The Impact of HIV/AIDS on Foreign Direct Investment: Evidence from Sub-Saharan Africa

Elizabeth Asiedu*
Department of Economics
University of Kansas

Yi Jin†
Department of Economics
Monash University

Isaac Kalonda-Kanyama‡
Department of Economics and Econometrics
University of Johannesburg

April 2012

Abstract

We employ panel data from 40 countries in sub-Saharan Africa over the period 1990-2008 to examine whether HIV/AIDS has a causal effect on FDI. We find that HIV/AIDS has a negative but diminishing effect on FDI, and this adverse effect occurs even when the HIV prevalent rate is as low as 0.1 percent. The empirical result is then rationalized by a simple theoretical model.

JEL Classification: F34, F35, I20, O19.
Key Words: Foreign Direct Investment, HIV/AIDS.

Please address all correspondence to:
Yi Jin
Department of Economics, Monash University
Email: yi.jin@monash.edu

:

*Department of Economics, The University of Kansas, Email: asiedu@ku.edu
†Department of Economics, Monash University, Australia. Email: yi.jin@monash.edu.
‡Department of Economics and Econometrics, The University of Johannesburg, South Africa. Email: ikanyama@uj.ac.za

When labor supply, its quality and potential productivity are diminished as a result of HIV/AIDS, these trends act to discourage foreign direct investment, that is essential for economic development (ILO, 2005:8).

1 Introduction

The above quote suggests that foreign direct investment (FDI) is important for economic development, and that HIV/AIDS impedes FDI.[1] The idea that HIV/AIDS may have an adverse effect on FDI is not implausible, for the simple reason that healthy workers are more productive than sick workers. As a consequence, one would expect the health status of workers in host countries to have an impact on FDI. It is therefore surprising that although there is an extensive empirical literature on the determinants of FDI to developing countries in general, and to Sub-Saharan African countries in particular, research on how the health status of workers in host countries affects FDI is scant and also recent. We found only two published papers that have included a measure of health as a determinant of FDI: Alsan et al. (2006) and Azemar and Desbordes (2009). Alsan et al. (2006: 613) note that "To date, however, a relationship between population health and FDI has not been established in the empirical literature." They also assert that "To the best of our knowledge, this represents the first empirical investigation evaluating whether health directly affects FDI, ceteris paribus," (2006:614).

This paper empirically examines the relationship between HIV/ AIDS and FDI. The paper is partly motivated by anecdotal evidence which suggests that HIV/AIDS has an adverse effect on businesses, in particular, on FDI. According to a global survey conducted by The World Economic Forum (WEF) in 2003, about 33 percent of business leaders in developing countries that participated in the survey reported that HIV/AIDS has "affected their country's access to FDI in the past five years," (see Section 2 for details).

[1] The growth enhancing and poverty reducing effect of FDI has also been documented in several empirical studies (e.g., Hansen and Rand, 2006)

The panel data we use in the analyses cover 40 Sub-Saharan African (SSA) countries over the period 1990-2008. We employ the dynamic panel system General Method of Moments estimator (GMM) proposed by Blundell and Bond (1998) to estimate the effect of HIV/AIDS on FDI. We find that HIV/AIDS has a negative effect on FDI and the effect diminishes as the HIV/AIDS prevalence rate rises. Such an adverse effect occurs even when the prevalence rate is low, as low as 0.1 percent. We also show that our results are robust: they hold when we control for market size, openness to trade, infrastructure development, and natural resources intensity in host countries.

The paper extends the health-FDI literature by addressing some specification and endogeneity issues not considered in previous studies. First, we find that the relationship between HIV/AIDS and FDI is non-linear, while in Azemar and Desbordes (2009) HIV is treated as linear in their regressions. Second, the analysis of Oster (2009) points to the possibility that FDI may have a causal effect on HIV/AIDS, suggesting that the relationship between FDI and HIV/AIDS may be bidirectional.[2] Also, the data on HIV prevalence rates are likely to exhibit measurement errors (Bloom and Canning, 2008).[3] These two potential problems suggest that endogeneity may be a concern. Unlike Azemar and Desbordes (2009) which treats HIV as exogenous, our analysis accommodates the endogeneity of the HIV/AIDS. Another issue is that several studies have found that past FDI is correlated with current FDI as in Busse and Hefeker (2007) and Asiedu et al. (2009); however both Alsan et al. (2006) and Azemar and Desbordes (2009) do not take into account the persistent nature of FDI. We introduce the lagged FDI into the regression to capture its persistence. Finally, both papers employ OLS and Azemar and Desbordes (2009) take into account country fixed effects. OLS as well as fixed effects estimations produce inconsistent and biased estimates if FDI is persistent, HIV is endogenous

[2]Oster (2009) finds that exports has a positive and significant effect on HIV/AIDS in Sub-Saharan Africa. This suggests that export-oriented FDI (which is the type of FDI in most developing countries) may have a significant impact on HIV. The data on FDI by sector are not readily available for most SSA countries and so we are unable to test this hypothesis.

[3]See Bloom and Canning (2008) for a detailed discussion.

or when the time period of the panel is short (Arellano and Bond, 1991). The system GMM estimator that we employ for our estimations accounts for unobserved country-specific effects, mitigates any potential endogeneity problems, permits the inclusion of lagged dependent variable as well as endogenous explanatory variables, and also accommodates panel data with short time periods.

The paper also contributes to the small but increasing literature that examines the effect of HIV/AIDS on the growth rate of income per capita. The findings from these studies are mixed. Some studies find a positive effect, others find a negative effect, and some conclude that HIV/AIDS has no significant effect on income per capita growth.[4] Haacker (2004) asserts that the existing studies underestimate the effect of HIV/AIDS on growth. He argues that FDI is important for growth, and that the existing studies do not take into account the effect of the epidemic on FDI. This paper contributes to the literature by examining one of the channels through which HIV/AIDS may indirectly affect economic growth.

We now provide three reasons why we focus on SSA. First, the paper has important policy implications for developing countries in general, and SSA countries in particular. Specifically, FDI is crucial for poverty reduction in SSA, however, the region has received very little FDI and the investments are concentrated in only a few countries (Asiedu and Gyimah-Brempong, 2008).[5] Second, a majority of the people infected with HIV/AIDS live in SSA (about 66% of the 33 million people infected with the disease live in SSA); the region has the highest new infection rates (in 2009, about 71% of newly infected adults lived in SSA); and the disease is the leading cause of death among adults in the region (UNAIDS, 2010).[6] Finally, there

[4]For example Young (2005) finds a positive effect, McDonald and Roberts (2006), Juhn et al. (2008) and Kalemli-Ozcan and Tarun (2010) find a negative effect, and Bloom and Mahal (1997) find that HIV/AIDS has no significant effect on income per capita growth. See Bloom et al. (2004) for a survey of the literature on the effect of health on growth.

[5]For example from 2007-2010, only 8% of FDI to developing countries went to SSA. In addition, about 62 percent of FDI to the region went to 3 out of 48 countries: Angola (31%), Nigeria (15%) and South Africa (16%).

[6]Also, the top ten countries in the world with the highest HIV prevalence rates are all located in SSA: Swaziland (27%), Botswana (25%), Lesotho (25%), South Africa (21%), Zimbabwe (18%), Namibia (17%), Zambia (16%), Mozambique (14%), Malawi (13%) and Tanzania (7%).

is a widespread notion among policymakers in the region that the conclusions based on studies of non-SSA countries are not applicable to SSA because countries in the region are so different. Therefore, the findings from studies that are based solely on SSA will have more credibility with policymakers in the region.

We end the discussion by providing a rationale for focusing on HIV/AIDS instead of overall population health, as in Alsan et al. (2006), or focusing on other infectious diseases, as in Azemar and Desbordes (2009). HIV/AIDS is a global epidemic and the disease "has inflicted the single greatest reversal in human development in modern history" (UNDP, 2005: 10). The adverse effect of ill health on FDI is more profound for HIV/AIDS than other chronic and infectious diseases. This observation is consistent with the WEF survey data. Specifically, business leaders were asked to rate the effect of HIV/AIDS, malaria and tuberculosis on their businesses— and HIV/AIDS was consistently regarded as a more serious threat to businesses than either malaria or tuberculosis.[7] The relatively large adverse effect of HIV/AIDS on FDI, vis-a-vis other infectious diseases, can be largely attributed to the nature of the disease. Unlike other diseases, the most vulnerable group to HIV infection are working-age adults. About 92 percent of the people infected with HIV/AIDS are in the 15-49 age group (UNAIDS, 2010). Furthermore, in many moderate and high epidemic countries, the disease has led to a significant reduction in the size of the labor force, in particular, educated/skilled workers (see Tables 1 and 2). If human capital and physical capital are complementary, then a decrease in the quality and quantity of human capital will result in a decline in physical capital (Sala-i-Martin, 2005). Finally, the disease results in a decline in population, which in turn implies a shrinking market for businesses. Clearly this will have an adverse effect on FDI, in

[7]The countries in which the firms operated were categorized by HIV prevalence rates, level of development and also by geographical region. In all the categories, HIV/AIDS was considered a more serious threat. For example, about 60 percent of the firms operating in Sub-Saharan Africa reported that HIV/AIDS has a "serious impact" on their businesses. This constrasts with 50 percent for malaria and 39 percent for tuberculosis. For firms in low income countries, the numbers were 53 percent, 44 percent and 35 percent for HIV/AIDS, malaria and tuberculosis, respectively; and for firms in middle income countries, the numbers were 15 percent, 5 percent and 8 percent, for HIV/AIDS, malaria and tuberculosis, respectively.

particular, market seeking FDI.[8] Finally, in the growth literature, life expectancy at birth is often used as a measure of population health. We argue that life expectancy is not appropriate for analyzing the impact of the health of workers on FDI for the following reasons: (i) it reflects the health status of the total population, including children and the elderly, two groups are not part of the labor force; (ii) it measures mortality rates—does not take into account morbidity (sickness) rates, (Bloom et al., 2003); (iii) it is highly correlated with other country characteristics that affect FDI flows (e.g., income per capita, infrastructure development), and this makes it difficult to isolate the effect of health on FDI.

The remainder of the paper is organized as follows. Section 2 employs survey data to establish that one of the important channels through which HIV/AIDS affects businesses is a decline in productivity and/or an increase in absenteeism. We also provide data from selected countries to illustrate the effect of the epidemic on the quantity and quality of the labor force. Section 3 describes the data and the variables employed in the regressions, followed by the discussion of the estimation procedure in Section 4 and the report of the estimation results in Section 5. Section 6 presents a simple theoretical model to rationalize the empirical results. The final section concludes.

2 The Impact of HIV/AIDS on Businesses and FDI

HIV/AIDS can affect businesses through many channels (see Figure 1). The channels through which the disease affects businesses are well articulated in ILO (2008:25), which notes that

> HIV/AIDS results in increased costs to the employer and *decreased productivity* through the loss of skilled and experienced workers and consequential recruitment and training of new employees, through increased demand on the

[8]FDI can be broadly classified into two:(i) market seeking FDI serves domestic markets; and (ii) export oriented FDI targets foreign markets.

company's medical system and through *absenteeism* of both *ill workers and affected relatives and friends...*

HIV/AIDS can lead to a significant reduction in the size of the labor force (quantity of labor) and a loss of skilled labor (quality of labor). The effect of the epidemic on the quantity of labor force can be deduced from the data on life expectancy, and the effect on the quality of labor can be inferred from the data on the number of educated who have died from AIDS. In Section 2.1 we provide data from selected countries on life expectancy as well as the percentage of college educated people that are deceased from AIDS. In Section 2.2, we provide data from two surveys to demonstrate that the most important channel by which HIV/AIDS affects businesses is through a decline in labor productivity and/or an increase in absenteeism.

2.1 Impact of HIV/AIDS on the Labor Force

Table 1 shows data on life expectancy at birth and HIV prevalence for five countries in SSA. To facilitate the discussion, we interpret the period 1970-1990 as pre-epidemic period, and 1990-2008 as post-epidemic period.[9] The data suggest that HIV/AIDS has reversed the gains made in life expectancy in these countries. For example, life expectancy in Botswana declined from 64 years in 1990 to 55 years in 2009, which is close to the life expectancy in 1970.

Table 2 shows the percentage of college students who graduated in 1980, 1987, 1994 and 1999, and were deceased by 2001 as a result of AIDS. For example in Uganda, about 33 percent of the college students that graduated in 1980 had died of AIDS by 2001 (21 years after graduation). Also, 14.4 percent of the students that graduated in 1987 (14 years after graduation), and about 3 percent of the 1994 graduates had been deceased by 2001 (7 years after graduation). The loss of skilled labor is also significant in Malawi, Tanzania and Zimbabwe.

[9] Although the HIV/AIDS virus was identified in the 1980s, global awareness of the disease began in the 1990s. Also, the HIV/AIDS data prior to 1990 are not reliable (UNAIDS, 2010).

2.2 Channels by which HIV/AIDS affect Businesses

We begin with the Executive Opinion Survey conducted by the WEF in 2003, where business executives were asked to rate the impact of HIV/AIDS on various aspects of their businesses.[10] The survey covered a total of up to 7,789 firms in 103 countries, including 1,458 firms in 22 Sub-Saharan African countries. Our analyses pertain to the question:

> "How severely is the HIV/AIDS epidemic currently affecting the following aspects of your business: (i) productivity and absenteeism? (ii) death, disability, and funeral expenses? (iii) medical expenses? and (iv) recruitment and training expenses?"

The rating ranges from 1-7, where 1 means "extremely serious impact"and 7 means "minimal or no impact." Respondents were required to choose one number. To facilitate the interpretation of the data, we follow Bloom et al. (2003) and interpret a rating of 1-5 to mean HIV/AIDS has had "some impact"on a business and a rating of 6 or 7 to mean minimal or no impact. The analysis of the data reveals clearly that lower productivity and/or increased absenteeism consistently rank first as the most important channel by which HIV/AIDS affects investment. In Sub-Saharan Africa, 53% of firms surveyed reported that HIV/AIDS lowered their productivity and/or increased absenteeism, compared to 49% for funeral costs, 51% for medical costs and 49% for recruitment costs.

