Asian Economic and Financial Review, 2014, 4(9): 1146-1157

Asian Economic and Financial Review

journal homepage: http://www.aessweb.com/journals/5002

THE EFFECT OF HIV/AIDS ON ECONOMIC GROWTH OF SOUTHERN AFRICAN COUNTRIES

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ABSTRACT

This paper contributes to the existing literature by investigating the effect of health on overall economic growth in southern African nations. We examine interactions between health and economic growth by including both education and health among factors of production in a neoclassical growth model. Our findings, based on generalized least squares estimation of panel data models, suggest HIV/AIDS substantially and adversely affects the accumulation of human capital and thereby retards growth of per capita income significantly. While human capital remains crucial for growth, the effectiveness of policy depends on whether its focus is on the particular component of human capital, such as health for southern Africa, which serves as the more binding constraint on the rate of an economy's growth.

Keywords: HIV/AIDS, Economic growth, Instrumental variables, Recursive model, Education and health, Southern Africa.

Contribution/ Originality

"This paper contributes to the existing literature by investigating the effect of health on overall economic growth in southern African nations."

1. INTRODUCTION

The impact of HIV/AIDS on human capital and growth has been devastating in Sub-Saharan Africa (SSA) where some of the countries have faced declines in life expectancy of up to 20 years as a result of the disease taking on pandemic proportions. While the AIDS-related deaths have steadily declined from a high of 2.3 million in 2005 to 1.6 million in 2012, HIV/AIDS is ranked highest among the adult killing diseases in SSA (UNAIDS, 2013) where over 70 percent of the global HIV/AIDS deaths in 2012 occurred in SSA alone. According to the UNAIDS Report 2013, "although total financial resources for HIV programmes in low- and middle-income countries rose modestly in 2012, our ability to lay the foundation for an end to the AIDS epidemic continues to be undermined by a major resource gap." (p.3).

The epidemic has been worst in the 10 countries comprising southern Africa, the region of the present study. These countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe. The UNAIDS Report 2013 notes that the HIV prevalence had actually increased between 2001 and 2012 in these countries. While substantial declines were seen in Zimbabwe and less so in Botswana, Malawi, and Zambia, over 15 percent increase in South Africa, the most populous country in southern Africa, had raised the overall HIV prevalence in southern Africa by 2012. Several other countries within the group faced worsening trends as well.

Most empirical evidence suggests that the disease has had a significant adverse microeconomic impact on households and firms as well as on macroeconomies of the affected countries (Dixon *et al.*, 2001; Piot *et al.*, 2001; Tandon, 2005; Lovasz and Schipp, 2009). Increases in morbidity and mortality have threatened to eliminate 25 years of social development gains in several countries of Africa. Much evidence suggests that reductions in labor supply due to declining life expectancy will adversely affect future output while ill health and shortages of critical skills will lower economy-wide productive efficiency. Large increases in health care expenditures will also reduce public and private savings and further cause growth slowdown. A counter-argument, however, comes from Young (2005) and Lovasz and Schipp (2009) who claim that per capita income could even increase as population growth slows due to lower life expectancy.

Few studies have been conducted on the impact of HIV/AIDS on growth in these devastated countries. This paper is a partial attempt to enhance the limited research extant in this area. We study interactions between health and macroeconomic growth using a neoclassical growth model that includes health (as well as education) as an additional factor of production. Our findings, based on generalized least squares estimation of our panel models, suggest HIV/AIDS substantially and adversely affects the accumulation of human capital and thereby retards per capita income and growth significantly. While human capital remains crucial for growth, the effectiveness of policy might depend on whether its focus is on the particular component of human capital, such as health, for southern Africa, that serves as the more binding constraint on the rate of an economy's growth.

2. A BRIEF REVIEW OF LITERATURE

Most studies have found an adverse impact of HIV/AIDS on national income and growth. Tandon (2005) estimates the economic impact of HIV/AIDS in the Asian and Pacific region, and finds a particularly large decline in growth in Cambodia and Papua New Guinea. Dixon *et al.* (2001) augment a neoclassical growth model by including health. Their results indicate that for those African countries where the prevalence of HIV is relatively low the impact of the epidemic conforms to "normal' economic expectations. However, when the epidemic is more widespread, the macroeconomic impact of the epidemic is unclear within the context of their model. But Southern and Eastern African countries have experienced disruption of social and economic relationships resulting from a high incidence of HIV and malaria.

Lovasz and Schipp (2009) also find from their 1997-2005 panel model for 41 countries that HIV/AIDS are indeed associated with a decrease in per capita growth in SSA. More remarkably, McDonald and Roberts (2006) find from their study of 112 countries that a 1 percent increase in HIV prevalence leads to a 0.59 percentage point decline in per capita growth. Even in countries with relatively low HIV prevalence the marginal impacts are non-trivial. While the human and social costs of the HIV/AIDS epidemic are a major cause for concern, these results indicate that the macroeconomic effects of the HIV/AIDS epidemic have been substantial as well.

In a study based on data from 1990 to 1997, Bonnel (2000) suggests that HIV/AIDS has reduced the rate of African per capita growth by 0.7 percentage point per year. In addition, he claims the countries affected by malaria find their growth falling by another 0.3 percentage point per year. Such reductions are large when viewed against the actual African growth of 0.4 percent during 1990-97. A vicious circle that prevailed in much of Africa until the recent past indicates that HIV/AIDS has reduced economic growth and increased poverty, and this in turn has contributed to further spread of HIV.

3. EMPIRICAL STRATEGY AND DATA

To understand the effect of HIV/AIDS on growth, we extend the "human" capital inclusive neoclassical growth model (Mankiw *et al.*, 1992) by incorporating health as an additional form of human capital. Our production function can be simply written as follows:

$$Y_{it} = (K_{it})^{\alpha}(E_{it})^{\beta}(H_{it})^{\psi}(A_{it}L_{it})^{1-\alpha-\beta-\psi} \qquad (1)$$

where Y is real GDP in country i at time t. K, E, and H are stocks of physical capital, education capital, and health capital respectively. We allow *HIV/AIDS* to affect the accumulation of health capital, which is realistic for our sample countries because of the high incidence of the disease. Health capital depends on several factors. One main determinant would be total health expenditure in a country, both public and private. Infrastructure that can improve access to existing health facilities is another variable that is likely to raise health capital. With respect to effectiveness of public health expenditure, governance quality can matter substantially too. For better health, a rising level of education can also be highly important. Finally, we consider disease prevalence rate in general as a factor affecting health capital. Equation (2) summarizes our health equation:

$$H_{it} = f(Hexp_{it}, Infra_{it}, Gov_{it}, Educ_{it}, Dis_{it}) \qquad (2)$$

To simplify our model, we take the HIV infection rate to be a proxy measure for prevalence rate for diseases (Dis_{it}) for southern Africa. This way, we can estimate the impact of HIV on growth through its effect on health capital accumulation. Thus, health production function includes *HIV/AIDS* and other inputs as in equation (2).

Taking log differences of equation (1) yields our empirical equation for growth of real GDP per capita:

$$\Delta \ln y_{it} = \beta_0 + \beta_1 \ln(I/Y)_{t-1} + \beta_2 \ln(Edu/Pop)_{it-2} + \beta_3 (n+g+\sigma)_t + \beta_4 \ln (H/Pop)_{it} + e_{it} \qquad (3)$$

where y denotes the real *GDP* per capita, *I/Y* is the gross investment to *GDP* ratio, *Edu/Pop* is the education capital per capita, $(n+g+\sigma)$ is the sum of the population growth, the productivity growth, and the rate of capital depreciation, and *H/Pop* is the per capita health capital.

Next, we estimate health production. Our goal is to determine the effect of health on growth, yet health condition will in turn depend, at least partly, on a country's per capita income. Thus health is endogenous to the system. This gives rise to several modeling possibilities. Under the assumption that health improvement follows income growth with some lag, the least squares estimation will provide consistent estimates of the parameters in the health equation. If a contemporaneous effect is more realistic, however, a simultaneous equations structure will be preferable. Our health equation, specified with lagged incomes, can be written as follows:

$$\ln (H/Pop)_{it} = \gamma_0 + \gamma_1 \ln y_{t-1} + \gamma_2 HIV_{it} + \gamma_3 \ln TB_{it} + \gamma_4 \ln Cal_{it} + \gamma_5 Hexp/Y_{it} + \varepsilon_{it} \qquad (4).$$

Equation (4) shows that health capital depends on a number of factors including the incidence of *HIV* and tuberculosis, both widespread diseases in our sample region. Health situation also depends crucially on the average calorie consumption per person (*Cal*) and on the total health expenditure as a percentage of *GDP* (*Hexp/Y*). We also take lagged income as an important factor that influences general health condition in an economy.

Finally, investment in growth equation (3) also suffers from endogeneity. We account for this endogeneity by estimating an investment function in terms of several factors that literature suggests as important. The strength of domestic and foreign demand, and real interest rate, are commonly considered to be significant economic factors influencing investment. For long-term investment, however, institutional factors such as the level of corruption and the rule of law may also be relevant in ensuring that investment will yield substantial private return for a long time. Literature also suggests that long-term real investment can be affected by political variables which we proxy by the level of democracy versus autocracy (i.e., polity) that has been considered by many authors in an investment-growth relationship. These considerations lead to the following investment function:

$$\ln(I/Y)_{it} = \alpha_0 + \alpha_1 \ln GNP_{it-1} + \alpha_2 Rate_{it} + \alpha_3 Corrup_{it} + \alpha_4 Rulaw_{it} + \alpha_5 Polity_{it} + \alpha_6 Invfree_{it} + \upsilon_{it} \qquad (5)$$

The residual terms in the equations for growth, health capital, and investment are given by e_{it}, ε_{it} and υ_{it} respectively.

The model to be estimated in this paper consists of equations 3, 4, and 5 where investment and health (equations 4 and 5) can be estimated first and be plugged back into the growth equation (3). This recursive system avoids contemporaneous correlation among errors and hence allows *OLS* to provide consistent estimates of our parameters. At stage two, we check the robustness of our estimates by modifying the model into a set of simultaneous relationships.

Much of our dataset comes from the World Development Indicators (World Bank, 2013b). For several variables, however, we rely on a number of other sources, particularly the following: (World Health Organization, 2013), (Food and Agriculture Organization (FAO)), the governance site at the (World Bank, 2013a), and the (Integrated Network for Social Conflict Research, 2012).

4. RESULTS

Southern Africa consists of large economies such as South Africa and small economies such as Lesotho. One common problem encountered in panel data studies with differences in the country size is heteroskedasticity, whose presence makes OLS estimators inefficient. Thus, we estimate instead a generalized least squares (GLS) model to correct for heteroskedasticity and, to avoid error correlation across time, autocorrelation. The GLS results for equations 4 and 5 are reported in Table 1.

Investment: The GLS result for investment, specified in equation 5, which is an endogenous term in the growth regression, is presented in column 2 of Table 1 whereas health per capita (equation 4) is reported in column 3. We take gross fixed capital formation as a percentage of GDP to indicate investment. The estimation results for investment equation show that almost all coefficients are significant at 1 or 10 percent significance level except for change in Gross National Product (GNP), and investment freedom index. If investment responds to changing incomes through an accelerator effect, changes in the logarithms of GNP will capture the effect. Adopting such a course, however, does not lead to a statistically significant impact of income. Two-year lagged values of real interest rate are also included to see if investment is cost sensitive. The interest rate is found indeed to have a statistically significant impact with the expected negative sign. A rise in the interest rate makes borrowing more expensive leading to a cut in investment.

The direction of the effect of rule of law (*rulaw*) and political index (*polity*) matches with the expected signs whereas (the freedom from) corruption index has the unexpected negative sign. Our hypothesis was that a higher level of corruption leads to a lower level of overall economic freedom and greater long-term investment.The corruption is measured on a 100-point scale in which a score of 100 indicates very little corruption and a score of 0 indicates high corruption. It is possible that if corruption is predictable and its monetary implications for business are easily determined, then a higher corruption may not necessarily harm investment to a large degree. To the extent the rule of law is inversely correlated with corruption, they may essentially be indicating similar effects on investment.

The investment freedom index is not found to provide a significant effect on investment. Similar to corruption, investment freedom is measured on a 100 point scale in which a score of 100 indicates the maximum freedom in investment and 0 indicates no freedom. Our assumption that greater freedom in investment would lead to rising long term investment is not supported by our data.

Health: Moving to the health equation, life expectancy is generally considered to be a good indicator of health status in a country and we analyze the results for this dependent variable closely. Life expectancy may not, however, convey a full picture of health since it can be distorted somewhat in a country that highly emphasizes prevention of infant mortality but uses limited resources to maintaining health of older children and adults. Following Jamison *et al.* (2005) therefore, we also use adult survival rate as another indicator of health. Results suggest, however, that the independent variables do not significantly account for a large variation in the adult survival rate. We are thus led to focusing more on life expectancy.

The estimates of GLS regression for life expectancy are shown on the last column of Table 1. The coefficients are statistically significant and have expected signs. Increasing rates of HIV prevalence reduce the stock of health capital. A 10 percent higher incidence of HIV is likely to decrease health capital by 0.3 percent when we control for tuberculosis, calorie intake and lagged per capita income. A bigger reduction is observed in countries such as Zimbabwe where life expectancy fell precipitously from over 60 in 1990 down to 43 in 2003, remained virtually stagnant at 44 by 2009, and only then began to exhibit a steady improvement. Similarly, we find that a greater incidence of tuberculosis in southern Africa has a negative effect on the accumulation of human capital, as expected. Unsurprisingly, per capita income is associated positively with the health condition of a country. