The effects of HIV/AIDS infections and mortality on saving and investment

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The Effects of HIV/AIDS *Infections* and *Mortality* on Saving and Investment

by

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Abstract: There are competing views of how HIV/AIDS affects saving, and to a lesser extent, investment. One argument is that saving is reduced because of the disease; the other is that saving is actually increased. We find that saving is negatively impacted by the disease in poorer countries but increased in relatively wealthy countries. These results, however, do not translate through to investment. In fact, the absolute value of the impact the disease has on investment is considerably reduced for countries in all income brackets. We hypothesize that because of the significant transfer of resources from firms headquartered in relatively wealthy nations to subsidiaries and communities in poorer countries much of the negative impact that saving would necessarily have on investment is negated.

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Introduction

Halfway through its third decade, HIV/AIDS infections and mortality has topped the agenda of international debate due to the severe effects that this disease has on the economic well being of nations. In fact, according to the United Nations Program on HIV/AIDS (UNAIDS), in 2002 it was estimated that 47 million people worldwide were either infected with HIV, or had full-blown AIDS. In the same year it was estimated that over 3 million people had died of AIDS.[1]

HIV/AIDS erodes the capacity for economic growth and development through lower saving and investment, slow employment growth and pressures on government revenues. These combine to constrain efforts to prevent worsening poverty, and they may seriously compromise the achievement of sustainable socio-economic development in the hardest hit countries. Many of these nations have no proper infrastructure to begin with and any potential for infrastructure is either being lost or reallocated for disease-related purposes. In particular, job creation and employment depend on both domestic and foreign investment. Foreign investment may be discouraged by the uncertainty of the economy affected by this epidemic; furthermore, substantial domestic investment that could come from saving is lost due to the depletion of the workforce, or is being diverted because of the cost associated with treating the disease or burying the deceased.

It is difficult to measure the impact this epidemic has had on any particular economy, especially those that have been hardest hit such as African nations. One measure of this impact is reported in the World Banks' United Nations General Assembly Special Session on AIDS (UNGASS) Fact Sheet where per capita growth in sub-Saharan countries could fall by 0.5% to

[1] http://www.unaids.org/en/default.asp

1.2% as a direct result of AIDS.[2] The vast majority of studies draw the conclusion that HIV/AIDS has ". . . driven many people to penury, and is hindering poor countries from achieving their developmental goals" [Edwards and Al-Hmoud, 2004]. One of these goals is an increase in domestic saving and hence investment where unfortunately the typical response to the epidemic for relatively poor households is to reduce current saving [Bollinger and Stover, 1999; Booysen, 2002].

Effects on Saving

The general consensus is that *infections* reduce saving in two ways--directly and indirectly.[3] The direct way that saving may be reduced is obviously through higher medical expenditures for the treatment of the virus or if the infected is forced out of the work force. Indirectly, infections can lower saving if a family member has to drop out of the workforce to take care of a sick loved-one. Whatever the mechanism, this reduction of saving will in turn decrease investment and hinder economic growth [Over, 1992; Cuddington, 1993; Bonnel, 2000; Dixon et al., 2001; Bollinger and Stover, 1999; Zerfu, 2002; Oni et el., 2002].

On the contrary there is a belief that households with infected members may actually increase saving as a precaution for greater future income variability, increased medical expenses, and future funeral costs especially in countries where the HIV epidemic is well-established [Bonnel, 2000]. Robalino et al., [2002] argues that an infected individual with a high discount rate as a result of shorter life expectancy would increase consumption today and therefore reduce saving. This also implies that in relatively wealthy countries where HIV drug cocktails are easily

[2] http://www.worldbank.org/ungass/factsheet.htm

[3] From this point we use '*infections*' rather than 'morbidity' as many authors do because we believe that morbidity requires that the individual actually be ill from the disease, whereas *infections* do not. This fine point is critical when observing relatively wealthy nations where an individual can live indefinitely with HIV, but not show any signs of illness while simultaneously depleting their saving.

accessible and relatively affordable, the individual's discount rate is lower implying relatively higher saving than in poorer countries.

In terms of *mortality*, funeral expenditures become an issue and can in fact be very large in traditional societies. For example, the typical funeral expense in the United States is $8,000 for casket and burial[4]--this figure is over 25% of annual per capita GDP. In addition, relatives must leave work and travel to the funeral to pay their last respects with this rite of passage lasting days or weeks. The large, one-time expense of the funeral and the loss in time at work for relatives further increases the reduction in saving and investment. These expenses, especially the expense of traveling and time lost, may be especially large for rural populations where many may have to travel for days just to get to the funeral [Oni, S. A., et al., 2002].

