The Patterns of AIDS' Effects on Growth and Human Capital: Evidence from Africa*

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Abstract

The paper presents empirical evidence of AIDS epidemic effects on demography variables and accumulable factors. Using a panel of 47 Sub-Saharan African countries, we show that AIDS has negative and significant effect on life expectancy and fertility rate. Thus, a one percent increase in AIDS prevalence rate leads to a decrease of one month every year of the life expectancy in average. We also show that AIDS has a negative effect on investment rate, capital intensity and primary and secondary enrollment rate. Eventually, we find a strong negative effect of AIDS on GDP per capita. These findings outline the difference between the short and the long run effects of the epidemic on growth.

Key words: health, AIDS epidemic, human capital, growth, Sub-Saharan Africa

JEL Classification: I10, J11, O15, O40, O55

1 Introduction

The UNAIDS has released its 2008 "Report on the global AIDS epidemic" showing that there were an estimated 33 million people living with AIDS in 2007 in the World. Sub-Saharan Africa remains the most heavily affected by HIV, accounting for 67% of all people living with HIV and for 72% of AIDS deaths in 2007. In some countries, as Botswana, Lesotho and South Africa, the HIV prevalence rate among pregnant women attending clinics is more than 30%.

The social and economic consequences of such epidemic are huge. Families are broken, sometimes with an important number of orphans. The burden in family incumbering to provide health care for infected people is heavy and, has consequences on savings and

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investment. It also have important effect on national public policies directing finance to health care from others non satisfied needs. None has a doubt on the economic consequences of AIDS on hit countries. However, first estimation by Bloom and Mahal (1997) in a cross-country perspective found no evidence that AIDS impedes growth. These estimates have been criticized for the lack of appropriate data, since they were based on data for the period 1980-1992, when AIDS prevalence were low. Others estimates, in this first wave of tentative to assess the macroeconomic effects of HIV/AIDS were by Cuddington (1993) and, Cuddington and Hancock (1994). They examined the impact of AIDS on individual countries showing that the negative effects on Malawi and Botswana GDP per capita or growth rate were important.

A second wave of studies aiming to assess the impact of AIDS on growth find more evidence of the negative effects of the epidemic. Bonnel (2000) concluded from a cross-country study that AIDS on average reduced Africa's per capita growth by 0.7% points. McDonald and Roberts (2006), departing from studies that use cross-country cross-section method, estimate the AIDS' effects on growth in a cross-country panel data. They found that, in Africa, the marginal impact on income per capita of a 1% increase in HIV prevalence rate is minus 0.59%. Thus, at least, there is still debates on the magnitude of the AIDS impact on growth.

This paper has one goal which is to assess and separate the empirical effects of AIDS on variables that matters for growth, namely demographic and factors accumulable variables, from the effects on GDP per capita and growth. Doing so, we expect to differentiate the long run and short run effects of the epidemic.

Our estimates, based on data from the UNAIDS for 47 Sub-Saharan Africa, indicate that AIDS reduce life expectancy by one month every year for a 1% increase of the epidemics. It also have substantial negative effect on fertility rate. These results differs from the findings of Kalemli-Ozcan (2006) who depict a positive effect of AIDS on fertility. The effect on capital intensity and on investment rate are also negative. The impacts of AIDS in education are also negative. We then estimate the global effect on GDP per capital and find no significant evidence of AIDS effect on it. The one way to reconcile these findings is that the long run effects of AIDS have not already completely occurred.

The next section presents the econometric analysis. Section 3 set up the model. In section 4 we develop the policy analysis.

2 Econometric Analysis

2.1 The controverse

2.2 The data

2.2.1 HIV/AIDS

The data are from several international institutions and cover 47 countries of Sub-Saharan Africa on a yearly basis from 1970 to 2006[1]. Data on HIV/AIDS epidemic are from the UNAIDS fact sheets, which detail the spread of HIV infection on each UN country using several sources. The most reliable and comparable variable, both in time and space are HIV/AIDS prevalence rate among pregnant women in both rural and urban areas and reported AIDS cases. We mainly use HIV/AIDS prevalence rate among pregnant women.

[1] A sum up of available data by country can be found in appendix.

Nevertheless, those data are available only between 1987 and 2003 and have many holes. To build an extensive dataset one can first use the correlation between urban and rural prevalence within a country to "predict" the national data (see regressions in table 1). To build comparative data mostly between 1982 and 1990, one can use the correlation between AIDS case and HIV prevalence among women in urban areas. The correlation was indeed stronger at the beginning of the epidemics. Indeed people infected with HIV presented AIDS more frequently and rapidly AIDS because treatments were not available yet. In addition to that, AIDS cases were probably less underreported in urban areas, where health facilities are larger and better endowed. Equations used to predict the missing data are estimated using GLS regressions which have the following form:

$$hivu_t^i = \rho_u hivu_{t-1}^i + \lambda_u hivu_{t+1}^i + \gamma_u hivr_t^i + \alpha_u aids_{t-1}^i + u_i + \varepsilon_t^i \tag{1}$$

Dep. var.	HIV rural	HIV rural	HIV rural	HIV rural	HIV rural
Method	GLS	GLS	GLS	GLS	GLS
HIV rural (-1)	0.77** (18.3)	–	–	0.53** (15.4)	–
HIV rural (-2)	–	–	–	–	0.29** (9.0)
HIV rural (1)	–	0.59** (7.9)	–	0.49** (15.3)	0.70** (25.2)
HIV urban	0.18** (5.2)	0.31** (4.6)	0.64** (17.7)		–
Intercept	0.21 0.4)	−0.88 (1.5)	0.72 (0.3)	−0.07 (0.3)	0.02 (0.1)
Country fix.	No	Yes	No	No	No
N	197	189	273	256	279
# Country	33	32	38	37	38
Adj. R^2	0.89	0.86	0.62	0.92	0.91
# predict.	24	19	51	46	28

*,** indicate respectively significance at the 5% and 0.1% level

Table 1: Regressions used to predict HIV prevalence among pregnant women in rural area

On the contrary, AIDS cases do not appear to be a good predictor of HIV prevalence rate in rural areas. See table 2 for the regressions used for predicting missing data.

$$hivr_t^i = \rho_r hivr_{t-1}^i + \lambda_r hivr_{t+1}^i + \gamma_r hivu_t^i + u_i + \varepsilon_t^i \tag{2}$$

HIV prevalence rate among total population is finally calculated as a weighting average of HIV prevalence rate among rural and urban population. However, pregnant women prevalence rates are avalailable between 1987 and 2002 only. To complete the data set between 1982[2] and 1987 and after 2002, one can use reported AIDS cases and prevalence rate among the all population (see table 3).

$$\ln(hiv_t^i) = a \ln(aids_t^i) + u_i + \varepsilon_t^i \tag{3}$$

$$hivhp_t^i = \eta hivt_t^i + e_t + \varepsilon_t^i \tag{4}$$

[2]Prevalence rates of HIV are assumed to be null everywhere before 1982.

Dep. var.	HIV urban	HIV urban	HIV urban	HIV urban	HIV urban
Method	GLS	GLS	GLS	GLS	GLS
HIV urban (-1)	0.88** (23.4)	–	–	0.53** (14.9)	–
HIV urban (-2)	–	–	–	–	0.37** (11.2)
HIV urban (1)	–	0.57** (9.9)	–	0.46** 12.8)	0.62** (20.5)
HIV rural	0.14** (3.3)	0.41** (7.4)	0.54** (10.1)	–	–
AIDS case (-1)	–		0.08** (8.6)	–	–
Intercept	0.86* (2.2)	1.55* (2.7)	4.33** (4.6)	0.14 (0.6)	0.16 (0.6)
Country fix.	No	Yes	No	No	No
N	197	191	241	256	279
# Country	33	33	38	37	38
Adj. R^2	0.9	0.88	0.6	0.94	0.93
# predict.	21	18	20	46	28

*,** indicate respectively significance at the 5% and 0.1% level

Table 2: Regressions used to predict HIV prevalence among pregnant women in urban area