The second survey is the South African Business Coalition on HIV/AIDS survey conducted by the South African Bureau for Economic Research in 2005. The aim of the survey was to gauge the effect of HIV/AIDS on businesses that operate in South Africa. Table 3 summarizes the response to the question:

> "Has HIV/AIDS affected the production side of your company? Please rate the impact of HIV/AIDS on the following factors: (ii) lower labor productivity and/or increased worker absenteeism; (ii) higher labor

[10] See Bloom et al. (2003) for a discussion of the survey results.

turnover rates; (iii) loss of experience and vital skills; (iv) higher recruitment and training costs; and (v) higher employee benefit costs (e.g., medical aid, pension, life and liability insurance).

Respondents were asked to select one of five options: (a) no impact; (b) small impact; (c) moderate impact; (d) large impact; and (e) don't know. We interpret options (b), (c) or (d) to mean that HIV/AIDS has had some impact. Table 3 shows the percentage of firms that reported that the disease has had some impact on their business.[11] We report the data by industry (Panel A), by firm size (Panel B) and by employee skill-level (Panel C). Clearly, the conclusion is consistent with the WEF survey: that overall lower productivity and/or increased absenteeism is the main channel through which HIV/AIDS affects businesses.

2.3 Effect of HIV/AIDS versus that of Malaria and Tuberculosis

This subsection focuses on the effect of HIV/AIDS on firm's business in SSA, compared to the effect of malaria and tuberculosis. According to the 2003 WEF survey, HIV/AIDS is seen as worse than either malaria or tuberculosis (TB). Respondents were asked the question of how serious they considered the impact of HIV/AIDS, malaria and TB on their business. At the regional level, 60% of respondents in SSA gave responses that suggested that HIV/AIDS has had or will have a serious impact on their business, compared to 50% and 39% of respondent that reported the impact of malaria and TB respectively. However, the percentages of firms that experienced a serious impact of HIV/AIDS, malaria and TB varied over countries as shown in Table 4.

It appears from Table 4 that the impact of HIV on business is higher in high-prevalence regions than in low-prevalence ones. This can be seen by comparing the proportions of firms that reported a serious impact of HIV/AIDS on business in Southern Africa (high-prevalence region) and those in Western Africa (low-

[11] In calculating the percentages, we excluded the businesses that selected option (e), i.e., the "don't know" option.

prevalence region). For example, more than 72% of firms in Botswana, Mozambique, South Africa, Zambia and Zimbabwe reported a serious impact of HIV/AIDS while less than 56% of firms in Gambia, Ghana, Mali, Nigeria and Senegal reported a serious impact of the epidemic.

Table 4 also reports the percentage of firms that reported some impact of the three diseases on their business.[12] The percentage of firms that anticipated or were experiencing some impact of HIV/AIDS varied with the national prevalence rates: 72% of respondents in countries with HIV/AIDS prevalence rates above 1%; 94% of respondents in countries where national prevalence rates are between 15% and 19%; and 98% of respondents in countries where prevalence rates are 20% above (WEF, 2003). In most of the countries the proportion of firms that anticipated or were experiencing some impact of HIV/AIDS was higher than the proportion of firms that reported the effect of malaria and those that reported the effect of TB. For example, 77% of respondents in Botswana reported a serious impact of HIV/AIDS compared to 9% and 32% for malaria and TB, respectively.

3 The Data and the Variables

The analyses utilize panel data from 40 countries in Sub-Saharan Africa over the period 1990-2008. The dependent variable is fdi where $fdi = \ln(1+FDI)$, and FDI is net FDI inflows in ten billion U.S. dollars.[13] As it is standard in the literature, we average the data over three years to smooth out cyclical fluctuations. We use the percentage of adults that are HIV positive in a country, hiv, to capture the severity of the HIV/AIDS epidemic. Table 5 shows the value of hiv averaged from 1990 to 2008, for the countries in our sample.

Control Variables: Following the literature on the determinants of FDI, we include the following control variables in our benchmark regressions: $trade/GDP$ as

[12] The number of firms that reported some impact of HIV/AIDS on business include firms that reported a serious impact and those that reported a moderate impact.

[13] The data on net FDI are negative for some of the observations. Converting to billions of dollars and adding one ensures that all the observations are positive.

a measure of openness to trade, and gross fixed capital formation as a share of GDP to measure infrastructure development.[14] All else equal, openness to trade and a better physical infrastructure should have a positive effect on FDI. Large domestic markets imply a greater demand for goods and services and therefore make the host country more attractive for FDI. However, it is possible that the size of the market needs to achieve a certain minimum threshold for the positive effect to be realized (Asiedu and Lien, 2003). Therefore following Asiedu and Lien (2003), we include GDP and the square of GDP as explanatory variables in our regressions. The data for HIV and the control variables are from the World Development Indicators (WDI) published in 2011.

Robustness Variables: Several studies have found that FDI restrictions, political instability and weak institutions deter FDI (Wei, 2000; Asiedu and Lien, 2011). However, the data on these variables cover a very limited number of countries in Sub-Saharan countries. To conduct our robustness checks, we use three variables to measure the intensity of natural resource exports. These variables are *fuels, minerals* and *natexp*, which, respectively, measure the shares of the value of fuels, minerals and the sum of fuels and minerals in total merchandise exports**.** The use of these variables is motivated by the fact that FDI inflows to SSA mostly go to a handful of countries and that it is concentrated in specific sectors. Table 6 shows the summary statistics of the variables included in our analysis.

4 Estimation Procedure

We estimate a linear dynamic panel-data (DPD) model to capture the effect of previous FDI flows on current flows. DPD models contain unobserved panel-level effects that are correlated with the lagged dependent variable, and this renders standard estimators inconsistent. The GMM estimator proposed by Arellano and Bond (1991) provides consistent estimates for such models. This estimator often

[14]Gross fixed capital formation includes funds spent on the construction of roads, railways, schools, commercial and industrial buildings and land improvements.

referred to as the "difference" GMM estimator differences the data first and then uses lagged values of the endogenous variables as instruments. However, as pointed out by Arellano and Bover (1995), lagged levels are often poor instruments for first differences. Blundell and Bond (1998) proposed a more efficient estimator, the "system" GMM estimator, which mitigates the weak instruments problem by using additional moment conditions.[15] As a consequence, we use the more efficient and less biased system GMM estimator for our regressions.

