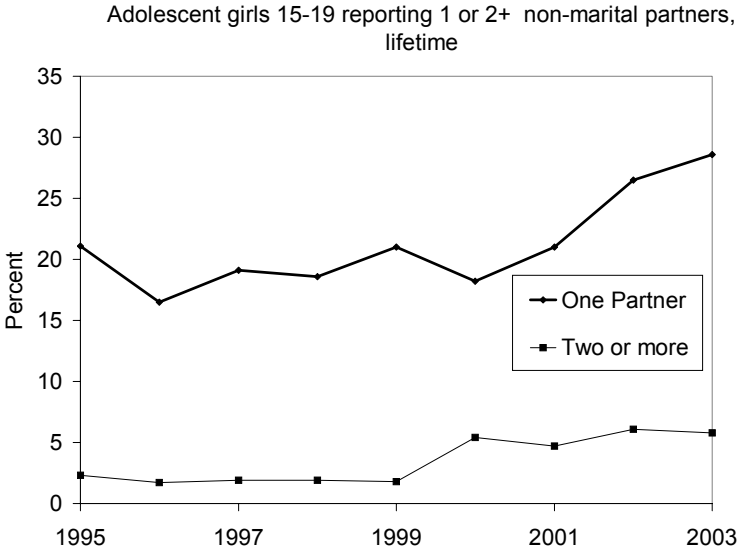

Fig. 4.12 Number of sex partners of adolescent girls in Uganda. *Source*: Gray (2005)

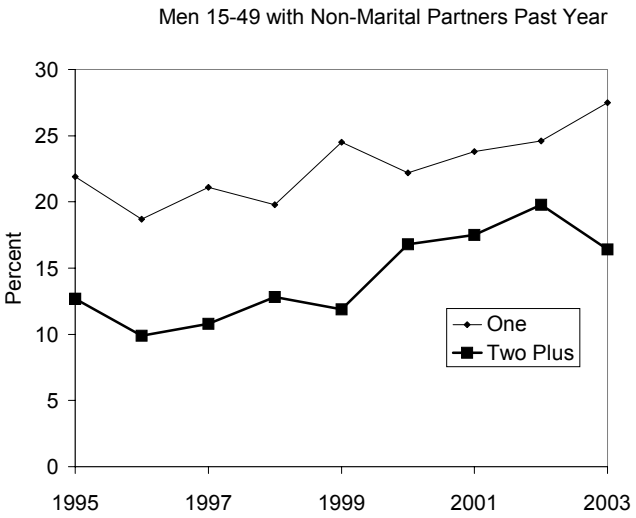

Fig. 4.13 Married men with one or more non-marital sex partners in Uganda. *Source*: Gray (2005)

In Uganda, it is common practice for married men to have sexual partners who are not their wives. Despite the campaign to be faithful to one wife (in Uganda, it is called "no grazing"), the data shows no reduction in the number of partners by married men since at least 1995. Given that nearly half the infected people are married, it is difficult to conclude that the "Be Faithful" campaign is a success.

4.6.2 An Epidemiological Interpretation of the Ugandan Results

The total number of people living with any disease in a population is a product of only two factors: the incidence rate (the number of new cases occurring in any time period) and the duration of disease among affected persons. The duration depends on how long it takes a patient to fully recover or to die. In the case of HIV/AIDS, during 1992–1999, when prevalence in Uganda fell substantially, full recovery from AIDS was out of the question. Moreover, increasing the length of survival through triple-combination therapy only became available in developed countries in 1997. Most people in Uganda would not have had access to this treatment between 1992 and 1999.

Mosley (2005) asks the following question: Can we find an epidemiological explanation of falling HIV/AIDS prevalence in Uganda? Prevalence at year t is

defined as follows: P(t) = I(t) + I(t–1) + …+ I(t–6) where I(t) is the incidence during year t. Here, we confine the prevalence at time t, P(t) to the accumulation of 7 years of incidence because the average longevity of a patient after becoming HIV-positive is 7 years in Africa without access to triple therapy. Thus, a falling value for P(t) could simply be explained by higher incidence in the distant past that is causing the fall in the value for P(t) at present. After examining the data from Uganda, Mosley (2005) concluded that the most likely explanation is exactly that. Of course, deaths due higher incidence in the past are not the only explanation. As Fig. 4.14 shows, the use of condoms substantially increased among the adolescents between 1998 and 2002.

Quantifying the effects, Mosley concluded that 6.2% of the decline in prevalence over a period of can be explained as follows: 5% of the decline can be explained by mortality and the rest for other reasons.

In order to claim that ABC worked for Uganda, we need evidence regarding how each component contributes to Uganda's plan.

For Abstinence, Gray (2005) notes the following facts for the Rakai District of Uganda. In 1995, the average age of first sexual contact for boys was 17.1 years. By 2002, the age has fallen to 16.2 years. For girls, during the same period, it had fallen from 15.9 to 15.5. He notes that while sexual abstinence before marriage is highly desirable, 14% of all girls have coercive first sex without condoms. Moreover, there is economic pressure to engage in paid sex (for example, to cover school fees). In addition, males in Uganda accept premarital sex as part of the local culture (Green 1994).