In addition to household saving, Breuer [2000] and Zerfu [2002], support the argument that a decline in the labor force will lower tax revenues for governments and increase expenditures due to high medical costs; this will obviously reduce public saving to a greater extent in countries that are hardest hit by the epidemic. Arndt and Lewis [2000, 2001] study the impact of HIV/AIDS in South Africa and their conclusion was that by 2010 national savings will decline from 17% of GDP to 14.2% of GDP. On the other hand, Haacker [2002] states that in general the impact that the disease has on aggregate changes in saving appear to be relatively small and especially in relatively wealthier nations.

The effects of HIV/AIDS on saving are mixed regarding relatively wealthy versus relatively poor countries: wealthier countries have more mechanisms and better infrastructure to cope with this epidemic, while on the other hand proportionately poor countries are more negatively affected by this epidemic due to the low amount of available resources.

[4] http://financialplan.about.com/cs/funerals/

Effects on Investment

Moatti et al., [2003] and Hacker [2002] stress the fact that the cost effectiveness of treating this epidemic determines the impact on saving and/or investment in any given country. Private businesses investing in worker education and treatment of this epidemic will ultimately have costs that are lower than the costs associated with the loss of experienced workers, increased absenteeism, reduced productivity, and many other negative effects. The implications would be that we should see a transfer of investment from wealthier to relatively poorer countries whereby a firm's headquarters would transfer funds to its international subsidiaries.

George and Whiteside [2002], and Glenn [2003] support the claim that a company's investment in prevention and care will positively affect investment in developing nations; this is most obvious in the mining industry in Africa. According to George and Whiteside [2002], in 1999, 75% of retirements and 59.1% of deaths in that industry were due to HIV/AIDS. Since companies in this area have taken bold steps in co-operation with workers to help with treatment costs, firms have experienced an increase in productivity and a decrease in the cost of hiring, training, and retirement payments.

Bloom et al. [2001] provide many examples of firms not only investing in their workers and the worker's families, but also community action programs dedicated to informing the public about the disease as well as providing community investment. A significant portion of these companies are headquartered in relatively wealthy countries. This implies that they are essentially exporting investment to relatively poor countries to cover the costs of these projects as well as worker treatment programs. Empirically we may actually see that any negative impact on investment in poorer countries could be mitigated by the inflow of investment from wealthier countries.

Our Study

This paper is essentially a direct extension of Edwards and Al-Hmoud [2004] where they stratify the data by per capita income over a large cross-section of countries to evaluate the relationship between growth and HIV/AIDS. In their study they found that the impact infections and mortality has on growth varies considerably over income groups. As most studies suggest, they found that poor countries are negatively impacted by infections and mortality, but that this relationship actually reverses as countries grow wealthier. They hypothesized that the growth in the industry surrounding the epidemic in rich countries must be outweighing the negative impact from the depletion of vital resources such as loss of labor.

Cuddington [1993] originally adapted the use of the Solow [1956] growth model to address the impact HIV/AIDS has on saving. His study focused on trying to estimate future impacts on economic variables with regard to the case study of Tanzania. Using a series of simulations, and extrapolating to the year 2010, he found that as domestic saving fell because of the expense of AIDS-related medical costs and losses in worker productivity, GDP in Tanzania could fall by as much as 15 to 25 percent. In his study, however, he actually chooses the value of the parameter that estimates the reduction in saving. In fact, Cuddington states that ". . . no estimate of the effect of AIDS on private or public saving is available."

In our study, we find that HIV/AIDS infections and mortality has a positive effect on saving in relatively wealthy countries and a negative relationship in relatively poor countries. The nexus between HIV/AIDS and investment is not as clear. Our results indicate that there is not a relationship in either the poorest or the wealthiest of countries; only the second-tier (out of four income brackets) has a statistically significant and negative relationship but with a greatly reduced magnitude from what one would expect. Given that the poorest of countries are the ones most affected, we hypothesize that the argument above for the transfer of funds from corporations in relatively wealthy countries to subsidiaries in poorer countries is possibly a partial explanation.

The paper is arranged as follows. Section 1 addresses the specific form of the econometric model with particular modifications, the testing methods used to assure that our results are statistically adequate, and the reasoning behind our stratification of the data. Section 2 discusses the data while Section 3 tables the results and section 4 draws a conclusion.