We now point out some potential caveats of the system GMM estimator and discuss how these problems are addressed. First, the system GMM procedure assumes that there is no second order autocorrelation in the idiosyncratic errors. Second, the instruments may not be valid. To address these potential problems, we test for autocorrelation and the validity of instruments for each regression. Specifically, for each regression, we report the p-values for the test for second order autocorrelation as well as the Hansen J test for overidentifying restrictions. Another relevant issue is that the test for autocorrelation and the Hansen J test lose power when the number of instruments, i, is large relative to the cross section sample size (in our case, the number of countries), n. Specifically, when the instrument ratio, r, defined as $r = n/i$, is less than 1, the assumptions underlying the two procedures are likely to be violated (Roodman, 2007; Stata, 2009). Furthermore, a low r raises the susceptibility of the estimates to a Type 1 error—i.e., producing significant results even though there is no underlying association between the variables involved. The easiest solution to this problem is to reduce the instrument count by limiting the number of lagged levels to be included as instruments to the point where $r \geq 1$ (Roodman, 2007; Stata, 2009). Therefore, for cases where $r \geq 1$, we do not restrict the number of lags of the dependent variable used for instrumentation. For cases where $r < 1$, we test whether our results hold when we limit the number of instru-

[15] The system GMM uses more instruments than the difference GMM, and therefore one might expect the system estimator be more biased than the difference estimator. However, Hayakawa (2007) shows that the bias is smaller for the system than the difference GMM. Specifically, the bias of the system GMM estimator is smaller because it is a weighted sum of the biases of the difference and the level estimator, and that these biases move in opposite directions.

ments. Finally, including time dummies in the regressions has two advantages: it mitigates the effects of fluctuations in FDI flows; and it also increases the likelihood that the assumption of no correlation across individuals in the idiosyncratic disturbances will be valid (Roodman, 2007). We therefore include time dummies in all our regressions.

We estimate the equation:

$$fdi_{it} = \alpha hiv_{it} + \beta hiv_{it}^2 + \rho fdi_{it-1} + \Sigma_{j=1}^{J} \gamma_j Z_{jit} + \theta_i + \lambda_t + \varepsilon_{it} \tag{1}$$

where i refers to countries, t to time, $fdi = \ln(1+FDI)$, hiv is HIV adult prevalence rate, Z is a vector of control variables, and θ_i and λ_t are country-specific and time-specific effects, respectively.

We now provide some details about our estimation strategy. First, we use the two-step GMM estimator, which is asymptotically efficient and robust to all kinds of heteroskedasticity. Second, as noted in the introduction, hiv, and therefore hiv^2 are likely to be endogenous. Therefore in our regressions, we specify hiv and hiv^2 as endogenous variables. Third, the control variables are treated as strictly exogenous. Finally, our regressions utilize only internal instruments—we do not include additional (external) instruments.

5 Empirical Results

We shall first mention that the effect of HIV/AIDS on FDI can be derived from equation (1) as $\partial fdi/\partial hiv = \alpha + 2\beta \times hiv$. Therefore, the parameters of interest are α and β. Table 7 reports the estimation results. In columns (1) and (2) we control for market size, trade openness and infrastructure development. However, the coefficient of fixed investments is not significant (p-value = 0.777) in the regression in column (1) in which the number of instruments is curtailed. When the number of lags of the variables used in instrumentation is unrestricted (column 2), the coefficient of fixed investments is rather significant at the 1% level of significance. In columns (3) and (4), on the other hand, we drop fixed investments and respectively run the regression with a limited number of instruments (column 3) and the full set of instruments (column 4).

Three notable points follow from Table 7. First, the p-values for the test for autocorrelation and the Hansen J test show the validity of the instruments and the absence of second order autocorrelation in the first differenced errors. Second, $\widehat{\alpha}$ and $\widehat{\beta}$ are significant at the 1% level in all the regressions. The third point is that $\widehat{\alpha} < 0$ and $\widehat{\beta} > 0$, implying that HIV/AIDS has a negative and diminishing effect on FDI. It also implies that there exists a critical value of hiv, which we denote by hiv^*, such that $\partial fdi/\partial hiv = \widehat{\alpha} + 2\widehat{\beta} \times hiv^* = 0$. Note that hiv^* takes on a different value for each regression. Furthermore, $\partial fdi/\partial hiv < 0$ when $hiv < hiv^*$, suggesting that HIV/AIDS is negatively correlated with FDI when $hiv < hiv^*$. To facilitate the interpretation of our result, we define $\overline{hiv}$ as the value of hiv averaged over the period 1990-2008, and we compute the value of $\overline{hiv}$ for each of the countries in our sample (see Table 6). In Table 7 we also report the value of hiv^* and the percentage of countries for which $\overline{hiv} < hiv^*$. This percentage reflects the share of countries for which HIV/AIDS is negatively correlated with FDI. Note that the value of hiv^* is quite high—it ranges between 12.5% and 19%, and in at least 85% of the countries in the sample HIV/AIDS is negatively correlated with FDI. Also note that the proportion of countries with the average HIV/AIDS prevalence rates below the critical values increases from 85% to 87% when we drop fixed investments with curtailed instruments (columns 1 and 3), while this proportion (90%) does not change at all when the full set of instruments is used (columns 2 and 4).

To further elucidate our results, we evaluate the estimated value of $\partial fdi/\partial hiv$ at reasonable values of hiv. Specifically, we evaluate $\partial fdi/\partial hiv$ at the 25^{th}, 50^{th}, 75^{th}, 90^{th} percentile and the mean of $\overline{hiv}$ for each sample group and we report the values in Table 8. As shown in Table 8, the estimated value of $\partial fdi/\partial hiv$ is negative and significant at the 1% level for the various values of hiv, suggesting that overall, HIV/AIDS has a negative impact on FDI flows. We use the regressions reported in Column (1) to illustrate our point. With the estimated coefficients, we have $\partial fdi/\partial hiv = -0.0031 + 2 \times 0.0001 \times hiv$. The 25^{th}, 50^{th}, 75^{th}, and 90^{th}

percentile and the mean of $\overline{hiv}$ roughly corresponds to the average value of hiv for Benin, Equatorial Guinea, Tanzania, South Africa and Central African Republic respectively (see Table 5).

Table 8 also portrays the diminishing effect of HIV on FDI. Specifically, the magnitude of $\partial fdi/\partial hiv$ declines as hiv increases from the 25^{th} percentile to the 90^{th} percentile. For example, the adverse impact of a one percentage point increase in hiv on FDI for the 25^{th} percentile country (i.e., Benin, with $\overline{hiv} = 1.12$) is equal to about 9.7 times the effect in the 90^{th} percentile country (South Africa, with $\overline{hiv} = 13.38$). This result implies that overall, HIV/AIDS deters FDI in Sub-Saharan Africa; however, FDI is more sensitive to HIV/AIDS in low prevalence countries than in high prevalence countries.

With regard to the control variable, it follows from Table 7 that all else equal, openness to trade and infrastructure development positively and significantly affect FDI inflows to SSA countries. Moreover, GDP has a threshold effect, meaning that this variable has a positive effect on FDI only if total income exceeds a certain critical level. These results are consistent with previous studies. On the other hand, lagged FDI has a negative effect. This may be suggestive of the fact that some characteristics that pertain to FDI in SSA middle income countries are producing a confounding and unexpected effect when the information from both low income countries and middle income countries in SSA is pooled altogether in the regression.

5.1 Robustness Regressions

In this section, we shall check the robustness of the results in the previous section. More specifically, we found that the relationship between HIV/AIDS and FDI is negative and diminishing. Keeping in mind the fact that FDI inflows to SSA mostly go to a handful of countries and that it is concentrated in specific sectors, we reestimate our model by including variables that are related to natural resources. To capture the intensity of natural resource, we include three different measures: the share of fuels in the total merchandise exports (*fuels*), the share of minerals in the total merchandise exports (*minerals*), and the share of fuels and minerals in total merchandise exports (*natexp = fuels + minerals).* We also control for the number of telephone by 100 people to account for infrastructure development in the host country. Note that infrastructure development was also controlled for in the main regression by including gross fixed investments.