2.2.2 Other data

Urbanization data are from United Nations World Urbanization Prospects (2007) (UNWUP)[3]. In African countries the rate of education enrolment is correlated with the level of urbanization and the latter is also linked to HIV/AID progression. Infant mortality data are available on a five-year average basis in the UNWUP. We compute the annual data with an algorithm that minimizes the yearly variation of the annual growth rate of data taking the value of the series in the years 1970, 1975, 1980, 1985 and 1990 as given. This procedure is therefore very similar to an Hodrick-Prescott filter. Fertility and life expectancy data are published by the World Bank every two or three years since 1960. We compute the annual data with the same procedure as before. Demographic data, such as working age population are from UN data. Estimates of GDP and net formation of fixed capital (in constant US$) are provided by the United Nations Statistics Division on a yearly basis. Education data including primary and secondary enrolment rate and the ratio of the number of pupil per teacher on the primary level are from UNESCO data. These data are available yearly since 1990 and every five year from 1960 to 1990. Missing years are extrapolated from five-year data using our smoothing algorithm. The data on conflicts are extracted from the third version of the Armed Conflict Dataset of the Uppsala Conflict Data Program, Uppsala University (UCDP) and International Peace Research Institute (Oslo) (UCDP/PRIO, December 2007). This dataset contains annual observations of conflicts about all members of the international system, as defined by Gleditsch & Ward (1999), between 1946 and 2006.

[3]The 2007 Revision Population Database

Dep. var.	$\ln(HIV_{pw})$	$\ln(HIV_{pw})$	HIV_{pw}
Method	GLS	GLS	GLS
ln(AIDS)	0.19** (4.7)	–	–
ln(AIDS (-1))	–	0.17** (5.3)	–
HIV_{tot}	–	– (	0.96** (18.3)
Intercept	3.2** 4.7)	3.1** (3.7)	5.96** (2.9)
Country fix.	Yes	Yes	No
Year fix.	Yes	Yes	Yes
N	456	494	80
# Country	42	42	41
Adj. R^2	0.32	0.3	0.87
# predict.	43	111	125

*,** indicate respectively significance at the 5% and 0.1% level

Table 3: Regressions used to predict HIV prevalence among pregnant women from reported AIDS cases and prevalence within the all population

3 Results

To assess the effects of AIDS on demographic, education and macroeconomic varibales, we run the following panel within regression with country and yearly fixed effects:

$$\mathrm{Y}_t^i = \alpha AIDS_{t-1}^i + \sum_{k=1}^{K} \beta_k CONTROL_{kt}^i + u_i + \eta_t + \varepsilon_t^i \tag{5}$$

where Y_t^i is the dependent variable Y at time t in the country i, u_i is the fixed effect of the country i, η_t is the year fixed effect and "CONTROL$_k$" represent the control variables. The fixed effects take into account the heterogeneity between countries in terms of infrastructure, wealth or religion as well as the impact of global shocks such as crop or oil prices.

3.1 AIDS and demography

HIV / AIDS is likely to affect a country through different mechanisms and variables. HIV /AIDS disease is not a one shot shock that decreases the population level of a country. On the contrary, it is a long lasting disease, which can affect demographic figures as life expectancy, fertility rate and therefore the population level. We consider Sub-Saharan Africa because it is the region most affected by AIDS in terms of death. Our estimations cover the 47 Sub-Saharan African countries from 1970 to 2006. Our concern is whether and in which scale AIDS had an effect on demographic variables.

AIDS reduces life expectancy in two ways. First, it is likely to increase infant mortality by its impact on pregnant women and, secondly, it causes a huge number of death in African countries due to the absence of the needed health care.

Results are given in Table 5. AIDS has a significant negative effect on life expectancy. A 1 point increase in AIDS prevalence rate implies a decrease in life expectancy of 0.07 years. The time fixed effects captures the climbing trend in life expectancy in the absence

Variable	# obs.	Mean	Std. Dev.	Min	Max	Source
GDP per worker ($)	1 662	1483	1933	98	19376	UN
Work. age pop.	1 702	5715	8960	36	76656	UN
Fertility	1 726	6.0	1.3	1.9	8.5	World Bank
Life expectancy	1 727	50.7	7.6	23.6	73.2	UN
Infant Mortality	1 610	109.6	36.8	14.6	206.4	UN
HIV Preval. (%)	1 623	3.7	6.7	0	41.7	UN Facts sheets
Primary school	1 562	77.0	33.2	8.0	179.6	UNESCO
Secondary school	1 536	21.6	18.4	1.1	114.0	UNESCO
Urbanization (%)	1 739	29.0	14.3	2.4	84.1	UN
Civil conflict	1739	0.2	0.2	0	1	UCDP/PRIO
Civil war	1739	0.2	0.2	0	1	UCDP/PRIO

Notes: Variables are averaged over 1970-2006. GDP per worker is GDP over working age population. Fertility is the total number of children per woman. Life expectancy is at birth. Infant mortality is for 1000 births. HIV prevalence is the previously built variable. School variables are gross enrollment in primary and secondary schools. Urbanization is the share of population in urban areas.

Table 4: Descriptive statistics

of AIDS. It shows a very slow progress on life expectancy in the period. The variable Civil war, indicating wether a country had experienced a severe internal wars, has a strong negative effect on life expectancy.

We also analyze the impact of AIDS on fertility rate. Some theoretical models (see Kalemli-Ozcan (2003)) predict that increased education of women reduces fertility due to the raise in the cost of childbearing. In the same line, the higher cost of childbearing in urban zone is associated with a decrease in fertility. The coefficients of correlation between the different variables (see appendix) show that GDP, urbanization, AIDS and education are negatively correlated to fertility.

We estimate the equation (5) with fertility rate as the dependent variable. Regression (2) shows that fertility rate is a steady variable. To exhibit the effects of education, urbanization and income, which are the traditional determinants of fertility, one can regress directly the fertility rate on those variables (regression (3)). The results shown in column (3) indicate that AIDS has indeed a significant negative effect on fertility. A 1 point increase in HIV prevalence lessen the number of births by 0.02 in average per year. For a disease which has been endemic from more than twenty years from now, it induced a huge cumulated effect on population growth. Time fixed effects depict a decreasing trend in fertility and urbanization also has a negative effect on fertility. Increase in secondary education and urbanization also reduces fertility. A one percent increase of the urban population decreases the number of birth by 0.01. To desentangle the direct and indirect effects of AIDS, education, urbanization and infant mortality on fertility, one can instrument the lagged fertility rate using the regression (3). AIDS has a significant negative effect on fertility, which gets stronger in the long-run, as fertility is influenced by customs.

Another important effect of AIDS already emphasized in the literature is its impact on working people. By its nature, AIDS is more likely to affect young adult and therefore hit the working population. However, our estimation of equation (5) with the working population as dependent variable give a very little effect of AIDS on working age population. In regression(5), AIDS have a negative effect on working age population. While,

in reg. (6) where life expectancy have been added the AIDS variable is not significant anymore. The effects of AIDS on the working force go mainly through a decrease of life expectancy.

Dep. var.	Life Exp.	Total Fertility			ln(Work. age pop.)	
Regressions	(1)	(2)	(3)	(4)	(5)	(6)
Method	Within	Within	Within	Within (IV)	Within	Within
$HIV_{pw}(-1)$	-7.55^{**} (20.2)	0.03 (1.2)	-2.41^{**} (10.1)	-0.93^{*} (2.0)	-0.04^{**} (6.0)	0.02 (1.9)
Life Exp.(-1)	0.95^{**} (197.2)	–	–	–	–	0.001^{**} (11.2)
Fertility(-1)	–	1.00^{**} (316.2)	–	$0.59^{**}\dagger$ (3.4)	–	–
ln(Work. Pop(-1))	–	–	–	–	0.96^{**} (203.1)	0.95^{**} (207.5)
ln(GDP per cap.(-1))	-0.03 (0.6)	-0.01 (1.6)	-0.11^{*} (2.5)	-0.05 (1.0)	–	–
Primary enrol.(-1)	–	-0.02 (1.9)	0.24^{**} (3.4)	0.12 (1.5)	–	–
Secondary enr.(-1)	–	0.04 (1.9)	-1.52^{**} (8.9)	-0.74 (2.4)	–	–
Infant Mort.(-1)	–	0.06^{**} (4.4)	0.46^{**} (3.8)	0.24 (1.7)	–	–
Urbanization (-1)	–	0.00 (0.0)	-1.41^{**} (5.1)	-0.46 (1.3)	–	–
Civil conflict	–	–	–	–	-0.006^{**} (4.9)	-0.004^{**} (5.9)
Civil war	-0.12^{*} (2.0)	–	–	–	-0.011^{**} (7.3)	-0.008^{**} (3.6)
Intercept	7.60^{**} (7.6)	-0.05 (1.2)	7.20^{**} (18.0)	2.87^{**} (2.1)	0.31^{**} (9.0)	0.31^{**} (9.3)
Country fix.	Yes	Yes	Yes	Yes	Yes	Yes
Year fix.	Yes	Yes	Yes	Yes	Yes	Yes
N	1571	1367	1368	1312	1591	1591
# Country	47	45	45	45	46	46
Adj. R^2 (within)	0.98	1.00	0.75	0.76	1.00	1.00