1. The Model

The econometric model that we use is a simple ordinary least squares regression with particular modifications. Specifically, the model takes the forms

$$\begin{aligned}\text{Investment}_{it} = {} & a_{0r} + a_1\text{Infection}_{i,t-1} + a_2\text{Growth}_{i,t-1} + a_3\text{GDP}_{i,t-1} + a_4\text{Literacy}_{i,t-1} \\ & + a_5\text{PopGrowth}_{i,t-1} + a_6\text{IndGrowth}_{i,t-1} + e_{it}\end{aligned} \qquad (1)$$

$$\begin{aligned}\text{Saving}_{it} = {} & b_{0r} + b_1\text{Infection}_{i,t-1} + b_2\text{Growth}_{i,t-1} + b_3\text{GDP}_{i,t-1} + b_4\text{Literacy}_{i,t-1} \\ & + b_5\text{PopGrowth}_{i,t-1} + b_6\text{IndlGrowth}_{i,t-1} + u_{it}\end{aligned} \qquad (2)$$

$$\begin{aligned}\text{Investment}_{it} = {} & c_{0r} + b_1\text{Mortality}_{i,t-1} + c_2\text{Growth}_{i,t-1} + c_3\text{GDP}_{i,t-1} + c_4\text{Literacy}_{i,t-1} \\ & + c_5\text{PopGrowth}_{i,t-1} + c_6\text{IndGrowth}_{i,t-1} + v_{it}\end{aligned} \qquad (3)$$

$$\begin{aligned}\text{Saving}_{it} = {} & d_{0r} + d_1\text{Mortality}_{i,t-1} + d_2\text{Growth}_{i,t-1} + d_3\text{GDP}_{i,t-1} + d_4\text{Literacy}_{i,t-1} \\ & + d_5\text{PopGrowth}_{i,t-1} + d_6\text{IndGrowth}_{i,t-1} + r_{it}\end{aligned}. \qquad (4)$$

The ‘Growth’ variable is the annual growth rate in per capita real GDP, ‘GDP’ is per capita real GDP, ‘Literacy’ is the percentage of the population 15 years and older who can read and write, ‘PopGrowth’ is annual percentage population growth, and ‘IndGrowth’ is an annual percentage measure of industrial growth. ‘Infection’ is defined as the number of people infected with HIV/AIDS per thousand of population, while the ‘Mortality’ variable is the number of deaths attributable to HIV/AIDS per thousand of population. As for the dependent variables, 'Saving' is defined as gross domestic savings as a percentage of GDP, and 'Investment' is defined as gross domestic investment as a percentage of GDP.[5]

Several features of these models should be noticed. First, the constant terms in each model vary by region as delineated by the Penn World Tables (PWT) version 6.1 [Heston, et al., 2002]. Controlling for regionally-specific fixed effects has been shown to be a significant statistical issue in empirical models [Edwards and McGuirk, 2004; Edwards, 2005]. We do not estimate this with country-specific effects for a couple of reasons. One reason is that per the PWT 6.1, there are 15 defined regions for which to capture much of the mean heterogeneity across countries. The other reason pertains to the fact that we would like to keep the degrees of freedom as high as possible; if we were to estimate country-specific fixed effects, the degrees of freedom would be TI-I-K (T is the total number of years covered, I is the total number of countries, and K is the number of estimated determinants [see Wooldridge, 2003]). In our case, with T=2 and the number of observations in each income bracket only around 40, the resulting degrees of freedom would be too small to gain reliable inference from our results. Second, to control for possible feedback from investment or saving to the control variables, we lagged all right-hand-side variables by one year. Barro consistently uses lagged determinants as instruments to control for feedback [e.g., Barro, 1996], with Temple [1999] suggesting that this is the best solution to the problem.

Regressions (1) - (4) are also stratified by per capita real GDP. This is important because we would expect the coefficients of the infection and mortality variables to vary from developing

[5] The formal definitions of these variables from the World Banks' World Development Indicators, 2004, edition is as follows: gross domestic savings are calculated as GDP less final consumption expenditure; gross domestic investment consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.

to developed nations. For example, we might expect the coefficient for the mortality variable in regression (4) to be negative, but to rise or fall in absolute value as we move to a higher income bracket because of the cash cost of burials relative to income in wealthier nations. There is also no reason to assume that any of the control variables would have the same impact on saving or investment in poor countries as they would in wealthy countries. Even if the coefficient estimates on the control variables could be statistically accepted as being equal across income levels, asserting *economic* equality would be a stretch. Hence, capturing the purest effects of HIV/AIDS on investment and saving must require that all variables are allowed to vary across income levels.

The process we use for the stratification procedure is somewhat ad hoc, but has statistical appeal. We start from the lowest per capita GDP observations and increase the sample by $100 increments until (after accounting for the determinants and the regional effects) a rule-of-thumb 30 degrees of freedom can be maintained. This lends itself to four layers of stratification for the income groups; less than $400 per capita GDP, $400 to $1200, $1200 to $4000, and greater than $4000. This stratification was determined for models (1) and (3) with the same stratification used for models (2) and (4). The sample sizes for these brackets are 41, 43, 40, and 38 observations respectively. This stratification is a direct extension of Edwards and Al-Hmoud [2004].