Table 9 reports the result of the robustness regressions. The regressions in columns (1), (2) and (4) include the variables *fuels*, *minerals* and *natexp*, one at a time. Column (3) includes both components of the natural resources export intensity, in contrast to column (4) where their sum is used. Finally, columns (5) and (6) augment the regressions in columns (3) and (4) by including the number of telephones by 100 people (*infrastructure*) as an additional explanatory variable. The variable *trade/GDP* was dropped from the regression in column (6) because its coefficient was not significant.

Two main points emerge from the robustness regressions in Table 9. First, the coefficients of the variables *fuels*, *minerals* and *natexp* are significant at the 1% level, except for the variable *minerals* in the regression where we control for *infrastructure.* Furthermore, when *infrastructure* is included in the regression, its coefficient also significant at the 1% level. Second, and more importantly, the results are robust: $\widehat{\alpha}$ is negative and significant at the 1% level and $\widehat{\beta}$ is positive and significant at the 1% level in all the regressions. In addition, the magnitudes of $\widehat{\alpha}$ and $\widehat{\beta}$ are fairly stable across specifications.

6 A Simple Model of HIV/AIDS and FDI

The discussion in Section 2 suggests that lower productivity and/or increased absenteeism is the most important channel through which HIV/AIDS affects businesses. Here we present a simple model to rationalize the above empirical results. The model incorporates the productivity/absenteeism effect of the epidemic with the following three features. First, we assume that infected workers have lower productivity than uninfected workers. Second, infected workers take days off from work when they fall sick.[16] [17]The third feature is related to a negative externality of the disease. The morbidity (sickness) rate and the mortality (death) rate of HIV/AIDS is quite high. The sickness and death of infected co-workers may affect the work environment and lower morale at the workplace. In addition, uninfected workers may be reluctant to interact with infected workers for fear of being infected. Clearly, these factors lead to a reduction in overall productivity at the workplace. We incorporate such a negative externality by assuming that infected workers lower the productivity of all workers. Thus the total (labor-augmented) productivity can be decomposed into two parts: the "idiosyncratic" part which is determined by the individual's HIV status and "non-idiosyncratic" part which is determined by the overall health of the entire labor force. Therefore in our model, the HIV prevalence rate enters the goods production function as a determinant of effective units of labor.[18] The existence of such an externality is crucial in establishing the non-linear effect of HIV/AIDS on FDI.

We now describe the model. Consider an environment where a host country uses capital, k, and labor, n, to produce output according to the following production function:

$$f(k, n) = k^{\theta} n^{1-\theta}. \tag{2}$$

Here, $k = k_d + k_f$, where k_d is domestic capital and k_f is foreign-owned capital, i.e., FDI. We assume that k_d is exogenously determined and k_f earns a rate of return r, determined by the world capital market. The population of workers in the host country is normalized to unity. Let $h \in (0, 1)$ be the share of the workers that are HIV positive. We use subscripts "1" and "2" to refer to uninfected and infected

[16]For example in Swaziland, about 25 percent of the workers are absent from work every month because of HIV/AIDS (IRIN, 2009).

[17]Grossman (1972) also includes sick time as a source of disutility, based on the argument that health capital differs from other forms of human capital: a person's stock of knowledge affects his market and nonmarket productivity while his stock of health determines the total amount of time available for his market and nonmarket activities.

[18]In the health-development literature, health is usually considered an important component of human capital and enters the goods production function either as a factor of input (Bloom et al, 2004; McDonald and Roberts, 2006), or as a determinant of the total factor productivity (e.g., Acemoglu and Johnson, 2008).

workers, respectively. Denote workers' labor supply by n_1 and n_2, respectively. Then their effective labor supply is equal to $(1-h)\,n_1$ and $\alpha h n_2$, respectively, with $\alpha \in (0,1)$ reflecting the assumption that infected workers have lower productivity. To take into account the negative externality, we introduce a discount factor on the quality of labor supplied by all workers, $\gamma(h)$, such that $\gamma(h) \in (0,1)$. We assume $\gamma'(h) < 0$. This assumption implies that the negative externality gets bigger as the prevalence rate increases. Note that α pertains to only infected workers (i.e., the "idiosyncratic" productivity parameter) but $\gamma(h)$ affects all workers (i.e., the "non-idiosyncratic" productivity parameter). Thus, the aggregate effective labor supply (adjusted for quality) is given by

$$n = \gamma(h)\left[(1-h)\,n_1 + h\alpha n_2\right]. \tag{3}$$

For simplicity, we assume that the utility function is separable in consumption, c, and leisure time, l, and takes the form:

$$u(c,l) = \ln c + \eta \ln l, \tag{4}$$

where $\eta > 0$. We normalize time endowment to be equal to one. Let s be the time taken off by sick infected workers. Then the effective time endowment of infected workers is $1-s$. Thus the time constraint faced by healthy and infected workers are given by (5) and (6) respectively:

$$n_1 = 1 - l_1, \tag{5}$$

$$n_2 = 1 - s - l_2. \tag{6}$$

Finally the resource constraint for the host country is:

$$(1-h)\,c_1 + hc_2 = f(k_d + k_f, n) - rk_f. \tag{7}$$

The host country chooses c_1, c_2, n_1, n_2, and k_f to maximize:

$$U = (1-h)\,u(c_1,l_1) + hu(c_2,l_2), \tag{8}$$

subject to equations (2)-(7).

Total differentiating the first order conditions with respect to h yields

$$(1+\eta)(r/\theta)^{\frac{1}{1-\theta}} \frac{dk_f}{dh} = -\gamma(h)[1-\alpha(1-s)] + \gamma'(h)[(1-h)+h\alpha(1-s)], \quad (9)$$

$$(1+\eta)(r/\theta)^{\frac{1}{1-\theta}} \frac{d^2k_f}{dh^2} = -2\gamma'(h)[1-\alpha(1-s)] + \gamma''(h)[(1-h)+h\alpha(1-s)]. \quad (10)$$

Clearly $dk_f/dh < 0$ as long as any one of the following three conditions is satisfied: (i) $\alpha < 1$; (ii) $s > 0$; or (iii) $\gamma'(h) < 0$. This implies that HIV/AIDS has an adverse effect on FDI: (i) when infected workers have a lower productivity relative to uninfected workers, $\alpha < 1$; or (ii) when infected workers take sick time, $s > 0$; or (iii) when the negative externality generated by HIV/AIDS increases with the prevalence rate, $\gamma'(h) < 0$. From (10) we can see that $d^2k_f/dh^2 > 0$ if and only if $2\gamma'(h)[1-\alpha(1-s)] < \gamma''(h)[(1-h)+h\alpha(1-s)]$. This condition is easy to satisfy. Suppose we further assume that $\gamma(h)$ is concave. Then $\gamma''(h) > 0$ hence $d^2k_f/dh^2 > 0$. Note that defining γ as a function of h is critical for the non-linearity result. It is still possible to have $dk_f/dh < 0$ as long as $\alpha < 1$ or $s > 0$. However d^2k_f/dh^2 will be equal to 0 once γ is independent of h, suggesting that the effect of HIV/AIDS on FDI, although still negative, will be the same across different values of the prevalence rate. In summary, our simple model delivers the empirical result that HIV/AIDS has a non-linear effect on FDI, and the effect is diminishing under certain condition.

