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Does a Mature AIDS Epidemic Threaten Growth?

by

José Cuesta

Inter-American Development Bank

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Abstract

This paper models the impact on economic growth of HIV/AIDS when the epidemic is in a mature phase, in contrast with previous studies focused on periods of expansion, as in African countries. Simulations for Honduras, the epicenter of the epidemic in Central America, show that AIDS is not likely to threaten economic growth through either labor or capital accumulation channels; impacts are estimated between 0.007 and 0.27 percent points of GDP growth annually for the period 2001-10. Likewise, increasing spending on prevention, public treatment subsidies and treatment access will not jeopardize economic growth prospects. Critical factors that slash economic growth in Africa (such as human capital reductions and shifts in relative skills) are not strong in Honduras.

Key Words: HIV/AIDS, Growth Models, Policy Simulations, Prevention, Honduras.

JEL Classification: O4 Economic Growth and Aggregate Productivity; J1 Demographic Economics; I1 Health.

1. Introduction

Sustained and rapid economic growth is the backbone of the proposed strategies for development and poverty reduction in Honduras. The Government of Honduras (2001) estimates that annual growth rates of 4.5 to 5 percent, sustained over the next 15, years would be necessary to reduce substantially the current levels of household poverty (by 24 percentage points from an estimated 2002 level of 63.9 percent). In this context, HIV/AIDS is increasingly portrayed as transcending personal and social boundaries to constitute a threat to economic growth and welfare (Ministry of Health, 2001; UNAIDS and WHO, 2000a). In other parts of the world, where the epidemic hits hardest, its accumulated impact has been estimated as a dismal reduction of 25 percent of GDP (Cuddington, 1993a) and reductions in the annual growth rate of GDP of half a percentage point (Ainsworth and Over, 1994). In the Middle East and North Africa, more recent estimates by Jenkins and Robalino (2003) report dents in the annual growth rates between 0.2 and 1.5 percent, which implies a reduction of 35 percent of current GDP for the period 2002-2025. Even though HIV rates in Honduras are a long way behind those of the most notorious Sub-Saharan countries—2 percent of adults in the former as compared to 30 percent in the latter (UNAIDS and WHO, 2003)—the country is the epicenter of the disease in Central America.

Honduras poses an interesting case of analysis. Much of the impact of HIV/AIDS on economic growth in Africa and the Middle East comes from shifts in the relative composition of skills and sizable reductions in human capital accumulation; see Haacker (2002), Masha (2004) or Salinas and Haacker (2006) for recent reviews. The epidemic may not lead to such results in Honduras. In contrast to other countries where the infection is in an expansion phase, in Honduras strong population growth still takes place, and new entrants may well replace low-skilled individuals dying of AIDS, among whom the epidemic disproportionately concentrates.[1] Second, the epidemic is in a mature phase, with expected reductions in prevalence after the current period of stabilization. Both considerations would imply that the epidemic might not have brought about substantial shifts in the composition of skills. Nonetheless, there are still other factors associated with the epidemic that can affect economic growth rates. Among those, both the reduction in the ability of high-skill individuals to save out of incomes net of

[1] According to UNDP 2003 the growth of new entrants in the labour market averaged 4.7 percent per year during the 1990s, with an average of 5 percent between 1994 and 1997 when the epidemic was at its peak; many of those were low-skilled entrants. Employment growth increased by 4.9 percent in the same period, suggesting that the labor market was just able to absorb all new entrants.

HIV/AIDS-related spending[2] and the deterioration of human capital may also affect economic growth. The magnitude of such effects, however, remains an empirical question.

This paper first analyzes the extent to which HIV/AIDS constitutes a real threat to future economic growth in Honduras. Section 2 presents specific facts on the epidemic in Honduras. Next, the growth model of Cuddington (1993a) is extended to link *annual* variation rates of HIV/AIDS with *annual* economic growth rates. This methodology differs from previous studies in that it analyzes year-by-year impacts[3] along a more realistic epidemic-ridden counterfactual instead of a no-AIDS equilibrium scenario. Also, the model disaggregates the effects on economic growth resulting from impacts of AIDS channeled through labor and capital accumulation.[4] Even though our model constitutes a basic neoclassical one-sector model, its ability to capture multiple transmission channels of the epidemic to economic growth makes it relevant, and most recent studies likewise still build upon the neoclassical one-sector model, with some degree of variation. Attempts to deviate from this basic model by constructing multiple sectors or following an econometric approach are either burdened by astonishingly bold assumptions[5] or are reported to provide weak and inconclusive evidence, as convincingly argued by Haacker (2002).

Section 4 estimates such impacts and simulates the growth effects of changes in preventive interventions (awareness campaigns) and treatment interventions (equal access, reduction of treatment costs and increased public subsiding of treatment). Even though the literature has also analyzed the impact of other policies (such as use of condoms or HIV tests, as

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[2] Another dimension of the relationship between skills and HIV/AIDS is the impact of education on the spread of the disease. Over (1998) and World Bank (2002) argue that reducing the male-female educational gap is a critical intervention to curtail the transmission of the epidemic around the world. Interestingly. Brent (2006) questions that conclusion: he does not find that eliminating the education gap will slow down the spread of HIV/AIDS for a sample of 31 Sub-Saharan African countries. He suggests that income and religion both determine much of the impact of education on the prevention of HIV/AIDS. Although this issue is not explicitly explored in the paper, our simulations take into consideration educational gaps between socioeconomic groups.