Notes: *,** indicate respectively significance at the 5% and 1% level. T-values are between brackets.
(-1) denotes that the variable is one year lagged. † The predicted value of Fertility(-1) is taken from reg. (3).

Table 5: The effects of AIDS on demographic figures

3.2 AIDS and macroeconomic variables

In order to capture the economic effect of AIDS, we investigate whether there have been any impact on macroeconomic variables. To this end, we run the same estimation regression described in equation (5) with macroeconomic variable as dependent variable. The literature has emphasized the different mechanism through which AIDS affect the economy[4]. One aspect of AIDS, by its long lasting time, is to increase health expenditures or to reduce the earnings of a household and, therefore decrease the saving capacity. Thus, AIDS may induce a reduction in capital accumulation and investment and, then a decrease in GDP growth.

[4]See Boucekkine, Diene and Azomahou (2007) for a survey.

Estimations of the impact of AIDS on those variables are given in table 6. The effect of AIDS on GDP per capita is negative, significant and large once the effects of civil conflict are taken into account. The impact on GDP is also negative. The conflicts in the different countries appear to have strong negative impact on GDP and GDP per capita.

AIDS has a positive and significant effect on capital intensity. This is due, in the short run, to the capital deepening effect of AIDS through its negative impact on working age population.

AIDS has however no significant direct affect on investment rate. To conclude, AIDS has a strong effect on per capita GDP, which goes mostly through decrease of life expectancy and human capital.

Dep. var.	ln(GDP per cap.)		ln(GDP)		ln(Cap. int.)	ln(Inv. rate)
Regressions	(7)	(8)	(9)	(10)	(11)	(12)
Method	Within	Within	Within	Within	Within	Within
$HIV_{pw}(-1)$	-0.14^{**} (3.4)	-0.12^{*} (2.5)	-0.19^{**} (4.3)	-0.17^{**} (3.3)	0.04^{**} (6.0)	-0.23 (1.7)
ln(GDP per cap.(-1))	0.97^{**} (140.4)	0.96 101.7	–	–	–	–
ln(GDP(-1))	–	–	0.97^{**} 141.7	0.96^{**} (102.9)	0.00 0.1	0.06^{*} 2.6
ln(Work. Pop(-1))	–	–	–	–	–	–
ln(Cap. Int.(-1))	–	–	–	–	0.97^{**} 282.7	–
ln(Inv. rate(-1))	–	–	–	–	–	0.84^{**} 57.8
Civil conflict	-0.03^{**} 3.9	-0.04^{**} 4.7	-0.03^{**} 4.6	-0.05^{**} 5.5	0.01^{**} (5.1)	-0.02 (0.6)
Civil war	-0.07^{**} (7.4)	-0.09^{**} 7.8	-0.08^{**} 8.5	-0.11^{**} 8.8	0.01^{**} (7.4)	-0.01 (0.4)
Intercept	0.20^{**} (4.1)	0.27^{**} (4.1)	0.50^{**} (4.8)	0.70^{**} (5.0)	0.1^{**} (3.3)	-1.04^{**} (3.0)
Country fix.	Yes	Yes	Yes	Yes	Yes	Yes
Year fix.	Yes	Yes	Yes	Yes	Yes	Yes
Period	71-06	83-06	71-06	83-06	71-06	71-06
N	1551	1023	1583	1043	1551	1591
# Country	46	46	47	47	46	46
Adj. R^2 (within)	0.93	0.92	0.97	0.95	1.00	1.00

Notes: *,** indicate respectively significance at the 5% and 1% level. T-values are between brackets. Capital intensity in reg. (11) is total stock of physical capital divided by working age population. Investment rate in reg. (12) is private investment divided by GDP.