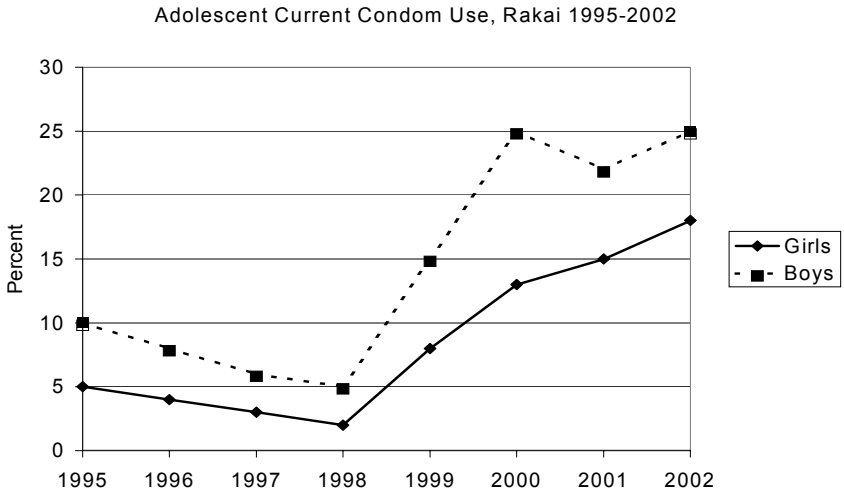

Fig. 4.14 Condom use among adolescents in Rakai district 1995–2002. *Source*: Gray (2005)

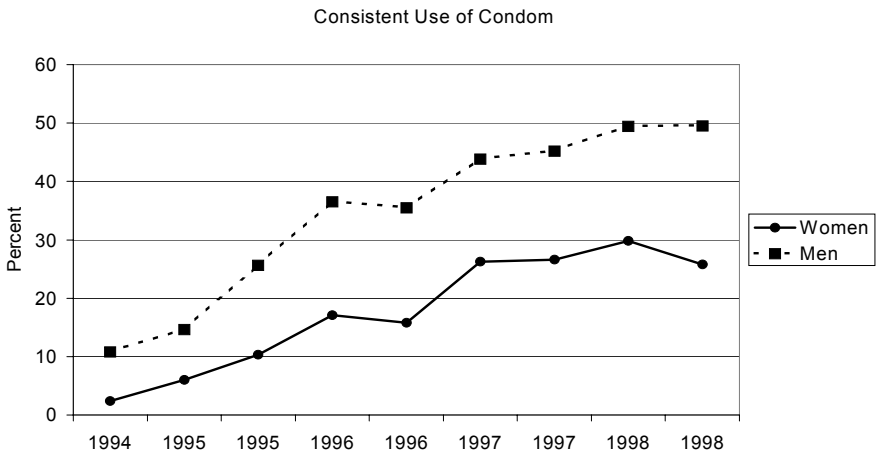

Fig. 4.15 Consistent use of condoms in Rakai, Uganda. *Source*: Gray (2005)

As we saw in Figs. 4.12 and 4.13, monogamy is neither rising for men nor for women. While 95.4% of married women are monogamous, only 55.1% of married men are monogamous. Thus, the "Be Faithful" slogan seems to have had very little effect in the population. The only part of the campaign that seems to have had any effect was the use of condoms (see Fig. 4.15 on the consistent use of condoms).

4.6.3 Do Africans Behave Differently?

Oster (2007a) has investigated whether there is something very peculiar about Africans. In sub-Saharan Africa, at least 90% of HIV infections are transmitted through heterosexual sex. Therefore, encouraging changes in heterosexual behavior has become an important part of the HIV prevention effort in that region. Oster notes that Africans have not changed their sexual behavior much in response to HIV. For example, a 1% increase in the HIV prevalence rate decreased the share of women with multiple partners by 0.4% points. For men, there was no change in this behavior (see also Haacker, 2002).

This result is in stark contrast with the big changes in behavior another high-risk group – gay men in the United States – exhibited when the first wave of HIV hit in the mid-1980s and no treatment was in sight. Figure 4.16 illustrates their behavioral response between 1984 and 1991. However, as we will see in Chap. 9, between 2001 and 2006, new HIV infections in gay men under 30 increased significantly in New York City and risky behavior continues to be a problem.

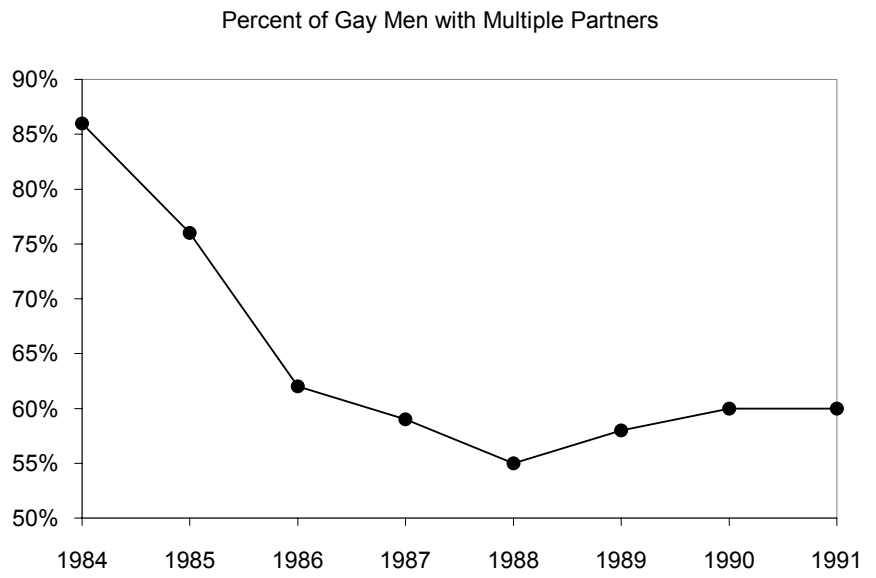

Fig. 4.16 Share of gay men with multiple partners in the United States 1984–1991. *Source*: MultiCenter AIDS Cohort Study Database

In theory, most people would adopt safer sexual practices in response to HIV risks (for example, monogamy). Oster examined African data to see if this theoretical relationship holds true in practice. Her results suggest a strong correlation between income, life expectancy and behavior change. Individuals with higher incomes and longer expected future life spans are more likely to respond to HIV risk by lowering their number of sexual partners. This alone goes a long way to explain the difference in behavioral response between Africa and the United States.

Oster also analyzed the effect of mortality risk on behavioral response, in a novel way. She compared regions in Africa with high malaria rates and low malaria rates. In areas with high rates of malaria, people already face a high risk of death from malaria. She argued that they would have little incentive to change their sexual behavior. This is exactly what she observed in the data; individuals who live in areas with high malaria prevalence have a lower behavioral response to HIV.

To evaluate the effect of different policy responses to the HIV epidemic, Oster developed a simulation model to track how the epidemic and sexual behavior evolve over time. Oster found that behavioral changes made little difference in the magnitude of HIV rates predicted by the model.

What are the policy implications? The implication of Oster's study is devastating for the ABC Plan for Africa. It simply would not work. However, a reduction in malaria risk, while completely unrelated to HIV risk, would have a big impact. We know that the reduction of malaria risk is inexpensive. Thus, money spent on preventing malaria, paradoxically, is a cost-effective way of reducing HIV risk.

4.6.4 An Economic Explanation of Why Ugandan Results Differ

It is well-known that migration, travel and trade are prime drivers of epidemics from one place to another. For example, in Chap. 1 we saw how air travel can affect the spread of infectious diseases like SARS and how trade routes and people movement converted the Spanish Flu of 1918 into a worldwide pandemic. McNeill (1976) noted how renewed trade networks spread the Black Death in the Middle Ages. He argued that the spread of Black Death was facilitated by the Mongol hordes in Asia. The turning point of the spread in Europe took place in 1291, when a Genoese admiral opened the Strait of Gibraltar to Christian shipping for the first time, by defeating the Moroccan forces. New shipping lines not only brought in goods faster; they also brought the plague to the rest of Europe. Thus, it is logical to see the spread of HIV/AIDS as a consequence of rising trade. That the geographical locations of trade routes have something to do with HIV/AIDS has been known for some time.

Klitsch (1992) was the first to note that, in Uganda, trade routes have had a clear relationship with HIV. He estimated that 62% of men and 30% of women in the main road trading centers had more than two sexual partners in the previous 5 years. Men were more likely to be seropositive if they lived in trading centers or villages. Compared with the rest of the population, men had three to five times more risk of being seropositive. Given the evidence, Klitsch deduced that "HIV transmission follows trade routes, and is probably linked to commercial sex. Rural trading villages may spread HIV to more rural villages."

Steinbrook (2007) examined the past evidence in India, and concluded, "India has perhaps five million truck drivers. About half drive long-distance routes that keep them away from home for a month or more; often they have a young male helper. Truckers are more likely than other men to be clients of sex workers, and sex work is common along major truck routes. The Golden Quadrilateral, an express highway that links India's four largest cities – New Delhi, Mumbai, Chennai, and Kolkata – traverses many areas where the rate of sexual transmission of HIV is high."

Okware (2007) noted that all the sites in Uganda that had showed a clearly declining trend in HIV/AIDS began to show a rise between 2003 and 2005 (see Fig. 4.17). Why did the prevalence in Uganda decline during 1993–2001 and why did it rise after that? Oster (2007b) found evidence that a large portion of such

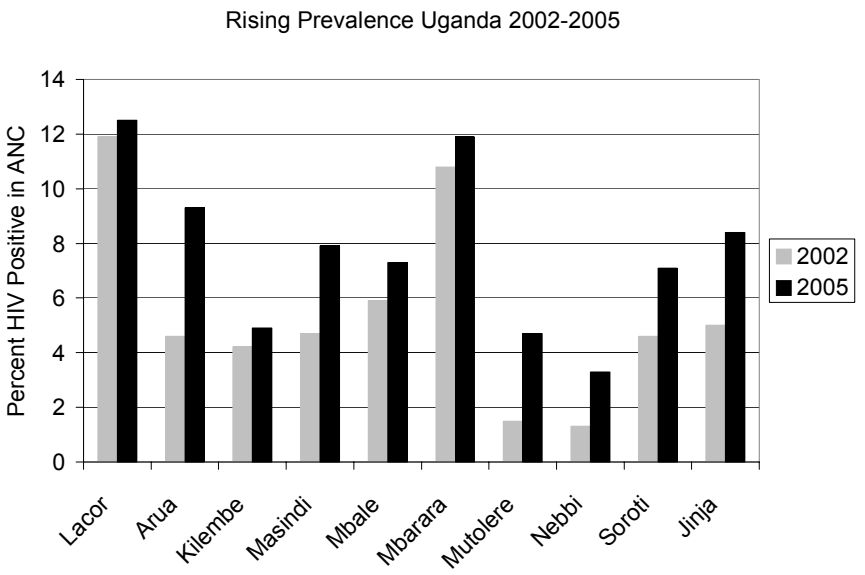

Fig. 4.17 Reversal of fortune in Uganda. *Source*: Okware (2007)

changes can be explained by changes in exports. This research confirmed the relationship between trade and the propagation of HIV that had been observed by other researchers, like Klitsch and Steinbrook.

Oster (2007b) wanted to relate new infections (incidence of HIV) with changing export values. Unfortunately, the incidence of HIV is rarely recorded in developing countries. If a person discovers that she has HIV in 1990, this does not mean she contracted it that year. Oster devised an indirect method. She argued that, given that contracting HIV in Africa was virtually a death sentence in Africa in the 1980s and in the 1990s, she could estimate the incidence by examining the excess mortality for different age groups in a given country by comparing it with a similar country that had not been affected by HIV/AIDS. She illustrates the theory behind the methodology in Fig. 4.18, which shows death rates for Egypt over the 1990s and Botswana in 2001 for different age groups. She argues that the pattern of death rates over the life cycle for Egypt is similar to Botswana, as expected for a country in its income level. Specifically, mortality is high in infancy and childhood, then low through the age of 40 and increasing after that – the typical U-shape we expect. In contrast, the pattern for Botswana produces a W shape, signaling significant AIDS mortality. Although death rates are similar to Egypt up to age 19, they are much higher after that, until late adulthood. This mortality pattern clearly reflects AIDS deaths, as virtually no other disease had this mortality path over the life cycle during the period of study. Thus, unlike the researchers who have been

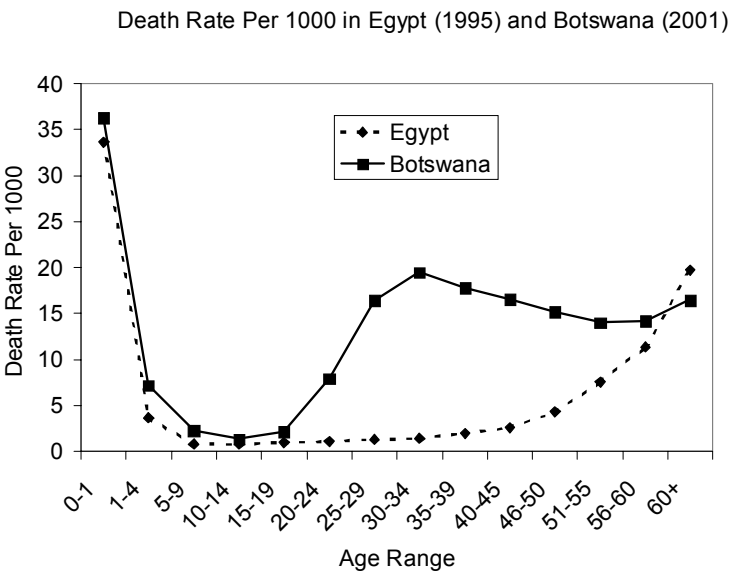

Fig. 4.18 Mortality rates Botswana versus Egypt. *Source*: Oster (2007b)

interested in the effect of HIV on mortality patterns, Oster is working the impact in reverse. By examining the mortality pattern, she reveals the HIV incidence.

There is one more adjustment to be made. Since HIV/AIDS death does not occur immediately after contracting the virus, Oster had to calculate the distribution of the time lag between the infection and the death. She uses mortality data for a number of years in a simultaneous equation framework with smoothing restrictions, and allows for a realistic path of death from the epidemic. She also makes a novel use of sibling mortality histories in the Demographic and Health Surveys to show that her estimates from the mortality calculated from the simulated tables seem to be a good match to actual mortality rates in areas where both are available.

Using this method, she recalculated the incidence and the corresponding prevalence in Oster (2006). In that paper, she correctly anticipated the overestimated HIV/AIDS prevalence that the UNAIDS acknowledged a year later (see Chap. 3 for a fuller discussion of this issue).

Oster (2007b) proceeds to build a model of the HIV epidemic, making explicit how HIV and economic activity may be linked. For the model, she notes: "The model builds on three observations. First, truck drivers and other migrants (i.e., those who spend time living or traveling away from home) tend to have more sexual partners than the average person. Second, the sexual partnerships these people have away from home tend to be higher risk than those they have at home, largely because their partners are more likely to be infected: for example, [they] are more

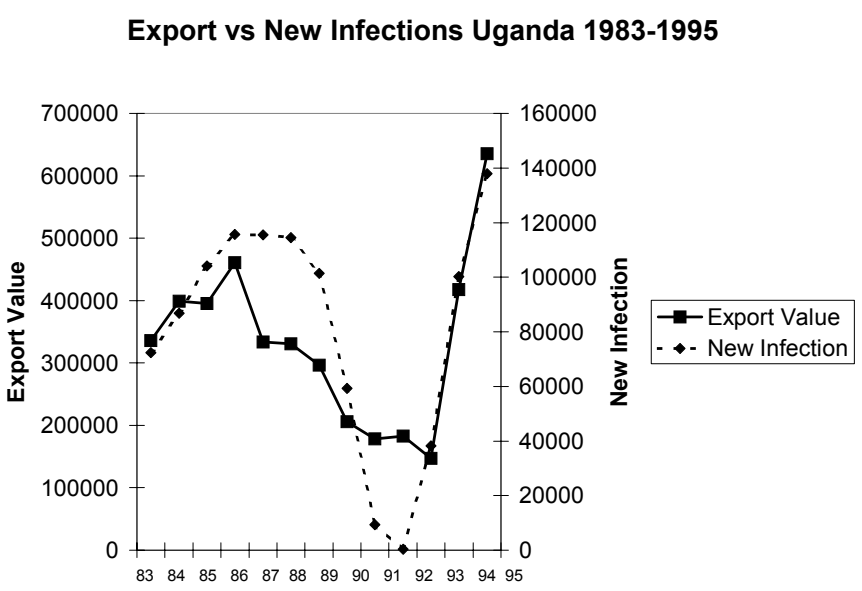

Fig. 4.19 Exports versus HIV incidence for Uganda. *Source*: Oster (2007b)

likely to be bar girls or commercial sex workers. Third, the partners (for the most part, wives) of those who travel may be more likely to have additional sexual partners while their spouses are away. These observations suggest that in times when there are more people traveling, there may be more HIV infections; that link is formalized in the model here. I begin by describing the model setup and then discussing the predictions. At the end of this section I provide evidence for the other necessary link here namely, a positive relationship between economic activity (exports) and the share traveling away from home. In addition to generating an overall connection between HIV and exports, the model also makes additional predictions about how this relationship should vary across groups and initial conditions."

She then applies the model to export data from Uganda. Ugandan exports are very closely tied to coffee. It was the principal export of Uganda in the 1980s and the 1990s. What she finds is a remarkable relation between exports and incidence for Uganda, illustrated in Fig. 4.19. In addition to Uganda, she applies the same methodology for Burkina Faso, Cameroon, Kenya, Malawi, Mali, Zambia and Zimbabwe. The results hold up for all countries, in varying degrees.

Oster (2007b) also notes the policy implications: "This result on Uganda has obvious, potentially important, policy implications. The connection between exports

and HIV in general also suggests specific avenues of HIV prevention. In particular, the implication that truckers and other migrants is a very important driver of the overall epidemic supports targeting prevention activities at that group (similar to the targeting done of prostitutes in Thailand). In addition, if increases in economic activity make the HIV epidemic worse, it suggests that aid groups aiming to increase growth should do so in collaboration with those seeking to decrease HIV."

Oster's research (2006, 2007a, b) shows that economics plays a significant role in the propagation of HIV/AIDS in high incidence countries. Thus, policies based on simple epidemiological models may fall short of desired effects if we ignore the economics of HIV/AIDS.

4.7 The Cost of Scaling Up Prevention and Treatment in Developing Countries

Many researchers are concerned with how much it would cost to scale up prevention and treatment programs. For example, Stover et al. (2006) estimate that if an investment of USD 122 billion is made before 2015, in 125 low- and middle-income countries, targeted at sexual transmission and transmission among injection drug users, it would avert 28 million new infections. They estimate the cost at about USD 3900 to prevent each new infection, but that this would save USD 4700 in foregone treatment and care costs per person, thus justifying the cost.

Similarly, interventions in other forms have been investigated. The World Bank (2006) provided a comparison of various types of interventions. We report this in Table 4.6. It gives us a unique perspective on different types of interventions. For example, we find that by far the most cost effective interventions are achieved through sex workers and the management of sexually transmitted infections. Given our discussions about how trade routes and sex workers provided a potent combination for expanding the disease and that there is high correlation between different sexually transmitted diseases and HIV/AIDS, these results should not be surprising. Surprisingly, mother-to-child transmission intervention turns out to be very expensive in India. This is not a universal finding (see Chap. 9).

Data from India also provides another insight into the cost effectiveness of the scale of operation of HIV/AIDS projects. A study by Guinness et al. (2007) examines data from HIV/AIDS projects targeted at commercial sex workers in Andhra Pradesh and Tamil Nadu – two large southern states of India – during the financial year 2001–2002. Figure 4.20 illustrates their findings. It shows that costs go up as the coverage increases. The analysis of the data suggests a point of minimum efficient scale. This scale of operation is achieved when 1,500–2,000 persons are covered by the operation.

Table 4.6 Summary of cost-effectiveness analysis of HIV/AIDS program in India

	HIV infections averted after 5 years in millions	Infant HIV averted after 5 years	Program cost over 5 years in millions of dollars	Cost per HIV infection averted	Cost per DALY saved
Sex worker intervention	5.6	160,000	$298	$53	$2.66
STI management	3.2	90,000	$780	$47	$2.35
VCTC	3.5	110,000	$782	$199	$9.96
High risk men	5.6	160,000	$1,887	$308	$15.42
Youth interventions	3.5	110,000	$5,203	$1,324	$66.20
MCTC	0.3	350,000	$898	$2,568	$128.40

Source: World Bank (2006). *Notes*: *DALY* disability adjusted life years; *STI* sexually transmitted infections; *VCTC* voluntary counseling and testing center; *MCTC* mother to child transmission

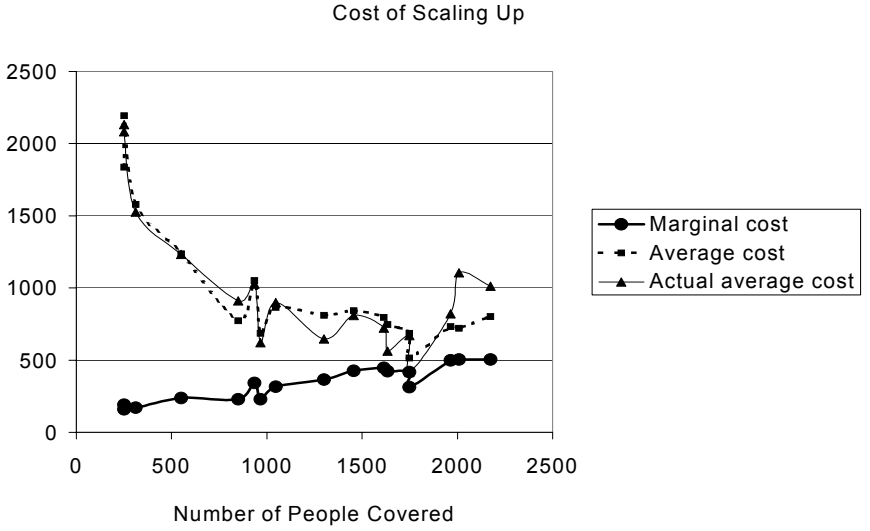

Fig. 4.20 Marginal and average cost of HIV/AIDS programs. *Source*: Guinness et al. (2007)

The findings from this study have clear policy implications for the planned scaling up of HIV/AIDS programs around the world. If prevention and treatment are to be scaled up, what should be the optimum size for each center? This study provides an idea. However, as the authors note, the findings are far from universal. Andhra Pradesh and Tamil Nadu show substantial differences. Thus, we would need to apply the results of this research with caution for other regions and other countries (Hellinger 1998).

4.8 Economic Tradeoffs

Economics is full of tradeoffs. Consider the simple case of a flat rate tax on individual incomes. A government might think of it as an endless source of revenue. If expenditure falls short of revenue, all it has to do is to increase the tax rate. Unfortunately, there is a tradeoff. The higher the rate, the higher is the incentive to hide the income or to hive it off to a low tax regime country. Thus, beyond a certain rate, the revenue will not rise any further. Here we will consider two such tradeoffs. One is a tradeoff between the influx of foreign money to fight HIV/AIDS against the destabilizing effect on the exchange rate. The other is the tradeoff between using each marginal dollar to combat one disease or another.

4.8.1 The Zambian Dilemma

In this subsection, we will follow McPherson (2007) to illustrate the problem using the example of Zambia. Zambia has a high-prevalence, generalized HIV/AIDS epidemic. In 2006, Zambia's population was 11.5 million and growing at the rate of 2.2% per year. The HIV prevalence rate among adults 15–49 years was 17%, an estimated 98,000 people died of AIDS, the number of children and adults (0–49 years) living with HIV was around 1.1 million and the number of AIDS orphans was estimated to be 710,000. Forty-six percent of the population was aged 0–15 years. The GDP of Zambia was USD 6.93 billion making the average per capita income around USD 600 in current dollars or USD 900 when adjusted for purchasing power parity. The income was not evenly distributed, so 64% of Zambians had expenditures below the USD 1 per day. At 46% of the total population, there are over 5 million children in Zambia. Of them, suppose there are 1 million children affected by HIV/AIDS. Then, USD 1 billion would be required to meet the welfare needs of children affected by HIV/AIDS. This would be equivalent to 14% of Zambia's GDP or 17% of total (public and private) consumption expenditure, 54% of total government expenditure, 48% of total imports of goods and services and 309% of international grants provided to the government. And this is not a one-time expenditure. Presumably an equal amount has to be spent every year.

The inflow of such a large amount of money, even if it came from foreign sources, would have a series of unwelcome side effects. First, inflation would likely rise. With the economy currently incapable of efficiently absorbing existing flows of foreign assistance and the government budget in deficit, any additional expenditure would add to the money supply, boosting the rate of inflation. Second, the balance of payments would deteriorate. The large inflows of resources would significantly raise the real value of the local currency. That would contribute to low economic growth, increasing international debt, accelerating imports and lowering exports. Third, the additional expenditures would crowd out private sector investment. It would raise the wages of the skilled professionals such as teachers, nurses,

managers, administrators and child care specialists. This would feed into general labor input cost in the long run, making the private sector less competitive. Fourth, the economy would become significantly more dependent on aid and remain that way for the indefinite future. Thus, even when foreign aid is available to confront the issue of AIDS orphans, it is not an unmitigated blessing.

4.8.2 The Tradeoff Among Competing Needs

Any country has competing needs for money. For developing countries, the competition among needs is even more acute. Many needs are life and death issues for many citizens. Economists have developed the concept of biggest effect for the marginal dollar. The concept is simple. Suppose we have one extra dollar to spend on the welfare of the population. Which program should get it? If we assume that the lives of all citizens are equally valuable, then the marginal dollar should be spent where it saves the most lives.

Let us we examine the proposal of Stover et al. (2006) to invest in prevention programs targeted at sexual transmission and transmission among injection drug users, in order to avert 28 million new infections. Each additional life saved through HIV/AIDS prevention would cost USD 3,900. Compare that with the WHO (2005) proposal of extending maternal and newborn health coverage to 95% of the poorest countries in the world. The total 10-year cost of implementing this proposal is estimated at USD 39 billion. The number of lives saved would exceed 100 million. Thus, the cost of each life saved is USD 390 – about one-tenth of the cost of the life saved in the Stover et al., proposal. Bryce et al. (2005) come up with a different proposal for saving the lives of children. They estimate that USD 5.1 billion in new resources annually would save 6 million children's lives in the 42 countries responsible for 90% of child deaths in 2000. The average cost per child's life saved would be USD 887.

The question that arises is whether we can justify singling out HIV/AIDS for increased funding when the lives could be saved in other programs in a much more inexpensive fashion. Even among the different programs for HIV/AIDS, there are competing needs. Should the money be spent on mother-to-child transmission or should it be spent on needle exchange? Should money be targeted to sex workers or should it be targeted to men who have sex with men? Halperin (2007) has raised this issue (along with many other economists at earlier times).

There are a number of justifications for spending money on HIV/AIDS (and other infectious diseases). First, the reason for spending more on HIV/AIDS is the nature of the disease: it is infectious. Thus, prevention of the disease implies much more than just saving the life of that one person. In economic terms, such diseases have negative externalities. It is precisely for this reason that cholera, tuberculosis and other infectious diseases are a public health problem, not just another disease that affects people. Second, prevention through targeted groups (such as sex

workers or truckers) is extremely cost effective, as they provide the largest conduit for disease propagation among other groups of people. Third, many targeted programs for HIV/AIDS do not simply go into the prevention and treatment of HIV/AIDS alone. The money is spent on general health care. One good example is the MAP program of the World Bank (which is discussed in Chap. 7).

4.9 The Economics of SARS

Severe acute respiratory syndrome (SARS) provides a glimpse into a set of policy responses from policymakers in the developed world. It jolted them to take many unprecedented steps, after an initial lack of response. SARS emerged in southern China in November 2002. It spread rapidly along international air routes in early 2003, as far away as Canada. Asian countries had the most cases (7,782) and deaths (729). SARS challenged Asian health care systems, disrupted Asian economies and tested the effectiveness of the International Health Regulations of the World Health Organization (WHO) (also see our analysis of the International Health Regulations in Chap. 8). Worldwide, there were 8,437 people infected and 813 deaths. Outside Asia, the country most affected by SARS was Canada. There were 250 infected people in Canada, resulting in 38 deaths.

The WHO implemented extensive actions to respond to SARS. Its response was delayed by an initial lack of cooperation from officials in China. The WHO activated its global infectious disease network. It deployed public health specialists to affected areas in Asia to provide technical assistance. The WHO also established international teams to identify the cause of SARS and to provide guidance for managing the outbreak. Its ability to respond to SARS in Asia was limited by its authority under the existing International Health Regulations.

Asian governments initially struggled to recognize the SARS emergency and to organize an appropriate response. They ultimately established control once the very negative economic impact SARS produced became clear. Their initial response was hindered by a number of problems: (1) poor communication; (2) ineffective leadership; (3) inadequate disease surveillance systems; and (4) insufficient public health capacity. Improved screening, rapid isolation of suspected cases, enhanced hospital infection control, and quarantine of close contacts ultimately helped to end the outbreak. The SARS outbreak added impetus to the process of revising the International Health Regulations. The WHO and its member states have since expanded the scope of required disease reporting to include all public health emergencies of international concern and devised a system for better cooperation with the WHO and other countries. It has also set up an emergency response system.

The SARS crisis temporarily dampened consumer confidence in Asia, costing Asian economies USD 11–18 billion. SARS had significant, but temporary, negative impacts on a variety of economic activities, especially travel, tourism and manufacturing.

The estimated impact of the short term effects of SARS can be split into three broad categories: the demand side effect, the effect of rising cost and the country risk effect. Lee and McKibbin (2003) estimated the impact. Their model is a general equilibrium model that has the virtue of taking into account compensatory effects. For example, if tourists shun Hong Kong as the preferred destination, they might go to Maldives, thereby compensating one country's loss by another country's gain. Not surprisingly, Hong Kong suffered the biggest loss (Table 4.7).

Table 4.7 Temporary shock of SARS as a percentage of GDP

	Total effects	Demand shift	Cost rise	Country risk
United States	–0.07	–0.01	–0.06	0.00
Japan	–0.07	–0.01	–0.06	0.00
Australia	–0.07	0.00	–0.06	0.00
New Zealand	–0.08	0.01	–0.08	0.00
Indonesia	–0.08	0.01	–0.09	0.00
Malaysia	–0.15	0.01	–0.16	0.00
Philippines	–0.10	0.04	–0.14	0.00
Singapore	–0.47	–0.02	–0.45	0.00
Thailand	–0.15	0.00	–0.15	0.00
China	–1.05	–0.37	–0.34	–0.33
India	–0.04	0.00	–0.04	0.00
Taiwan	–0.49	–0.07	–0.41	–0.01
Korea	–0.10	–0.02	–0.08	0.00
Hong Kong	–2.63	–0.06	–2.37	–0.20
OECD	–0.05	0.00	–0.05	0.00
OPEC	–0.07	–0.01	–0.05	0.00
Canada	–0.10	–0.09	–0.01	0.00

Source: G-Cubed (Asia Pacific) Model version 50n. Figures taken from Lee and McKibbin (2003)

There have been a number of single country studies as well. For example, Darby (2003) examines the case of Canada and concludes that Canadian losses amounted to 1.5 billion Canadian dollars or 0.15% of Canadian GDP, with the Toronto area being the hardest hit.

The entire episode of SARS lasted just a few weeks. It did not kill many people. Yet the negative economic impact was sharp and swift. This episode and the subsequent bird flu outbreaks in different parts of the world prompted the Congressional Budget Office to produce a potential impact study. It considered

two scenarios: Mild (where 25% of the population is affected but not seriously ill, with 1.4% fatality) and Severe (where 30% of the population is affected and a third of them are seriously ill, with 2.5% fatality). They estimated that the supply side impact of a potential pandemic on GDP would be about 4.25% in the severe scenario and about 1% in the mild scenario (Congressional Budget Office 2006).

Box 4.1 Contrasting SARS with HIV/AIDS

SARS is a fast-moving disease, like most forms of influenza. The beginning of an epidemic to the end of the cycle lasts 3 months. The method of transmission of SARS is well-known. There are vaccines available to stop it and there are treatments available for persons with SARS. HIV/AIDS, on the other hand, is a slow-moving disease. In most cases, it stays undetected for years. Infected HIV patients stay outwardly healthy for years. Once somebody is infected with HIV, there is no cure. There is no vaccine to protect uninfected persons.

Infection with SARS and other similar diseases results from even minimal physical contact. Thus, with the help of modern transportation and large populations living in close quarters, it can rapidly spread from one corner of the globe to another in a matter of weeks, as the 2003 outbreak showed. Such diseases would take about a month to build up from a few to a thousand cases. Then it would take perhaps 2–4 weeks to spread from Asia to Europe and the Americas. It has been estimated by the UK health authorities that imposing a 90% restriction on air travel would delay the peak of a pandemic wave by only 1–2 weeks. A 99.9% travel restriction might delay a pandemic wave by 2 months. Thus, for SARS and similar diseases, travel restrictions would do very little to stop the spread of disease.

HIV propagation is slow. It has taken decades for the disease to spread from Western Africa to the rest of the world. This may suggest that it would be easy to stop its propagation. However, given the time it takes for people infected with HIV to show signs of full-blown AIDS, it is still difficult to stop HIV propagation through travel restrictions. For people moving legally from one country to another temporarily, for tourism or other purposes, it is all but impossible to detect an HIV-positive person without running a medical test (using either saliva or blood). It is still prohibitively expensive to run such tests for every single traveler with a sufficient degree of accuracy of the test to make it universal for all travelers. Thus, for all practical purposes, travel restrictions do not work. Of course, this has not stopped many countries from imposing legal barriers on travel and migration (see Chap. 9). Moreover, such restrictions are completely ineffective in the case illegal migration. Today, more than half of global migration takes place illegally.

4.10 Implications for Other Global Diseases

There is evidence that the substantial difference in the transmission rates between the United States and sub-Saharan Africa are due to untreated bacterial sexually transmitted infections. One implication of this evidence is that expanding treatment of other sexually transmitted infections may prove to be a cost effective way to reduce the incidence of HIV/AIDS. Another implication is that lower levels of economic development are not necessarily the root cause of higher rates of HIV/AIDS prevalence or vice versa. Poverty reduction is too broad a goal to constitute what might be termed an HIV/AIDS prevention strategy. Moreover, there is no clear evidence that reducing poverty and income inequality will necessarily reduce HIV/AIDS prevalence. These findings point to the importance of understanding reasons for differences in disease prevalence rates in order to ensure specific and cost effective interventions, a conclusion that applies equally to other diseases and pandemics.

It is difficult to predict the impact of HIV/AIDS on economic development. Since HIV/AIDS strikes the population at a productive age, it may reduce the labor force more than the entire population, and the labor participation rate would fall. However, a decline in the supply of labor would lead to a rise in capital per labor unit in the short run. Nevertheless, in the long run, the supply of capital may fall if rising HIV/AIDS leads to less saving and investment. In addition, falling life expectancy and rising mortality due to HIV/AIDS may lead to lower future economic growth. HIV/AIDS destroys human capital and reduces that transmission of human capital between generations, leading to declining levels of education. The slow-moving nature of HIV/AIDS produces higher costs of treatment and palliative care than epidemics that kill quickly. These additional costs can decrease GDP growth by reducing savings and investment. On the individual level, HIV/AIDS can reduce income and increase costs. However, it is difficult to determine the impact of HIV/AIDS on all macroeconomic variables. As a result, the impact of HIV/AIDS on overall economic welfare, in the form of changes to GDP, remains unclear. Since HIV/AIDS is a slow-moving epidemic, its economic impact will not likely be the same as for fast-moving epidemics.

Microeconomic and epidemiological models for Uganda show that promoting sexual abstinence before marriage and monogamy are less effective HIV/AIDS prevention strategies than condom promotion. Moreover, behavioral responses to HIV/AIDS risk depend on life expectancy. Reducing the risk of death from malaria would be a more effective strategy to increase incentives to change sexual behavior to reduce HIV risk. This finding demonstrates the importance of scientific investigation into the effectiveness of behavioral change strategies and is relevant to the issue of inducing behavioral change to minimize the impact of other diseases and pandemics.

Evidence from Uganda regarding the connection between exports and HIV suggest that targeting prevention at vulnerable groups, notably truckers, would be an effective strategy in generalized HIV epidemics. In addition, if increases in economic activity make the HIV epidemic worse, economic growth strategies need to incorporate HIV prevention strategies. In Chap. 1, we noted the impact of trade and people movement on the propagation of fast-moving epidemics. This highlights the importance of incorporating disease prevention in economic growth strategies in the case of other diseases and pandemics as well. However, as we will see in Chaps. 8 and 9, the need to prevent the spread of infectious diseases must be balanced against the economic importance of trade and people movement and must respect human rights as far as possible.

Another economic issue raised by HIV/AIDS is the side-effect of large increases in foreign aid to combat HIV/AIDS in high-prevalence, low-income countries. Where foreign aid increases the money supply, inflation may rise and the balance of payments may deteriorate. Large inflows of resources could significantly raise the real value of the local currency, thereby producing low economic growth, increased international debt, higher imports and lower exports. Additional expenditures would raise the wages of skilled professionals, making the private sector less competitive in the long run. The economy would become significantly more dependent on aid and remain that way for the indefinite future. Thus, foreign aid is not an unmitigated blessing. These findings apply equally to foreign aid that is targeted at other diseases and pandemics.

Another question is whether we can justify singling out HIV/AIDS for increased funding when lives could be saved in other, less expensive programs. There are a number of justifications for spending money on HIV/AIDS (and other infectious diseases). First, since HIV/AIDS is infectious, HIV prevention saves more than the life of the person who avoids HIV infection. Second, prevention targeted at vulnerable groups is a cost effective means to reduce disease propagation among the general population. Third, where HIV/AIDS funding is spent to strengthen general health care systems, the benefits are not limited to HIV/AIDS alone.

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