7 Conclusion

This paper empirically examines the effect of HIV/AIDS on FDI, using evidence from Sub-Saharan African countries. To evaluate this effect, we conducted our analysis using the dynamic panel data estimation methods. We particularly allowed for endogeneity and nonlinearity of HIV/AIDS in the estimation. We found that HIV/AIDS adversely affects FDI to countries in SSA and that this adverse effect is diminishing as HIV/AIDS prevalence rate increases. By the virtue of the significant nonlinear relationship between FDI and HIV/AIDS, we found that there exists a critical value of HIV/AIDS prevalence such that HIV/AIDS is negatively related with FDI in countries where the prevalence rate is less than the critical value. More specifically, HIV/AIDS prevalence rates are negatively correlated with FDI inflows for at least 80% of countries in the sample.

References

[1] Acemoglu, D, and S. Johnson (2008), “Disease and Development: The Effects of Life Expectancy on Economic Growth,” *Journal of Political Economy* 113(5), 949–995.

[2] Alsan M., D. E. Bloom, and D. Canning (2006), “The Effect of Population Health on Foreign Direct Investment Inflows to Low- and Middle-Income Countries,” *World Development* 34(4), 613–630.

[3] Arellano, Manuel and Stephen Bond (1991), “Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations,” *Review of Economic Studies* 58, 277–297.

[4] Arellano, Manuel and O. Bover (1995), “Another Look at the Instrumental Variable Estimation of Error Component Models,” *Journal of Econometrics* 68 (1), 29–51.

[5] Asiedu, Elizabeth and Kwabena Gyimah-Brempong (2008), “The Impact of Trade and Investment Liberalization on Foreign Direct Investment, Wages and Employment in Sub-Saharan Africa,” *African Development Review* 20(1), 49-66.

[6] Asiedu, Elizabeth (2002), “On the Determinants of Foreign Direct Investment to Developing Countries: Is Africa Different?” *World Development* 30(1), 107–119.

[7] Asiedu, Elizabeth, Yi Jin and Boaz Nandwa (2009), “Does Foreign Aid Mitigate the Adverse Effect of Expropriation Risk on Foreign Direct Investment?” *Journal of International Economics* 78(2), 268–275.

[8] Asiedu, Elizabeth and Donald Lien (2003), “Capital Controls and Foreign Direct Investment,” *World Development* 32(3), 479–490.

[9] Asiedu, Elizabeth and Donald Lien (2011), “Democracy, Foreign Direct Investment and Natural Resources,” *Journal of International Economics* 84, 99–111.

[10] Azemar, C. and R. Desbordes (2009), “Public Governance, Health and Foreign Direct Investment in Sub-Saharan Africa,” *Journal of African Economies* 18(4), 667–709.

[11] Bloom, D. E., and D. Canning (2009), "The Economic Implications of Population Health," In: Durlauf Steven, Blume Larry., editors. New Palgrave Dictionary of Economics. 2nd. Vol. 6. Macmillan; New York: 516–521.

[12] Bloom, D. E., L. Bloom, D. Steven, and M. Weston (2003), "Business and HIV/AIDS: Who Me? A Global Review of the Business Response to HIV/AIDS," World Economic Forum Global Health Initiative, Geneva.

[13] Bloom, D. E., D. Canning, and J. Sevilla (2004), "The Effect of Health on Economic Growth: A Production Function Approach," *World Development* 32(1), 1–13.

[14] Bloom, D. E., and Ajay S. Mahal (1997), "Does the AIDS epidemic Threaten Economic Growth," *Journal of Econometrics* 77(1) 105–124.

[15] Blundell, R. and S. Bond (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics* 87, 115–144.

[16] Busse, M. and C. Hefeker (2007), "Political risk, Institution and Foreign Direct Investment," *European Journal of Political Economy* 23, 397–415.

[17] Grossman, Michael (1972), "On the Concept of Health Capital and the Demand for Health," *Journal of Political Economy* 80(2), 223–255.

[18] Haacker, Marcus (2004), "HIV/AIDS: The Impact on the Social Fabric and the Economy," In The Macroeconomics of HIV/AIDS, ed. M. Haacker, 198-258. Washington DC: International Monetary Fund.

[19] Hansen, H. and J. Rand (2006), "On the Causal Links between FDI and Growth in Developing Countries," *The World Economy* 29(1), 21–41.

[20] Hayakawa, K. (2007), "Small Sample Bias Properties of the System GMM Estimator in Dynamic Panel Data Models,“ *Economics Letters* 95, 32–38.

[21] International Labor Organization (2005), "HIV/AIDS and Work in a Globalizing World," ILO.

[22] IRIN (2009), http://www.irinnews.org/Report.aspx?ReportId=82946.

[23] Juhn, Chinhui, Sebmen Kalemli-Ozcan and Belgi Turan (2008), HIV and Fertility in Africa: First Evidence from Population Based Surveys.

[24] Kalemli-Ozcan, Sebmen and Belgi Turan (2010) , "HIV and Fertility Revisited," NBER WP 16115.

[25] Lucas, R. E. (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, XXII , 3–42.

[26] McDonald, Scott, and Jennifer Roberts (2006), "AIDS and Economic Growth: A Human Capital Approach," *Journal of Development Economics* 80, 228–250.

[27] Oster, E. (2009), "Routes of infection: Exports and HIV incidence in Sub-Saharan Africa," University of Chicago working paper.

[28] Romer, P. (1986), "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, XCIV, 1002–1037.

[29] Roodman, D. (2007), "A Short Note on the Theme of Too Many Instruments," Center for Global Development Working Paper 125.

[30] Rosen, Sydneya; Ketlhapile, Mpefeb; Sanne, Ianb; DeSilva, Mary Bachmana, 2008. "Differences in Normal Activities, Job Performance and Symptom Prevalence between Patients Not Yet on Antiretroviral Therapy and Patients Initiating Therapy in South Africa," *AIDS* 22, S131–S139.

[31] Sala-i-Martin, Xavier (2005), "On the Health-Poverty Trap," in Gulliem Lopez-Casasnovase, Berta Rivera and Luis Currais, ed., Health and Economic Growth: Findings and Policy Implications.

[32] Stata (2009), Stata Longitudinal Data/Panel Data Reference Manual, Stata Press, College Station, TX: StataCorp LP.

[33] Thirumurthy H, Goldstein M, Graff Zivin J, 2008. "The Economic Impact of AIDS Treatment: Labor Supply in Western Kenya," *Journal of Human Resources* 43, 511–552.

[34] UNCTAD (2009), World Investment Report, Cross-border Mergers and Acquisitions and Development. United Nations, New York. Geneva.

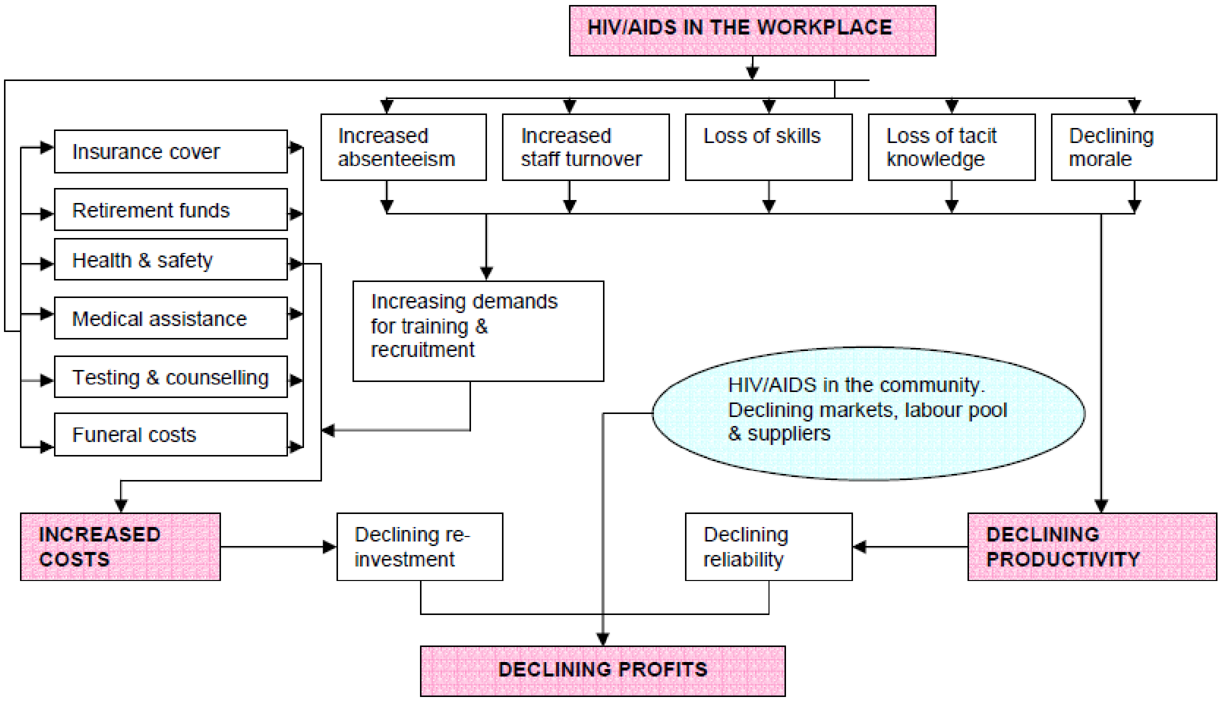
[35] UNDP (2005) Human Development Report. New York: UNDP.

[36] UNAIDS (2010), Report on the Global AIDS Epidemic. Geneva: UNAIDS.

[37] Wei, S. J. (2000), "How Taxing is Corruption on International Investors?" *Review of Economics and Statistics* 82(1), 1–11.

[38] Young, A. (2005), "The Gift of the Dying: The Tragedy of AIDS and the Welfare of Future African Generations," *Quarterly Journal of Economics* 120(2), 423–466.

Figure 1: Mechanisms by Which HIV/AIDS May Affect FDI



Source: UNAIDS, The business response to HIV/AIDS: Impact and lessons learned (UNAIDS, 2000).

Table 1: Life expectancy and HIV rates in selected countries

Country	Life Expectancy (years)			HIV Pevalence Rate (%)	
	1970	1990	2009	1990	2009
Botswana	54.41	64.09	54.95	3.5	24.8
Lesotho	48.88	59.16	45.35	0.8	23.6
South Africa	52.85	61.41	51.62	0.7	17.8
Swaziland	47.93	60.4	46.32	2.3	25.9
Zimbabwe	54.84	60.8	45.44	10.1	14.3

The data on life expectancy are from the World Development Indicators, 2011

Table 2: Percentage of College Graduates Deceased by 2001 by year of Graduation

	Graduation Year			
Country	1980	1987	1994	1999
Malawi	24.8	17.8	5.6	0.7
Tanzania	10.5	9.3	0.9	1.7
Uganda	33.3	14.4	2.8	1.9
Zimbabwe	18.4	17.6	3.5	2.4

Source: IRIN (2009)

Table 3. Impact of HIV/AIDS on Businesses in South Africa

	Number of Firms	Number of Employees	Productivity/ Absenteeism	Labor Turnover	Loss of Experience	Medical Cost	Recruitment Cost
Panel A: By Industry							
Mining	38	4,641	65	52	60	60	50
Manufacturing	317	63,308	58	48	41	54	41
Financial	43	108,975	58	45	41	54	38
Transport	111	111,562	53	40	30	48	38
Motor	38	4,641	32	39	28	30	24
Building and Construction	201	18,270	40	28	26	28	16
Wholesale	77	5,372	28	25	24	20	14
Retail	153	11,682	26	23	23	17	14
Panel B: Firm Size							
Large	107	251,546	80	71	70	82	59
Medium	196	421,997	72	59	55	55	43
Small	691	19,291	33	25	27	25	25
Panel C: Skill Levels							
Semi-Skilled	473	163,150	55	48	45	45	40
Skilled	289	46,757	35	28	25	30	25
Highly Skilled	95	4,774	12	6	8	15	8

Source: SABCOHA (2005) and author's calculations.

Table 4. Percentage of firms that reported serious or some impact of HIV/AIDS, malaria and tuberculosis on their business

	HIV/AIDS		Malaria		Tuberculosis	
Countries	serious impact	some impact	serious impact	some impact	serious impact	some impact
Angola	38	85	66	98	40	87
Botwana	77	96	9	45	32	80
Cameroon	71	96	70	95	55	89
Chad	86	98	69	92	61	90
Ethiopia	72	95	53	80	52	82
Gambia	42	87	72	94	41	90
Ghana	55	89	45	88	29	80
Kenya	63	96	43	87	31	84
Madagascar	35	78	33	83	30	73
Malawi	76	91	41	88	50	91
Mali	54	84	57	95	32	68
Mauritius	3	38	0	9	0	16
Mozambique	72	91	68	92	41	85
Namibia	68	100	26	89	23	89
Nigeria	46	77	41	74	29	70
Rwanda	54	78	52	76	12	70
Senegal	41	67	59	81	44	67
South Africa	79	100	26	74	48	82
Tanzania	74	94	65	94	49	83
Uganda	63	94	64	93	43	89
Zambia	80	97	66	90	66	93
Zimbabwe	94	100	39	82	73	94

Source: World Economic Forum, 2003.

Table 5. Average HIV/AIDS prevalence rates

Country	HIV Rate	Country	HIV Rate
Angola	1.40	Liberia	1.49
Benin	1.12	Madagascar	0.10
Botswana	23.2	Malawi	12.4
Burkina Faso	1.89	Mali	1.23
Burundi	3.77	Mauritania	0.50
Cameroon	5.32	Mauritius	0.51
Central African Republic	5.82	Mozambique	8.70
Chad	2.92	Namibia	12.0
Comoros	0.10	Niger	0.60
Congo, Rep.	4.71	Rwanda	4.97
Cote d'Ivoire	5.48	Senegal	0.45
Equatorial Guinea	2.67	Sierra Leone	1.26
Eritrea	1.22	South Africa	13.4
Ethiopia	2.29	Sudan	1.37
Gabon	4.74	Swaziland	21.2
Gambia, The	0.62	Tanzania	6.93
Ghana	2.03	Togo	3.27
Guinea	1.07	Uganda	8.82
Guinea-Bisau	1.45	Zambia	16.6
Lesotho	20.3	Zimbabwe	24.2

Table 6. Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Foreign Direct Investment/GDP (%)	276	0.02	0.05	-0.08	0.51
HIV Prevalence (%)	249	5.13	6.65	0.10	28.7
Per capita GDP growth (%)	272	1.28	5.79	-31.3	38.3
Infrastructure (telephones per 100 persons)	278	2.34	4.75	0.06	28.6
Fixed investment/GDP (%)	261	19.7	10.2	3.47	90.3
Trade/GDP (%)	269	74.1	38.8	12.8	245.8
Fuels	181	11.4	24.4	0.00	99.4
Minerals	194	12.3	20.8	0.00	87.7
Natexp	181	23.9	29.5	0.00	99.7

Table 7. The Effect of HIV/AIDS on FDI in SSA: Main regression

	(1)	(2)	(3)	(4)
HIV prevalence rate (%), hiv, $\widehat{\alpha}$	-0.0025***	-0.0035***	-0.0031***	-0.0038***
	(0.000)	(0.000)	(0.000)	(0.000)
$hiv \times hiv$, $\widehat{\beta}$	0.0001***	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)	(0.000)
Other Variables				
Lagged FDI	-0.3052***	-0.3328***	-0.1040***	-0.0714***
	(0.000)	(0.000)	(0.000)	(0.000)
$lgdp = Ln(GDP)$	-0.4149***	-0.4607***	-0.3782***	-0.4320***
	(0.000)	(0.000)	(0.000)	(0.000)
$lgdp \times lgdp$	0.0103***	0.0114***	0.0093***	0.0105***
	(0.000)	(0.000)	(0.000)	(0.000)
$Trade/GDP$ (%)	0.0002**	0.0003***	0.0002***	0.0002***
	(0.000)	(0.000)	(0.000)	(0.000)
Fixed Investment/GDP (%)	0.00002	0.0002***		
	(0.777)	(0.009)		
Constant	4.1528***	4.6473***	3.8216***	4.4542***
	(0.000)	(0.000)	(0.000)	(0.000)
Critical value of hiv, hiv^*(%)	12.5	17.5	15.0	19.0
% of Countries with $\overline{hiv} < hiv^*$	85.0	90.0	87.0	90.0
Number of Observations	191	191	198	198
Number of Countries, n	40	40	41	41
Number of Instruments, i	35	50	34	49
Instrument ratio, $r = n/i$	1.1429	0.8000	1.2058	0.8367
Hansen J Test (p-value)[1]	0.5521	0.6328	0.1574	0.4484
Serial Correlation Test (p-value)[2]	0.4572	0.3929	0.2945	0.2780
Limited instruments?	Yes	No	Yes	No

Notes: hiv is the percentage of adults that are HIV positive, $\overline{hiv}$ is the value of hiv averaged from 1990-2008; $hiv = hiv^*$ when $\partial fdi/\partial hiv = 0$.

P-values in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

[1]The null hypothesis is that the instruments are not correlated with the residuals.

[2]The null hypothesis is that the first difference regression exhibit no second order serial correlation.

Table 8. $\partial fdi/\partial hiv = \widehat{\alpha} + 2\widehat{\beta} \times hiv$**, evaluated at different values of** hiv

Percentile of $\overline{hiv}$	Value of hiv	Corresponding country	$\partial fdi/\partial hiv$
25^{th}	1.12	Benin	-0.0029***
			(0.000)
50^{th}	2.67	Equatorial Guinea	-0.0026***
			(0.000)
75^{th}	6.93	Tanzania	-0.0017***
			(0.000)
90^{th}	13.38	South Africa	-0.0003***
			(0.000)
Mean	5.78	Central Africa	-0.0015***
			(0.000)

Notes: hiv is the percentage of adults that are HIV positive, and $\overline{hiv}$ is the value of hiv averaged from 1990-2008.
P-values in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 9. Robustness Checks

	(1) Fuels	(2) Minerals	(3) Fuels&Min.	(4) Natexp	(5) Infrastr (1)	(6) Infrastr (2)
hiv, $\widehat{\alpha}$	-0.0022***	-0.0025***	-0.0021***	-0.0021***	-0.0020***	-0.0025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$hiv \times hiv$, $\widehat{\beta}$	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.0000	(0.000)
Other Variables						
Lagged FDI	-0.7733***	-0.5803***	-0.7589***	-0.6801***	-0.7570***	-0.6948***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$lgdp = Ln(GDP)$	-0.9229***	-0.7026***	-0.9452***	-0.8611***	-0.9734***	-0.8977***
	(0.000)	(0.000)	(0.0000	(0.000)	(0.000)	(0.000)
$lgdp \times lgdp$	0.0213***	0.0165***	0.0218***	0.0199***	0.0225***	0.0209***
	(0.000)	(0.000)	(0.0000	(0.000)	(0.0000	(0.000)
$Trade/GDP$ (%)	-0.0001***	0.0001***	-0.0001***	-0.0001***	-0.0001***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)	
Fixed Investment/GDP(%)	0.0008***	0.0010***	0.0008***	0.0010***	0.0008***	0.0014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fuels	0.0015***		0.0014***		0.0014***	
	(0.000)		(0.000)		(0.000)	
Minerals		0.0003***	0.0001***		0.0002*	
		(0.000)	(0.000)		(0.053)	
Natexp				0.0007***		0.0007***
				(0.000)		(0.000)
Infrastructure					-0.0014***	-0.0022***
					(0.000)	(0.000)
Constant	9.9714***	7.4505***	10.225***	9.2712***	10.522***	9.6251***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Critical value of hiv, hiv^*(%)	11.0	12.5	10.5	10.5	10.0	12.5
% of Countries with $\overline{hiv}$ <hiv^*	80.0	85.0	80.0	80.0	80.0	85.0
Number of Observations	143	143	143	143	143	143
Number of Countries, n	35	36	35	35	35	35
Hansen J Test (p-value)[1]	0.6335	0.5527	0.7033	0.6927	0.6976	0.2932
Serial Correlation Test (p-value)[2]	0.1170	0.9436	0.1147	0.0643	0.1039	0.0587

Notes: hiv is the percentage of adults that are HIV positive, $\overline{hiv}$ is the value of hiv averaged from 1990-2008; $hiv = hiv^*$ when $\partial fdi/\partial hiv = 0$

P-values in parenthesis. ***$p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

[1]The null hypothesis is that the instruments are not correlated with the residuals.

[2]The null hypothesis is that the first difference regression exhibit no second order serial correlation.