[3] From a purely epidemiological viewpoint, Brent (2006) argues that it is the new cases each year rather than the number of cumulative infections that becomes more useful in monitoring the effectiveness of particular interventions against HIV/AIDS.

[4] Typically, the effects of AIDS on economic growth have been analyzed through several channels: size of labor force, labor force productivity, capital accumulation and health spending. See Jenkins and Robalino (2003) for a concise review of these channels and others that are less frequently analyzed (such as fiscal balances or the public wage bill).

[5] Among such assumptions, populations are modelled as unable to age as in Salinas and Haacker (2006), or the epidemic is modelled to affect productivity by some pre-determined quadratic equation used across different countries as reported in Haacker (2002).

in Jenkins and Robalino, 2003) data on such behaviors are not available in Honduras.[6] Conclusions bring this paper to an end, finding that labor effects dominate capital effects, although the latter are not negligible. In addition, preventive policies may lead to not only greater epidemiological benefits than treatment interventions (World Bank, 1997), but also slightly larger economic growth gains.

2. The HIV/AIDS Epidemic in Honduras

The epidemic began in Sub-Saharan Africa, and its incidence there well exceeds infection rates elsewhere (UNAIDS and WHO, 2000b). In 2000, the average adult HIV incidence of 8.8 percent in Sub-Saharan Africa clearly exceeded Caribbean averages of 2.3 percent, North American, South and South-East Asian and Latin American averages between 0.5 percent and 0.6 percent, and a 0.35 percent average for the rest of the world. In Honduras, HIV rates stand at approximately 2 percent (with concentrations of 8-10 percent among higher-risk populations of commercial sex workers, prisoners and men who have had sex with men), much below rates in Sub-Saharan Africa. Still, Honduras accounts for 60 percent of all reported cases in Central America (Global Fund, 2003). The epidemic has also gone through a *feminization* process in the country. Gender ratios have declined from six males infected with the virus per infected female in the early 1980s to 1.2 in 2000,[7] and AIDS has become the single most important cause of death among fertile-aged women (UNAIDS and WHO, 2000a). In contrast with South America, North America and Europe, where homosexual transmission predominates, the epidemic is transmitted mainly through heterosexual sex in Honduras, accounting for 83 percent of all registered cases in 2000 (Ministry of Health, 2001). According to the Global Fund (2003) AIDS disproportionately affects prime working age population (80 percent) and high-risk groups such as sex workers and Afro-descendants on the Northern Coast.

There are also large geographical differences in the incidence of the epidemic. San Pedro Sula, the most industrialized city in the country and a traditional stopover for migrants heading to the United States, reports the highest rates in the country. In that city the incidence of HIV exceeds 3 percent of the adult population, which is comparable with rates in high-incidence

[6] For example, the last available information reported by UNAIDS (checked on line June 14, 2007) reports that the percentage of youths aged 15-24 who used a condom last time they had sex with a casual partner is unknown. www.unaids.org/em/Regions_Countries/honduras.asp

[7] Sub-Saharan African women are 1.2 times more likely to be infected than men, as reported by Brent (2006).

Caribbean countries such as Bahamas, Bermudas, or the Dominican Republic. Nevertheless, the dynamics of the epidemic in Honduras differ from Caribbean trends. Official projections indicate that the epidemic reached in Honduras a *plateau* in the mid-1990s, while projections for Caribbean countries in Nicholls et al. (2000) show rising HIV rates that are expected to reach peaks of between 5 percent and 8 percent of the adult population.

Although official figures in Honduras are suspected of underestimation, such suspicions are not supported by reliable evidence. Officially, the Ministry of Health (2003) recognizes 15,717 sero-positive persons between 1985 and 2003 (as the latest available figures). UNAIDS corrects these figures and reports, instead, a disappointingly imprecise estimate of infected cases between 35,000 and 99,000; unfortunately, the sources of these data remain unclear. Ministry of Health (2001) official figures show that the incidence of AIDS reached a peak in 1991 in San Pedro Sula and in 1996 for the rest of the country. Thereafter, the epidemic stabilized at levels of 0.50 percent in San Pedro Sula and 0.10 percent in the rest of the country. Figure 1 shows these trends. Interestingly, the evolution of the epidemic depicted by official data in Honduras is reassuringly in line with estimates in Sub-Saharan Africa (see Brent, 2006), suggesting a turning point in incidence between 15 and 17 years after the first case is observed.

Although there is no direct information on AIDS rates by education or skill categories, there exists some information by occupation. By matching higher education with certain occupations (such as doctors, for instance), the high-skill category was assigned a share of 28.6 percent of the total cases of AIDS. Differences in productivity and concentration of incomes according to skill categories were obtained by estimating decade averages from household income surveys. As a result, high-skill workers are found 3.3 times more productive than low-skill workers. Given that these figures reflect the situation through both peak and stable periods of the epidemic, the productivity impact of the epidemic is already internalized in the analysis. This estimate will then be changed in the simulations. Also, low-skill workers and their families account for 66 percent of total incomes.