We acknowledge that there could be many more control variables added to the regressions, but due to the size of our data set and to the fact that we stratify by income levels, we had to be selective. All of the included control variables in the regressions exist to try to correct for possible dependence between the residuals and the infection and mortality variables. For instance, it is obvious to assume that per capita GDP would both be correlated with the number of infections as well as the number of mortalities. It is commonly thought that as countries become more developed, the percentage of the population infected with the disease diminishes. It is also obvious to assume that per capita GDP may be correlated with investment and saving. If per capita GDP were not included, a theoretical breakdown of the independence assumption would result. Not only will the other control variables have similar reasons for their entry into our models but the standard regressors of population growth, GDP, and growth are common in the literature [see Levine and Renelt, 1992].

We chose to include a measure of illiteracy in our control group instead of the commonly chosen education or schooling variables because as shown by Rojanapithayakorn [1994], the ability to read is all that is needed to impact the number of HIV infections. In fact, it was shown that in Thailand--where formal schooling is low, an increase in infection awareness campaigns resulted in an approximately 45% increase in condom use among sex workers (Bloom and Mahal [1997], and Edwards and Al-Hmoud [2004] also use a similar variable in their regressions).

To determine the statistical adequacy of our models given our small sample sizes, we use a battery of statistical testing procedures to assure that the typical normal and identically distributed assumptions of the errors in equations (1) - (4) hold. This will not only assure us that our estimates are unbiased and consistent, but that all test statistics are valid--at least to the degree that our data does not exhibit serially correlated errors which we control for in a limited manner by separating our data by one year (achieving a larger spread was not possible due to the availability of the data). But even if the errors are serially correlated, the estimators are still unbiased and consistent; standard errors will be biased [Baltagi, 2001]. To test for omitted variables (i.e., non-linear determinants) we use the Regression Specification Error Test (RESET) developed by Ramsey [1969]; to test for homoskedasticity we use the White's [1980] test which does not require the assumption of normality; to test for a normal conditional distribution, we test for the third moment (skew) being equal to zero, and the fourth moment (kurtosis) equal to three.

In addition to these basic tests, because parametric heterogeneity has become a significant issue in empirical work [Yang and Edwards, 2005; Durlauf et al., 2001; Bosworth and Collins, 2003], we employ the Hansen test [Hansen, 1992]. Of course this test was meant for testing parametric stability in time series work, but is easily adaptable for cross-sectional studies as long as a coherent ordering is maintained. It has been shown in recent studies that parameters are likely to vary by region [Edwards, 2005] and/or by initial levels of per capita GDP [Durlauf, et al., 2001]. To this end, we order our data by regional levels of lagged per capita GDP to capture both effects.

2. The Data

The data we use comes from two sources. The infection and mortality variables are acquired from the CIA's World Fact book. While we admit that this data is suspect as to its accuracy, multi-year data on AIDS mortality is hard to come by. We get the dependent variables and the control variables from the World Bank's World Development Indicators, 2004, database.

The saving and investment variables are for the years 2000 and 2002, while the dependent variables are for the years 1999 and 2001. There are a total of 162 observations covering 85 countries resulting in an average of 1.9 observations per country. Our data covers a broad range of countries according to per capita levels of GDP and are listed according to the per capita GDP stratification in Appendix A.

3. The Results

As a precursor to the stratified regressions, Table 1 displays the estimates from regressions (1) - (4) that are pooled across income levels. The estimates confirm the belief that on average HIV/AIDS does indeed lower investment and saving in a statistically significant manner. Having said this, it does appear as though the consequence on saving is almost twice that of investment. Accounting for this may be the fact that the investment variable as measured does include levels of foreign direct investment which would be partially offsetting the total effect as seen in the domestic saving estimate. It is also interesting to note that mortality affects investment about 12 times more than infections, while impacting saving about 9 times more than infections. To explain this phenomenon at this stage would be futile because as will be seen in Tables 2 and 3 below, this relationship varies considerably across income levels.

Table 1: Pooled Regressions

	Investment		Saving	
Infection	-0.068 ** (0.000)		-0.153 ** (0.000)	
Mortality		-0.819 ** (0.000)		-1.447 ** (0.000)
IndGrowth	0.141 * (0.093)	0.136 (0.102)	-0.0006 (0.996)	-0.018 (0.904)
Growth	0.763 ** (0.000)	0.746 ** (0.000)	0.194 (0.467)	0.189 (0.490)
PopGrowth	0.638 (0.391)	0.679 (0.358)	-1.029 (0.399)	-0.954 (0.443)
Literacy	0.033 (0.285)	0.028 (0.361)	0.084 (0.109)	0.078 (0.146)
GDP	0.003 (0.961)	0.002 (0.970)	0.202 * (0.063)	0.217 ** (0.049)
Cons	15.664 ** (0.000)	16.092 ** (0.000)	9.929 * (0.079)	9.876 * (0.087)
RESET	0.560	0.568	0.133	0.586
White	0.019	0.057	0.000	0.000
Skew	0.362	0.429	0.290	0.258
Kurtosis	0.235	0.257	0.010	0.009
Hansen:				
Infection	0.041		0.033	
Mortality		0.048		0.031
Ind. Prod.	0.077	0.074	0.273	0.283
Growth	0.057	0.061	0.168	0.199
Population	0.029	0.035	0.089	0.100
Literacy	0.062	0.071	0.093	0.113
GDP	0.419	0.409	0.160	0.144
No. of Regions	2	2	3	3

Dependent variable is marked at the column heading. In the first row are the coefficient estimates with P-values in parentheses. * implies significance at 10%, ** implies significance at 5%. The second row contains p-values for the first four tests and Hansen statistics below. A value of 0.47 or greater for the Hansen statistic indicates that the null of a stable coefficient is not a valid assumption at the 5% level.

The results for the stratified regressions are shown below. Table 2 lists the estimates and test statistics for the stratified saving regressions while Table 3 lists the estimates for the investment regressions. In each table, the income brackets are labeled in the top row, coefficient estimates in the second row, and test statistics in the third row. It is important to note that to correct for parametric instability in the saving/mortality regression for the $\leq$ \$400 bracket, an interaction between the region of South Africa and growth had to be included. The original Hansen statistic for growth was 0.519, above the 0.47, 5% cutoff. Also because of a failure of the RESET test for the saving model in the \$400 to \$1200 income bracket, a respecification of the model that included an interaction between population growth and both infections and mortality was required. For increased readability, Tables 2 and 3 simply list the coefficient estimates on the infection and mortality variables with the control estimates listed in Appendix B.

What Table 2 shows is that there is definitely a significant amount of income heterogeneity in coefficient estimates for the infection and mortality estimates (Appendix B also depicts a significant amount of heterogeneity across the control variable estimates). It seems as though much of the negative relationship in Table 1 was driven by correlations for the poorest of countries. Having said this, there are even more important results from the stratified regressions that should be brought to light.

Table 2: Results for Saving Regressions (2) and (4)

Variables	≤ $400		$400 - $1200		$1200 - $4000		> $4000	
Infection	-0.111 ** (0.042)		-0.584 ** (0.000)		0.029 (0.295)		0.093 ** (0.018)	
InfectionX Population			0.240 ** (0.001)					
Mortality		-1.219 ** (0.026)		-8.148 ** (0.000)		0.443 (0.247)		1.199 ** (0.015)
MortalityX Population				3.548 ** (0.000)				
RESET	0.732	0.761	0.066	0.074	0.687	0.613	0.737	0.759
White	0.606	0.661	0.428	0.428	0.425	0.425	0.423	0.423
Skew	0.948	0.963	0.120	0.306	0.111	0.083	0.759	0.746
Kurtosis	0.220	0.209	0.067	0.239	0.813	0.768	0.123	0.122
Hansen:								
Infection	0.090		0.085		0.024		0.018	
Mortality		0.135		0.034				0.020
Ind. Prod.	0.044	0.040	0.213	0.217	0.116	0.024	0.248	0.074
Growth	0.154	0.180	0.179	0.161	0.122	0.105	0.059	0.117
Population	0.049	0.049	0.089	0.198	0.093	0.129	0.337	0.022
Literacy	0.045	0.044	0.133	0.087	0.068	0.098	0.249	0.068
GDP	0.073	0.070	0.096	0.103	0.099	0.072	0.229	0.218
No. of Regions	0	0	2	2	3	3	4	4

Dependent variable is domestic savings. In the first row are the income bracket delineations; in the second row are the coefficient estimates with P-values in parentheses. * implies significance at 10%, ** implies significance at 5%. The third row contains p-values for the first four tests and Hansen statistics below. A value of 0.47 or greater for the Hansen statistic indicates that the null of a stable coefficient is not a valid assumption at the 5% level.

The test statistics in Table 2 tells us that all four models have the usual, desirable statistical properties. All of the standard distributional tests have p-values well above 0.05, and the Hansen statistics are all well below the 5% cutoff of 0.47. In combination, we can be assured that our models are statistically adequate with regard to distribution and parametric stability.

Three of the four models have at least 30 degrees of freedom, while the highest income group fell three degrees of freedom short of our objective. Since the common rule of 30 degrees is simply a 'rule-of-thumb', we do not find this particularly troubling.

Also of considerable interest is the fact that the relationship between both infections and mortality, and saving is non-linear with respect to population growth for the $400-$1200 bracket. For countries in this income bracket that have population growth rates below 2.433% and 2.296% respectively, the impact on saving from infections and mortality respectively is negative, but reverses for population growth rates above these levels. According to our data, 25 countries have average population growth rates above 2.296% and 15 are above 2.433%.[6] The only plausible explanation must reside in the simple thought that for these countries, the fast growing population must be adding to saving faster than the loss of saving from a decreasing population. One of the only ways an argument like this would hold water is if the majority of the countries with high population growth rates also had relatively low saving so any addition to saving by a rapidly growing work force would weigh heavily.

For the infections group, out of the 25 countries above 2.296% population growth 19 of the countries are in the bottom 50% of saving, while for the mortality group 13 of the 15 countries are in the bottom 50% of saving. Nevertheless, in general, the pattern of the coefficients across income groups is in agreement with the findings of Edwards and Al-Hmoud [2004]; the relationship between infections and mortality on saving is negative for low income countries, but reverses for wealthier countries.

We also see that the absolute values of the coefficients for mortality are considerably larger than for illness. We believe that for the ‘low’ and ‘middle’ income groups, this is due to

[6] The 15 countries are Burkina Faso, Swaziland, Benin, Guatemala, Nicaragua, Honduras, Angola, Guinea-Bissau, Mauritania, Namibia, Rwanda, Uganda, Madagascar, Chad, and Belize. The remaining 10 countries are Senegal, Malaysia, Cote d'Ivoire, Tanzania, Ethiopia, Djibouti, Gabon, Mali, Pakistan, and Nigeria.

the fact that taking care of an infected individual reduces saving gradually over a period of time, even though the total cost of care may be quite significant. Furthermore, a depletion of saving due to a family member taking care of a sick-loved one may not require that the family member completely drop out of the workforce—this individual may still be able to work part-time. This also holds true for the infected individuals themselves. Since being infected with the disease does not require that the individual be morbid, that individual may still work their regular jobs even though at a decreased level of productivity.

When the individual passes away, the funeral expenses are a one-time, contemporaneous depletion of resources and would impact saving to a much greater extent than would the infection. These explanations only pertain to the negative relationship for the 'low' and 'middle' income groups, and will not suffice for the differences in magnitudes for the ‘high’ income group and their positive coefficients.

While the signs of the coefficients on infections and mortality in the 'high' income case can be rationalized with Bonnel’s reasoning, the difference in magnitudes cannot. We believe the reason the infections coefficient is much smaller than the mortality coefficient is due to two factors. Precautionary saving increases as the number of infections rises due to the probability that any one particular individual may become infected. This will be true if an individual thinks that their sexual behavior results in a positive probability that they may become infected. As the number of mortality cases increases, these individuals and their families start saving for not only the relatively high, one-time expense of funeral costs, but also because of the complete loss of income from the infected individual.

The general conclusion one can draw from Table 2 is that there does exist a statistically significant amount of heterogeneity in both the infections and mortality coefficients as you move from relatively poor to relatively wealthy countries. This reversing of the impact of HIV/AIDS on saving tends to support Bonnel's [2000] claim that the disease may actually increase saving at least for wealthier countries.

His belief is that because many households would experience greater income variability, they would increase saving as a precaution to satisfy future medical and funeral expenses, and a loss of income when the diseased individual passes away--especially in countries where the HIV epidemic is well-established. This is in contrast to poorer countries whose populations may not have the income to support much saving at all and would have to deplete existing resources without being able to adjust their ability to save. The establishment of the disease is critical to Bonnel's claim. It is commonly known that HIV/AIDS was first diagnosed in the United States in 1981, and soon thereafter Western Europe and sub-Saharan Africa [Bongaarts, 1996]. It was not until later that the disease started becoming a problem in other developing areas of the world, with statistically significant negative effects not seen until the late 1990's [Dixon, et al., 2001]. The results from the investment regressions are shown below.

Table 3: Results for Investment Regressions (1) and (3)

Variables	≤ $400		$400 - $1200		$1200 - $4000		> $4000	
Infection	-0.012 (0.832)		-0.068** (0.014)		0.065 (0.140)		-0.024 (0.169)	
Mortality		-0.390 (0.539)		-1.019** (0.001)		0.656 (0.166)		-0.322 (0.162)
RESET	0.066	0.057	0.271	0.415	0.238	0.313	0.660	0.655
White	0.426	0.426	0.428	0.428	0.425	0.425	0.432	0.407
Skew	0.112	0.094	0.572	0.608	0.125	0.114	0.082	0.083
Kurtosis	0.292	0.296	0.382	0.406	0.612	0.643	0.623	0.614
Hansen:								
Infection	0.160		0.085		0.033		0.076	
Mortality		0.116		0.090		0.021		0.060
Ind. Prod.	0.022	0.029	0.213	0.081	0.101	0.106	0.095	0.097
Growth	0.109	0.108	0.179	0.182	0.043	0.045	0.094	0.093
Population	0.025	0.024	0.089	0.064	0.036	0.033	0.081	0.080
Literacy	0.020	0.022	0.133	0.045	0.024	0.024	0.096	0.095
GDP	0.029	0.031	0.096	0.041	0.044	0.038	0.135	0.133
No. of Regions	3	3	5	5	2	2	0	0