Table 6: The effects of AIDS on macroeconomic variables

3.3 AIDS, growth and education

Several studies have tried to estimate the global effect of AIDS on growth. Early estimates by Over (1992) and Cuddington and Hancock (1994) found evidence of a negative important effect of AIDS on growth. These estimates based of a country specific effects suffer a lack of appropriate data. One of the first estimates in a cross-country basis is by Bloom and Mahal (1997) who found no evidence of negative effect of AIDS on growth. However, their studies have been criticized for the limitations in the data they used. Indeed, the

time period of their estimates (1980-1992) is characterized by a growing, but still limited, AIDS epidemic. More recently, McDonald and Roberts (2005) provide a new estimation of the effect of AIDS on growth through its impact on health capital. Their studies, based on more recent data from 1984 to 1999, is an estimation of a Solow-augmented model, following Mankiw and al. (1992). They introduce health capital as a accumulable factor as human and physical capital. Another difference is that they use panel estimation method applied to cross-country economic growth instead of cross-section method. They found strong and significant negative effect of AIDS on growth.

We estimate a Solow augmented model-type by introducing AIDS variable, it appears to have no effect significantly different from zero. Moreover, the estimation have a very limited explicative power of the variation of GDP per capita. We run another regression more structural with GDP in log as dependent variable and different variables of control. We found that AIDS has no significant effect on GDP. Schooling at primary and secondary level has a positive effect on growth.

The impact of AIDS on education is more likely negative. In our estimation, the impact of AIDS on primary school enrollment rate is negative when others variables as civil conflict are taken into account. Its effect on secondary enrollment is also negative, however non significant. Kalemli-Ozcan (2005) found the same negative effect of AIDS on education in Sub-Saharan Africa.

Dep. var.	Primary enrol.		Secondary enrol.		ln(GDP per cap.)	
Regressions	(13)	(14)	(15)	(16)	(17)	(18)
Method	Within	Within	Within	Within	Within	Within
$HIV_{pw}(-1)$	-0.11^{**}	-0.16^{**}	-0.03^{**}	-0.06^{**}	0.27	0.07
	(3.8)	(4.4)	(2.6)	(3.8)	(1.8)	(0.5)
Primary enrol.(-1)	0.97^{**}	0.93^{**}	0.03^{**}	0.03^{**}	0.16	0.16^{**}
	(116.9)	(76.6)	(8.2)	(5.5)	(3.6)	(2.7)
Secondary enr.(-1)	–		0.94^{**}	0.90^{**}	0.98^{**}	0.77^{**}
			(106.7)	(72.1)	(9.6)	(6.1)
ln(Cap. Int.(-1))	–		–	–	0.02^{**}	-0.16^{*}
					(0.2)	(2.0)
Urbanization(-1)	-0.10^{**}	0.03	0.07^{**}	0.10^{**}	–	–
	(2.8)	(0.6)	(4.7)	(4.0)		
Civil conflict	-0.02^{**}	-0.02^{**}	0.00	0.00	−0.02	-0.06^{*}
	(3.6)	(4.0)	(1.7)	(0.9)	(1.0)	(2.4)
Civil war	-0.03^{**}	-0.04^{**}	0.00	0.00	-0.15^{**}	-0.21^{**}
	(4.7)	(4.7)	(0.2)	(1.0)	(5.0)	(6.0)
Intercept	0.05^{**}	0.10^{**}	-0.02^{**}	-0.02^{**}	6.38^{**}	6.92^{**}
	(4.7)	(3.6)	(4.3)	(1.7)	(33.1)	(32.6)
Country fix.	Yes	Yes	Yes	Yes	Yes	Yes
Year fix.	Yes	Yes	Yes	Yes	Yes	Yes
Period	71-06	83-06	71-06	83-06	71-06	83-06
N	1461	974	1411	936	1406	943
# Country	47	47	46	46	45	45
Adj. R^2 (within)	0.93	0.90	0.96	0.93	0.17	0.16

Notes: *,** indicate respectively significance at the 5% and 1% level. T-values are between brackets.

Table 7: The effects of AIDS on ducation and growth

Therefore, AIDS had limited consequences on growth in the short run in Sub-Saharan Africa. However indirect effects on factors accumulation indicate that AIDS may have strong long-run effects on growth.

4 Simulated impact of AIDS on growth

One could now use the previous results to simulate for each country the dynamics effects of AIDS on growth. Indeed the dynamic of per capita GDP (in log) $y^i_{c,t}$ has been estimated using HIV prevalence rate a^i_t and internal conflicts variables $w^i_{k,t}$, $k = \{1, 2\}$:

$$y^i_{c,t} = \rho y^i_{c,t-1} - \alpha a^i_t + u^i + \eta_t + \sum_k \omega_k w^i_{k,t} \tag{6}$$

Equation (6) can be used to determine the overall effect of AIDS on GDP per capita dynamics. Let us define $t = 0$ as the year AIDS appears:[5]

$$\Delta y^i_{c,t} = -\alpha \sum_{s=0}^{t} \rho^{t-s} a^i_s \tag{7}$$

In the long-run, an permanent increase in HIV prevalence induces a decrease of GDP per capita about $\frac{\alpha}{1-\rho}$. As $\rho \approx 0.96$ and $\alpha \approx 0.12$ accourding to reg. 8 (table 6), a 10 point HIV prevalence in the population induces a fall of GDP per working age adult around 26% in the long-run! The following figures show the dynamics of GDP per capita (as pp. to the baseline) because of AIDS in several countries.

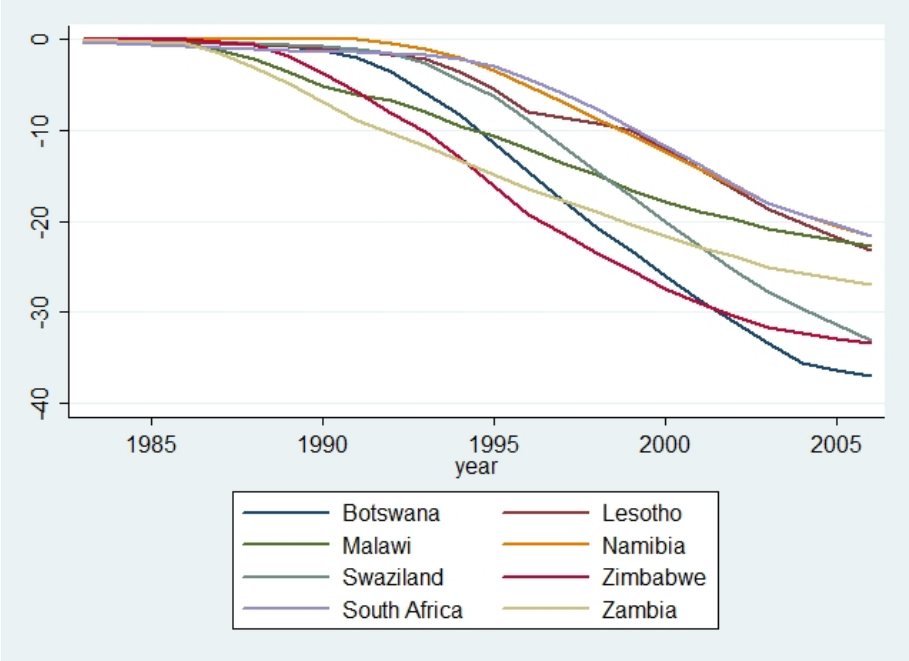

Figure 1: Decrease in GDP per adult in working age (pp.) due to AIDS in heavily hit countries

[5]Which is supposed to have occured around 1983 according to UNAIDS data.

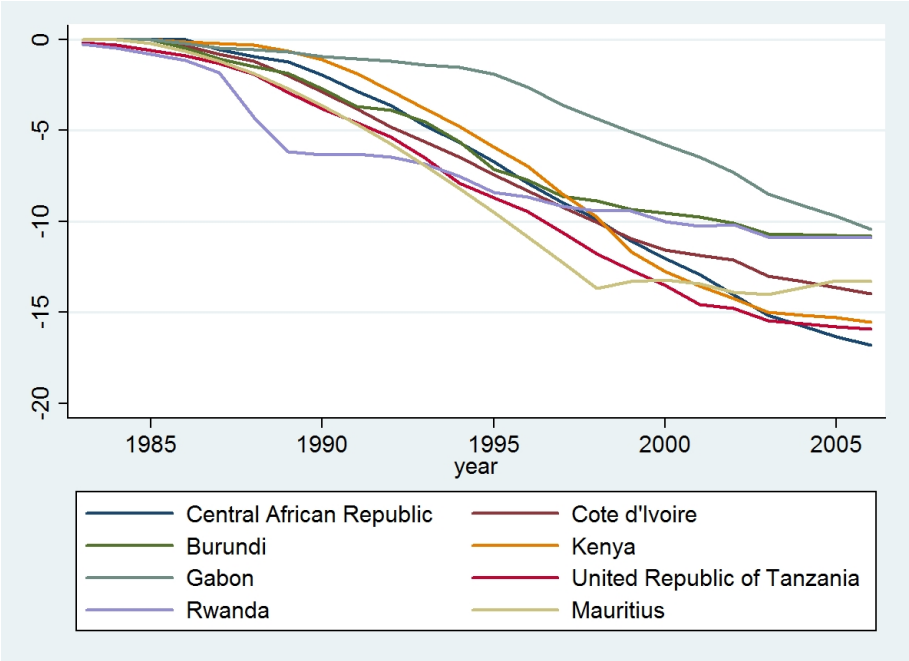

Figure 2: Decrease in GDP per adult in working age (pp.) due to AIDS in strongly hit countries

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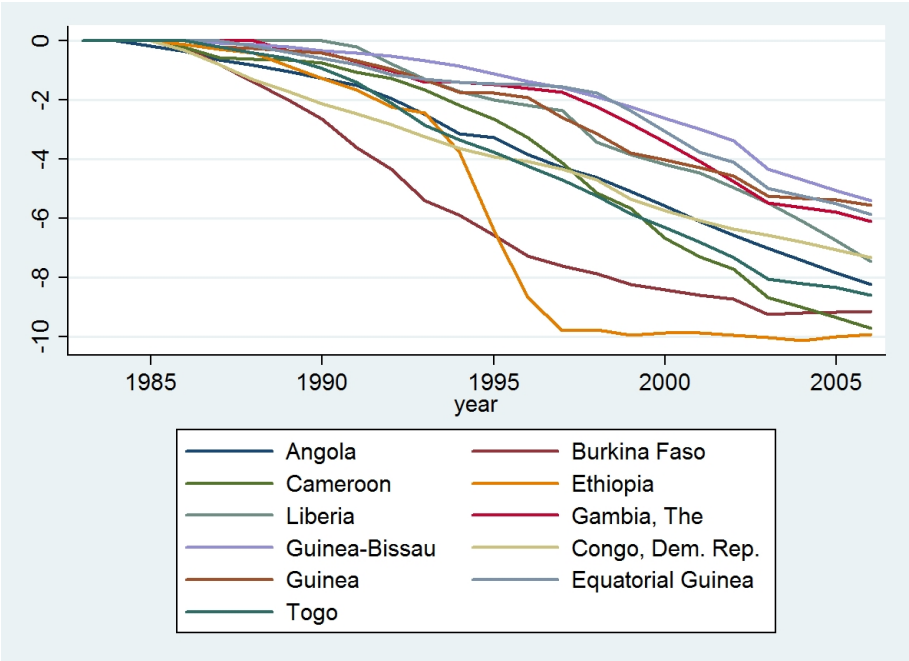

Figure 3: Decrease in GDP per adult in working age (pp.) due to AIDS in other hit countries