Decisive policy interventions against HIV/AIDS have not taken place until recently in Honduras. This is in part a reflection of financial constraints, but also of the low priority given to the epidemic in developmental and poverty reduction strategies, despite the reported commitment to halving the epidemic rates by 2015 as part of the Millennium Development Goals initiative. Another reason for the lack of significant policy intervention is official evidence pointing to the mature state of the epidemic; the incidence of HIV/AIDS is expected to decrease in the future. In any case, with the support of the Global Fund a series of prevention and treatment interventions are now in progress in the country (Global Fund, 2003). Prevention mainly consists of campaigns aimed at both the general public and high-risk groups. Recent mass-media campaigns and community outreach activities have targeted youth, male homosexuals and sex workers, promoting behavioral change to prevent HIV transmission. Treatment policies consist of training community health-care workers and physicians in the treatment of HIV and the expansion of antiretroviral treatment to more than 4,000 people living with HIV/AIDS. Improving infrastructure, opening new treatment centers in cities other than Tegucigalpa and San Pedro Sula, and training of legal personnel in human rights law with respect to people living with HIV/AIDS have additionally been identified as treatment priorities, with little progress so far.

Prevention costs amounted to US$7.3 million in 1999, representing 32 percent of total public disbursements related to HIV/AIDS and 5.5 percent of total public health costs in 1999 (Government of Honduras, 2001). Although cost information has not been periodically updated in Honduras, available data are particularly detailed when compared with studies using data for Africa, which typically resort to statistical techniques to deal with the large uncertainty associated with costs and their differences across groups (Masha, 2004, reviews such techniques) or simply "agree" on what is believed to be a reasonable average (see Meyer, Lasser and Reekie, 1994, for the use of such averages in South Africa).

The data available for Honduras suggest that segmented pricing and a high share of private financing suggest inequalities in treatment access. The Ministry of Health (1999, 2001) provides information on treatment costs in eleven public and private hospitals, as well as private costs in a sample of 1,000 HIV/AIDS diagnosed individuals. Differentials in treatment costs between low and high-skill groups can further be inferred from Ministry of Health (1999), which reports marked differences in treatment costs based on the nature of the health center and the socioeconomic background of patients. Annual treatment costs per person averaged US$2,330 in 1999 in a country with per capita income below US$1,000. Daily treatment costs in a private hospital for reportedly middle and high-income groups amounted to US$725, while treatment costs were US$153 for low-income patients in the same hospital; public hospitals averaged a cost of US$148 cost per day in 1999. It should also be noted that retroviral treatment costs amounted to US$24,000 per year, but only 10 percent of all registered patients had access to those treatments.[8] One may reasonably assume that all retroviral patients belonged to affluent groups, as such treatments were not then publicly financed in Honduras. The share of household financing, moreover, was estimated at 55 percent of total treatment costs, leading private financing rates among Central American countries but not greatly exceeding the 50 percent average share across the developing world noted in Squire, 1998). The remaining costs were shared as follows: 16 percent by the government, 28 percent by the international community, and 1 percent by private firms (Ministry of Health, 2001).

3. Modeling the Impact of HIV/AIDS on Economic Growth

Economic growth models introducing HIV/AIDS are widely used to analyze the macroeconomic impact of the epidemic, and one-sector neoclassical growth models were first introduced in the 1990s. (See Cuddington, 1993a, Cuddington and Hancock, 1994, and Cuddington et al., 1994, who were followed by Arndt and Lewis, 2000, Nicholls et al., 2000, Robalino, Voetberg and Picazo, 2002, and Haacker, 2002). Extensions have included the modeling of a dual economy, with formal and informal sectors—as in Over (1992), Cuddington (1993b), and Cuddington and Hancock (1995)—as well as multi-sectoral CGE models such as Kambou et al. (1993), Arndt and Lewis (2001) or, more recently, Wobst and Arndt (2004) and Arndt (2006). Other studies have explored the impact of HIV/AIDS on economic growth using econometric analysis, particularly Bloom and Mahal (1997), Dixon, McDonald and Roberts (2001) or Kumaranayake and Watts (2000). Others still, such as Bell, Brunhs and Gersbach (2006) have even used overlapping generation models to estimate longer-term effects.

One-sector models have sometimes been criticized for assuming full employment (Haacker, 2002). However, they are particularly attractive for their simplicity and flexibility in accounting for skill differences, socioeconomic-specific prevalence rates, savings behavior and infection-related costs. Dual models allow, in principle, for inter-sector mobility but impose strong assumptions on how different skills are able to move between sectors. For instance, the

[8] This figure is staggeringly above the estimates reported elsewhere on the wholesale minimum price for retroviral treatments. In effect, Borrell (2007) reports an average cost of US$ 3,019 for retroviral tablets in Central America in 1999. It is unlikely that hospitalization costs or differences in regulations regarding patents can fully explain the difference in the estimates. For a similar period, Borrell (2007) reports a minimum price of US$ 3,025 for retroviral tablets in Brazil while Assunçao and Carvalho (2006) report a cost of US$9,134 (plus US$ 1,905 for hospitalization costs) in that country.

sensitivity of CGE results to the numerous assumptions required to model the economy are well known. Likewise, econometric analyses tend to be inconclusive given either the short time spans analyzed by time series studies or the limitations of exploring inter-temporal issues—which are critical in examining an epidemic's multiple phases—in cross-sectional studies. As a result, a simple neoclassical model represents an adequate modeling option for the analysis of the epidemic in Honduras, where lack of productivity and underemployment are more salient features of the labor market than high levels of unemployment (see Cuesta and Sánchez, 2004). The one-sector basic model is extended, however, to account for several issues. First, existing one-sector models usually estimate the growth impact as foregone GDP with respect to an epidemic-free equilibrium counterfactual. Studies in this tradition report a reduction of GDP attributable to the epidemic up to 25 percentage points of current GDP in Sub-Saharan Africa (Cuddington, 1993a). The problem with this approach is that reporting the cumulative future impact on current GDP may provide substantial differences depending on what GDP is taken as ba aseline. A cumulative impact of the epidemic estimated for the next 15 years and expressed as 25 percent of today's GDP may well turn into a smaller impact if the same effect is expressed five years later as a proportion of (declining) GDP over the next 10 years. This implies that it may be more appropriate to measure the epidemic's impact on GDP by a gauge that is time-independent of the spans considered, such as impact on annual GDP growth.

Second, macroeconomic growth models have not typically included in their analyses the impact of AIDS-related policy interventions. Exceptions include Cuddington and Hancock (1994), who analyze the use of condoms and coping costs, and Nicholls et al. (2000), who consider the impact of drugs, hospitalization costs and HIV-related tests. Jenkins and Robalino (2003) include in their dual-sector model the analysis of prevalence of condom use and needle sharing. In this line, our model incorporates prevention and treatment costs and shares of public financing of treatments to explore the implications of HIV/AIDS policy options.[9] Also, the proposed model concentrates on the effects on GDP growth caused by *annual* AIDS rates instead of estimating steady-state accumulated impacts or some other notion of long-run equilibrium effects. It is the annual growth rates that matter most when poverty reduction, debt sustainability

[9] A limitation of including such policy options is that the analysis refer to first-round effects and the analysis does not include potential indirect effects such as an endogenous variation of future mortality rates or productivity following successful interventions. As a result, the estimates can be thought of as a floor estimate of potential effects.

and international financing come under fire. This is the case of a HIPC country as Honduras, whose economic growth performance is closely monitored every year under the debt-relief related Poverty Reduction Strategy initiative.

In our model, working-age population is divided into two groups, "low-" and "high-" skill groups. Incomplete primary education (a good predictor for poverty and informal employment in Honduras, as shown in Cuesta and Sánchez, 2004) is used to categorize low-skill individuals. Productivity changes are then estimated as variations in the product per worker for a decade and expressed as a gap between both skill groups' productivity levels. These estimates are obtained from available household surveys on labor that already incorporate the effects of the epidemic instead of arbitrarily assuming them, as previous studies have generally done. In a final modellng step, a highly disaggregated growth equation brings together labor and capital AIDS-related effects with policy interventions.

The aggregated Cobb-Douglas production function in Cuddington (1993a), equation (1), $Y = A\,L_e^{\alpha}\,K^{\beta}$, is first expanded to incorporate low (L) and high (H) skill categories of labor. The extended model also allows for different productivities ($\gamma_H = p\ \gamma_L$, $p>1$), different HIV/AIDS rates ($a_L = r\ a_H$, $r > 1$) and different sizes among human capital groups (n for low-human capital and $1-n$ for high-human capital categories of labor, respectively). Equation (2) shows the expansion of the production function:

$$Y = A[L\gamma_L(p+n(1-p)-a\,n-p\,a\,r(1-n))]^{\alpha}K^{\beta} \qquad (2)$$

The model next specifies a function of aggregated savings where resources used to combat the epidemic cannot be alternatively employed in productive activities. The savings ratio, s; the cost of AIDS treatment per person, c; the epidemic incidence gap between skill groups; r; and total prevention costs P, (which for simplicity are assumed to be exogenous, that is, unrelated to the size of the epidemic) all determine final savings:[10]

$$S = s(Y_{-1} - P - \eta\, c\,(a\,L + r)) \qquad (3)$$

Savings are further specified to incorporate distributive considerations, which are ultimately related to levels of investment. The low-skill group captures a proportion of income,

[10] In Honduras health budgets have been traditionally based on historic trends rather than results-oriented or project-specific accounting.

θ_L, smaller than the high-skill group, θ_H ($\theta_H = g\theta_L$, $g>1$). Similarly, savings rates vary among skill groups, as many studies show for developing countries (see Székely, 1998, and references therein). Thus, savings rates are differentiated for low (s_L) and high (s_H) skill groups. It is safe to assume that savings rates among high-skill individuals exceed those rates among low-skill individuals (that is, $s_H\, \theta_H\, Y = v\, s_L\, \theta_L\, Y$, $v>1$). This distinction in the ability to save is deemed central in our model as it determines investment. This effect via savings capacity is deemed more relevant than investment responses to capital-labor ratio ratios and, ultimately, on rates of return to capital that follow strong demographic effects of AIDS (as pointed out by Haacker, 2002). There appears to be no seamless link between investment behavior and rates of return in distorted capital markets in developing countries (Lucas, 1990), and there likewise do not appear to be substantial skill composition changes or strong demographic variations in Honduras even at the peak of the epidemic (Cuesta and Sánchez ,2004).

HIV/AIDS-affected individuals are also assumed to save out of disposable incomes after financing their medical treatments, if any. Treatment costs are financed both publicly and privately (in proportions of 1-η and η respectively). Contrary to most previous studies, which typically assume equal costs for everyone (see Masha, 2004), our model incorporates substantial differences in treatment costs among socioeconomic groups found in Honduras: $c_H = \phi\, c_L$, $\phi >$ 1, where ϕ is an index of differences in treatment costs. Savings can then be expressed in a highly disaggregated function in which HIV/AIDS-related variables are included:

$$S = [\theta_L (Y_{-1} - P)(g\, s_L + s_H) + (Y_{-1} - P) s_F] - \; c_L a_L \eta\, L(\phi\, s_H r(1-n) + s_L n) \qquad (4)$$

A capital formation function is defined next as a function of domestic savings (with a constant relation captured by k), foreign resources (F), and annual depreciation of existing capital stocks (δ). Previous macroeconomic analyses of HIV/AIDS have ignored the role of foreign flows (Nicholls et al., 2000) or simplistically assumed to be constant (Haacker, 2002). This omission is particularly misleading in Honduras as such flows represent a substantial proportion of GDP (about 12 percent in 2000, excluding remittances). The current aggregate stock of capital can be readily expressed as a function of past stocks, foreign additions of capital, and domestic savings:

$$\Delta K = F + k\, S - \delta\, K \qquad (5)$$

After substituting the savings equation (4) into the capital accumulation equation (5), the capital stock equation (6) incorporates the effects of AIDS through incidence rates (a), prevention costs (P), proportion of public financing (1-η) and differences in treatment costs (ϕ):[11]

$$K=\frac{1}{1+\delta}[(K_{-1}+F+s_F(Y_{-1}-P)\ +\ s_H g\theta_L(Y_{-1}-P)]-\frac{1}{1+\delta}k_h s_H\eta\phi c_L a_L rL(1-n) \qquad (6)$$

Increases in incidence, prevention spending, treatment costs and the share of public financing of the epidemic all have a negative impact on the accumulation of capital stocks. A highly disaggregated growth equation results from substituting (6) into (2). Applying the Chain rule allows to obtain the marginal impact of AIDS rates in GDP growth as:

$$\frac{\partial(\dot{Y}/Y)}{\partial(\dot{a}/a)}=-\alpha[n+pr(1-n)]\frac{\dot{a}}{a}\frac{a}{1-a}\ -\ \beta\frac{1}{K}s_L\eta c_L k_H vr[\phi(1-n)L]\frac{\dot{a}}{a}a \qquad (7)$$

There is an inverse relation governing the impact of AIDS in the economy-wide growth rate both through labor (left-hand side summand) and capital accumulation (right-hand side summand). Increases in AIDS incidence rates (a) and in their difference between groups (r); in the share of private financing of treatment costs (η); in treatment costs (c_L) and in socioeconomic differences in treatment costs (ϕ) all lead to a decreasing impact of AIDS on economic growth. As most of these variables have a negative impact on capital, K, the overall marginal effect on growth—from both direct and indirect sources—is ambiguous. (See Table 1.)

4. Simulations and Results

4.1. Simulations

Appendix 1 summarizes data sources and average values of the variables used in the analysis. By perturbing an individual variable or parameter and leaving the rest unchanged, successive simulations capture the specific marginal growth effect of such changes (see Table 2). The initial scenario keeps constant the baseline values of the year 2000 over the period 2001-10 ("*baseline*" simulation). Scenarios considered here simulate changes in the initial conditions of

[11] It is safe to assume that in Honduras as elsewhere, investors pertain to the high human capital group (i.e., $k_L=0$).

the epidemic and the economy. Regarding initial conditions, one scenario assumes that the high rates of AIDS currently observed in San Pedro Sula are extended throughout the country ("*high*"). Another scenario eliminates AIDS rate differences by skill group ("*uniform*"). The scenario "*productivity*" halves the productivity gap between low and high-skill groups. A second set of simulations refers to prevention and treatment interventions. The "*half cost*" scenario halves treatment costs across the board, while "*equal access*" simulates an eventual elimination of treatment cost differences by skill categories. In the "*financing*" scenario treatment costs increase up to a level comparable with Central American and Mexican shares. Finally, public prevention costs are reduced substantially in the simulated scenario "*prevention*."

4.2. Results of Simulations

The baseline simulation shows that the projected decline of AIDS rates is expected to have a positive impact on economic growth, although its magnitude is not substantial (0.017 percent points annually over a decade; see Table 3). This contrasts with much larger impacts reported in African countries and the Middle East, where the epidemic is still expanding, and dents on future growth rates reach on average 0.5 percent annually (Jenkins and Robalino, 2003). Interestingly, labor-driven effects of declining AIDS rates dominate capital accumulation effects, although this result is not surprising in a labor-intensive economy such as that of Honduras. The magnitude of impacts can be explained by the fact that AIDS deaths are not widespread as in the case of epidemic-ridden African countries. Besides, low-skill infected workers can be rapidly replaced in a country with strong population growth (2.7 percent annually throughout the 1990s) and a low-quality educational system that is also far from universal (Government of Honduras, 2001). As for high-skill workers, the slowdown in their deaths should allow an increase in savings, and ultimately in growth. Given the different demographics of a maturing epidemic, the usual considerations of labor mobility and substitutability in dual sector models do not apply here as compellingly as for other countries in Africa or the Middle East, where strong modeling assumptions are made on how different skill groups move among sectors (see Haacker 2002).

The demographics of the epidemic in Honduras are nonetheless expected to have ongoing socioeconomic consequences. The slowdown in the epidemic may mean a slight increase of low-skill workers in the economy and with it, their share of incomes, while a lower share of incomes available to high-skill individuals limits their capacity to save, invest, and accumulate capital.

Estimates confirm that the lower income share effect dominates the slowdown of deaths among high-skill individuals.

Estimates of policy interventions show that halving prevention costs and halving current treatment costs would both have the same repercussions for economic growth. Moreover, such impacts would not differ from the baseline. In other words, a dollar spent on prevention has the same positive marginal growth impact as a dollar spent on treatment in a situation where the epidemic is mature and not widespread. This result holds even when indirect effects in the form of decreased mortality rates or increased productivity are not endogenized. Even so, the impact of such policies on capital accumulation is accounted for by both prevention and treatment effects—which are typically not considered, as noted by Masha (2004)—and both are found to be positively related with growth rates. Therefore, if prevention interventions of the same cost as treatment policies have same growth effects and, as documented in the literature, larger epidemiological effects (World Bank, 1997), prevention should be preferred to treatment interventions even in the mature stage of the epidemic in Honduras.

Equalizing unitary treatment costs among skill groups has slightly larger gains in terms of economic growth increases with respect to baseline effects. That would imply that the current segmentation of prices disappears, so treatment costs for high-skill individuals diminish and rise for low-skill individuals. In that scenario, the capital accumulation effect dominates the labor effect, as incomes available for savings after paying for cheaper treatments increase among the high-skill and GDP grows at a faster pace. The exact opposite occurs when public financing decreases, so savings and investments are expected to decline, which would ultimately slow down economic growth. In fact, the estimated growth rate in this scenario is lower than in the baseline. This reflects that in a situation of declining AIDS rates, larger treatment subsidies are not the most adequate policy option for sustaining rapid economic growth.

The reduction of AIDS would provide the largest benefit of all the considered scenarios if the high epidemic rates of San Pedro Sula were extended nation-wide (the "*high*" scenario). On the other hand, reducing differences in terms of productivity and incidence of the epidemic among skill groups would not have a large marginal effect on economic growth. In fact, this impact is estimated to generate lower economic growth gains than in the baseline scenario. This evidence substantiates that any reduction in the capacity to save and in the magnitude of savings by high-skill individuals leads to an economic growth slowdown.

5. Conclusions

The present analysis shows that HIV/AIDS is unlikely to cause devastating effects in the economy of Honduras, as is the case in African countries with daunting rates, because the epidemic in Honduras is far from generalized. High-skill infected workers are only a quarter of all infected workers, and their infection rates are declining. In addition, labor markets readily replace low-skill workers who die of AIDS, as there is no dearth of low-skill new entrants in a country characterized by strong population growth and low-quality education. As a result, simulated changes in initial conditions and policy interventions lead to economic growth rates very similar to baseline economic growth. The epidemic would be expected to have a negative impact on growth, however, by reducing available income for savings in a scenario of equalizing productivity, equalizing treatment costs and increasing private treatment financing shares. Finally, an additional dollar spent on prevention and an additional dollar spent on treatment have the same impact on economic growth. Hence, it is the widely accepted larger epidemiological impact of prevention, rather than effects on economic growth, that makes such interventions desirable in Honduras.

More research needs to be carried out to validate the robustness of these results for Honduras as well as other countries where the epidemic is not expanding. Modeling can be improved by incorporating an endogenous link between AIDS and total factor productivity; by analyzing more complex links between AIDS policies and labor productivity; and by exploring alternative financing of interventions had not there been debt relief-related external financing. In any case, results provide low-bound estimates on the growth effects of a mature epidemic, confirming recent arguments found elsewhere (e.g., Cuesta, 2007) that pro-poor growth in Honduras depends more critically on factors that have nothing to do with AIDS, such as lack of strategic economic priorities or lack of participatory politics.

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Appendix: Data Sources

Variable	*Symbol*	*Source*	*Description*	*Value*	*Units*
HIV/AIDS					
Incidence	A	Ministry of Health, MoH (2001)	1980-2000 data	(0.09-0.41)	% of adult population
Incidence, annual growth rate	$\dot{a}/a$	Estimate	1980-2000 data	(0-10.7)	Annual growth rate, %
Incidence, index	R	MoH (2001)	1999 data	2.15	Index
Prevention costs	P	MoH(2001)	1999 data	32.5	% of public health spending
Treatment costs, low-skill	c_L	MoH(2001)	1999 data	2.33	1999 US$
Treatment costs, index	ϕ	MoH(2001)	1999 data	3.3	Index
Share of public financing	η	MoH(2001)	1999 data	16.8	% of treatment costs
ECONOMIC					
Labor productivity index	p	DGEC (1991-99)	1991-99 data	3.3	Index
Marginal labor productivities	α, β	Estimate	1991-99 data	0.65; 0.35	Coefficient
Labor stock	L	DGEC (1991-99)	1991-99 data	1,906,370	Number of Individuals
Capital stock	K	Estimate	Permanent Inventory, 1950-2000	6,720	Current million US$
Low-skill share	N	DGEC (1991-99)	1991-99 data	34	% household heads
Savings rate, low-skill	s_L	Central Bank of Honduras, CBH(1999)	1998-9 data	-11.6	% of savings over total household income
Savings rate, index	V	CBH(1999)	1998-9 data	21	Index
Investment rate, high -skill	k_H	Estimate	1999 estimate	35	% of total household income
Foreign capital flows	F	UNCTAD (2006)	1968-2000 data	187.4	Current million of US$
DISTRIBUTION					
Income share, low-skill	θ_L	DGEC (1991-99)	1991-99 data	36.8	% of economy-wide income
Income share, index	G	DGEC (1991-99)	1991-99 data	2.7	Index

Source: Author's compilation.

Notes: (1) Official estimates on capital stocks are not available in Honduras, for which gross fixed capital formation was annually added to an original 1950 stock of capital following the widely accepted Permanent Inventory Method.

(2) It is assumed that only the wealthiest two deciles invest. It is also assumed—somewhat arbitrarily given the lack of firm-specific investment data—that approximately a third of total private investment proceeds from households while the rest comes from undistributed gains of firms. Calibrations of this ratio did not lead to significant variations of the estimated effects of HIV/AIDS on GDP growth rates. As a result, the investment ratio over savings is estimated as 0.35 for the high-skill group.

(3) As there are no projections on future FDI flows, projections were estimated as the gap between projected gross fixed capital formation and total savings consistent with the Poverty Reduction Strategy Paper, Government of Honduras (2001), macroeconomic framework for 2000-10.

(4) The labor productivity index is estimated from output and working hours per worker reported in household surveys. Hence, the index is not derived from estimated differentials in skills among individuals. The traditionally calculated returns to skills do not account for self-selection among the most able individuals. Bedi and Gaston (1997) estimate for Honduras that failing to capture such individual talent may underestimate returns by as much as 5.2 percent points for males and 4.2 percent points for females.

TECHNICAL NOTE: A DYNAMIC FUNCTION OF THE EFFECTS OF HIV/AIDS ON GDP GROWTH

Applying the chain rule to equation (1), we obtain:

$$\frac{\partial(\dot{Y}/Y)}{\partial(\dot{a}/a)} = \frac{\partial(\dot{A}/A)}{\partial(\dot{a}/a)} + \alpha\frac{\partial LnL_e}{\partial L_e}\frac{\partial L_e}{\partial a}\frac{\partial a}{\partial t}\frac{a}{a} + \beta\frac{\partial LnK}{\partial K}\frac{\partial K}{\partial a}\frac{\partial a}{\partial t}\frac{a}{a} \quad (1')$$

As it is assumed HIV/AIDS does not affect total factor productivity, the effects of HIV/AIDS are exclusively transmitted through effective labor and capital accumulation. The resulting expression is:

$$\frac{\partial(\dot{Y}/Y)}{\partial(\dot{a}/a)} = [\alpha\frac{1}{L_e}\frac{\partial L_e}{\partial a}\frac{\dot{a}}{a}a] + [\beta\frac{1}{K}\frac{\partial K}{\partial a}\frac{\dot{a}}{a}a] \quad (1'')$$

Substituting the derivatives of K with respect to HIV/AIDS rate, *a*, equation (7) can be obtained by developing equation (6) as:

$$\frac{\partial(\dot{Y}/Y)}{\partial(\dot{a}/a)} = -\alpha[n + pr(1-n)]\frac{\dot{a}}{a}\frac{a}{1-a} - \beta\frac{1}{K}s_L\eta c_L k_H vr[\phi(1-n)L]\frac{\dot{a}}{a}a \quad (7)$$

Table 1. Marginal Effects on Growth

Variable	Symbol	Category	*Direct Marginal Effect*	*Indirect Marginal Effect (through capital accumulation)*	*Total Marginal Effect*
HIV/AIDS					
Incidence	a	Exogenous	Negative	Positive	?
Incidence, annual growth rate	$\dot{a}/a$	Exogenous	Negative	…	Negative
Incidence, index	R		Negative	Positive	?
Prevention costs	P	Policy	…	Positive	Positive
Treatment costs, low-skill	c_L	Policy	Negative	Positive	?
Treatment costs, index	ϕ	Policy	Negative	Positive	?
Share of public financing	$1-\eta$	Policy	Negative	Positive	?
ECONOMIC					
Labor productivity index	P	Exogenous	Negative	…	Negative
Marginal labor productivities	A, β	Exogenous	Negative	…	Negative
Labor stock	L	Exogenous	Negative	Positive	?
Capital stock	K	Endogenous	Negative	…	Negative
Low-skill share	N	Exogenous	Negative	Positive	?
Savings rate, low-skill	s_L	Exogenous	Negative	?	?
Savings rate, index	V	Exogenous	Negative	?	?
Investment rate, high-skill	k_H	Exogenous	Negative	?	?
Foreign capital flows	F	Endogenous	…	Negative	Negative
INCOME DISTRIBUTION					
Income share, low-skill	θ_L	Exogenous	…	Negative	Negative
Income share, index	G	Exogenous	…	Negative	Negative

Source: Author's compilation.
Note: Reported signs of the marginal impacts refer to the predicted sign that an increase in the respective variable causes on the annual GDP growth rate in equation (7)

Table 2. Simulated Scenarios (2000-2010)

Scenario	*Simulation*	*HIV/ AIDS rate* (a), %	*HIV/ AIDS annual growth rate* ($\dot{a}/a$), %	*Treat ment cost, Index* (ϕ)	*Treat ment cost, (c) US$*	*Prevention cost, (P), US$*	*HIV/ AIDS index (r)*	*Public finance share,* (1-η), *%*	*Income dispersion index (g)*	*Productivity gap index (p)*
Baseline	*Baseline*	0.11	-3.4	3.3	2230	3250	2.15	16.8	2.7	3.3
Initial Conditions										
High rate (SPS rate)	*High*	0.41	-3.5	3.3	2230	3250	2.15	16.8	2.7	3.3
No difference in HIV/AIDS rate	*Uniform*	0.11	-3.4	3.3	2230	3250	1.0	16.8	2.7	3.3
Half productivity gap	*Productivity*	0.11	-3.4	3.3	2230	3250	2.15	16.8	2.7	1.65
Prevention Policy										
Half prevention cost	*Prevention*	0.11	-3.4	3.3	2230	1625	2.15	16.8	2.7	3.3
Treatment Policies										
Half treatment cost	*Half cost*	0.11	-3.4	3.3	1165	3250	2.15	16.8	2.7	3.3
Equal access	*Equal access*	0.11	-3.4	1.0	2230	3250	2.15	16.8	2.7	3.3
Financing*	*Financing*	0.11	-3.4	3.3	2230	3250	2.15	68.0	2.7	3.3

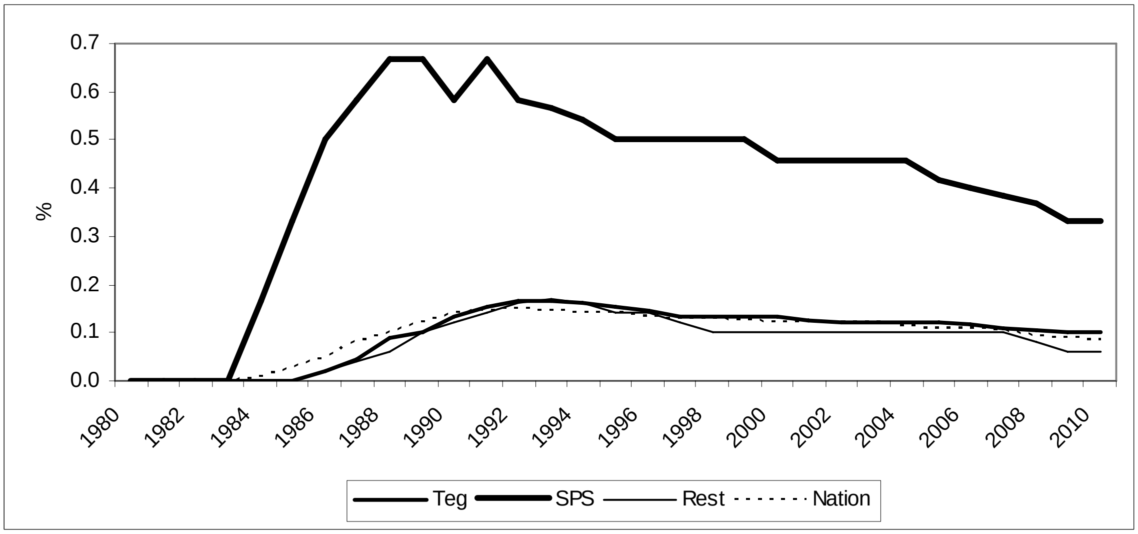
Source: Author's compilation.
Note: * The simulated financing rate equals the share of public financing observed in the rest of Central American countries and Mexico to 68% (Ministry of Health, 2001).

Table 3. Estimated HIV/AIDS effects on the annual growth rate of GDP, 2001-2010 (in percentage points)

	Baseline	*Initial Conditions*			*Prevention*	*Treatment*			% on total GDP growth effect(*)	
	Baseline	*High*	*Uniform*	*Productivity*	*Prevention*	*Half treatment cost*	*Equal Access*	*Financing*	Labor-driven	Capital-driven
2001	0.006	0.000	0.024	0.000	0.006	0.006	0.006	0.006	101.8	-1.8
2002	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	109.1	-9.1
2003	0.013	0.000	0.000	0.000	0.013	0.013	0.014	0.009	114.6	-14.6
2004	0.013	0.000	0.000	0.000	0.013	0.013	0.014	0.009	115.3	-15.3
2005	0.013	0.103	0.000	0.000	0.013	0.013	0.014	0.008	116.6	-16.6
2006	0.011	0.043	0.000	0.000	0.011	0.011	0.012	0.007	118.3	-18.3
2007	0.013	0.043	0.011	0.000	0.013	0.013	0.014	0.008	119.5	-19.5
2008	0.024	0.041	0.011	0.043	0.024	0.024	0.026	0.014	121.1	-21.1
2009	0.013	0.038	0.017	0.040	0.012	0.012	0.014	0.007	123.8	-23.8
2010	0.013	0.000	0.000	0.000	0.012	0.012	0.014	0.006	131.2	-31.2
Average	0.012	0.027	0.007	0.008	0.012	0.012	0.013	0.007	117.1	-17.1

Source: Author's compilation.
Note: (*) average for all scenarios.

Figure 1. Official Projections of AIDS Incidence among the Adult Population (%)



Source: Ministry of Health (2001).
Note: "Teg." refers to AIDS rates in Tegucigalpa; "SPS," rates in San Pedro Sula; "Rest' rates across the rest of the country; and "Nation" to the nation-wide incidence rate.