Dependent variable is the investment to GDP ratio. In the first row are the income bracket delineations; in the second row are the coefficient estimates with P-values in parentheses. * implies significance at 10%, ** implies significance at 5%. The third row contains p-values for the first four tests and Hansen statistics below. A value of 0.47 or greater for the Hansen statistic indicates that the null of a stable coefficient is not a valid assumption at the 5% level.

With the exception of the $400 to $1200 bracket, neither infections nor mortality have any statistically significant impact on investment. One hypothesis related to these results may simply be that the establishment and upkeep of capital for multi-national subsidiaries in developing countries requires a movement of investment resources from developed to developing countries; this would be the standard economic explanation. However, there is also reason to believe that a sufficiently large transfer of investment resources would be for treatment and education programs as well as economic enhancement programs for communities impacted by the disease.

Bloom et al. [2001], give numerous examples of multinational firms investing in developing nations to address the disease. For example, the International HIV/AIDS Alliance and businesses like Levi-Strauss, Glaxo-Wellcome, MTV International, and Tanqueray, are actively investing in community education and development programs in regions such as Latin America, Asia, and Africa. Glaxo-Wellcome's prevention and education program covers all of its' 55,000 employees world wide. Polaroid started an 'intensive' employee education program in 1987. Chevron, Nigeria Ltd., has invested heavily in its' 2,600 employees and the community with such programs as the *Chevron Workplace AIDS Prevention Program*, and the *Chevron Adolescent Reproductive Health Program*. There are many other multi-national firms taking part as well; Standard Chartered Bank (Paris) with over 570 offices in 50 countries many of which are in Africa; International Hotel and Restaurant Association (Paris) with over 750,000 operators, associations, and suppliers in more than 150 countries; Bristol-Myers Squibb Company (USA) with nearly 54,000 employees; and the list goes on.[7]

These programs may be either directly or indirectly investment enhancing. Directly, it seems reasonable to assume that many of these well-funded projects dedicated to employees, families, and the community provide direct investment in the form of fixed assets such as land improvements, schools, offices, hospitals, residential dwellings, etc. Indirectly, the education of the workforce would result in greater worker productivity and reduced absenteeism thus leading to increased inventories if the firms so choose. This would be particularly true in the mining industries.

It is obvious that there is a large transfer of resources from firms headquartered in wealthy nations to their subsidiaries and the communities in which their subsidiaries reside in

[7] Bloom et al. [2001] cite many authors as the sources for these examples. Please see their paper for the large list of citations.

relatively poor nations. However, there may be an argument based on our results in Table 3 that for countries with incomes between $400 and $1200, this phenomenon is not occurring given that the affect of the disease in investment is statistically significant and negative. In order to compare apples and apples with the saving results by viewing the simple correlation between the two variables instead of the interaction, the infections estimate for the saving regression is -0.273 and -3.01 for the mortality estimate. Given that the estimates for investment are much lower in absolute value, it seems reasonable to conclude that even though the transfer of funds is of order of magnitude lower than in the less than $400 group, it is still occurring just to a lesser extent.

4. Conclusion

In conclusion, this study has brought several interesting hypotheses to light. The first is that there does seem to be a significant amount of heterogeneity across income groups with regard to the impact that HIV/AIDS has on real economic variables. The second is that with regard to saving, the implied claims stated earlier that tell a tale of precautionary saving in wealthy countries and disproportionately negative effects due to the availability of resources in relatively poor countries, could very well be valid hypotheses. We have also found evidence supporting our hypothesis that a significant transfer of resources from firms in wealthy countries to subsidiaries, workers, and communities in poor countries are probably lessening the extent to which investment in poorer nations are impacted by the disease.

A possible policy implication of this study would to encourage even stronger support for employee and community education, treatment, and economic programs by multi-national firms for their developing country subsidiaries. This would help alleviate the decimation to saving that exists in those countries from medical and funeral expenses. Workers gaining in not only the education of disease awareness, but also education in general and increased worker longevity can only be seen as growth and saving enhancing.

Further research in this area should occur as more data becomes available. But should also be directed at possibly separating the extent to which this transfer of funds helps private sector growth, versus reduced governmental burden in these developing countries that are hardest hit by the disease.

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Appendix A

Countries for each income bracket:

< $400 GDP	$400 - $1,200 GDP	$1,200 - $4,000 GDP	> $4,000 GDP
Bangladesh	Angola	Belarus	Argentina
Burkina Faso	Benin	Belize	Barbados
Burundi	Bolivia	Botswana	Botswana
Central African Rep.	Cameroon	Colombia	Brazil
Chad	China	Costa Rica	Canada
Ethiopia	Cote d'Ivoire	Dominican Rep.	Chile
Ghana	Djibouti	Ecuador	France
Guinea-Bissau	Ghana	El Salvador	Gabon
Haiti	Guinea	Guatemala	Germany
Kenya	Guyana	Mexico	Italy
Madagascar	Honduras	Namibia	Japan
Malawi	India	Panama	Korea
Mali	Indonesia	Paraguay	Malaysia
Mozambique	Lesotho	Peru	Netherlands
Nigeria	Mauritania	Romania	Portugal
Rwanda	Nicaragua	Russia	Singapore
Sierra Leone	Pakistan	South Africa	Spain
Sudan	Philippines	Suriname	Switzerland
Tanzania	Senegal	Swaziland	Trinidad and Tobago
Uganda	Sri Lanka	Thailand	United Kingdom
Vietnam	Ukraine	Venezuela	United States
Zambia	Zambia		Uruguay
	Zimbabwe		

The countries of Ghana, Zambia, and Botswana appear in two separate income brackets. This is due to the fact that their income per capita status changed from 2000 to 2002.

Appendix B

Control Variable Estimates for Saving Regressions (2) and (4)

Variables	≤ $400		$400 - $1200		$1200 - $4000		> $4000	
	Infect.	Mort.	Infect.	Mort.	Infect.	Mort.	Infect.	Mort.
IndGrowth	0.272 (0.272)	0.310 (0.210)	0.172 (0.617)	0.047 (0.892)	-0.046 (0.785)	-0.055 (0.746)	0.189 (0.281)	0.193 (0.267)
Growth	0.409 (0.307)	0.351 (0.378)	0.188 (0.767)	0.180 (0.785)	-0.058 (0.887)	-0.063 (0.876)	1.102 (0.003)	1.094 (0.003)
GrowthSAfr.	1.836 (0.008)	1.679 (0.011)						
PopGrowth	-5.578 (0.072)	-5.174 (0.088)	-3.651 (0.138)	-3.236 (0.202)	1.715 (0.488)	1.645 (0.504)	3.392 (0.179)	3.412 (0.173)
Literacy	0.126 (0.101)	0.116 (0.121)	-0.004 (0.972)	0.017 (0.887)	-0.412 (0.138)	-0.392 (0.161)	0.186 (0.531)	0.182 (0.530)
GDP	45.337 (0.015)	48.171 (0.008)	7.514 (0.443)	5.748 (0.577)	10.243 (0.000)	10.127 (0.000)	0.206 (0.030)	0.210 (0.026)
Adj. R^2	0.488	0.501	0.600	0.568	0.537	0.541	0.785	0.788

Dependent variable is domestic savings. In the first row are the income bracket delineations; in the second row are the coefficient estimates with P-values in parentheses.

Control Variable Estimates for Investment Regressions (1) and (3)

Variables	≤ $400		$400 - $1200		$1200 - $4000		> $4000	
	Infect.	Mort.	Infect.	Mort.	Infect.	Mort.	Infect.	Mort.
IndGrowth	0.030 (0.903)	0.024 (0.923)	0.821 (0.000)	0.734 (0.000)	-0.092 (0.265)	-0.103 (0.213)	0.239 (0.020)	0.239 (0.019)
Growth	0.998 (0.007)	0.980 (0.008)	0.176 (0.646)	0.092 (0.793)	0.319 (0.131)	0.322 (0.129)	0.626 (0.002)	0.627 (0.002)
PopGrowth	6.479 (0.060)	6.262 (0.062)	-1.365 (0.519)	-1.737 (0.378)	3.297 (0.001)	3.289 (0.001)	-0.620 (0.580)	-0.646 (0.565)
Literacy	0.025 (0.751)	0.022 (0.783)	0.082 (0.290)	0.089 (0.219)	0.467 (0.000)	0.465 (0.000)	-0.396 (0.000)	-0.402 (0.000)
GDP	6.034 (0.723)	6.881 (0.683)	-9.876 (0.196)	-10.697 (0.135)	-1.490 (0.073)	-1.523 (0.069)	0.083 (0.072)	0.083 (0.072)
Adj. R^2	0.391	0.397	0.604	0.653	0.354	0.348	0.621	0.622

Dependent variable is domestic savings. In the first row are the income bracket delineations; in the second row are the coefficient estimates with P-values in parentheses.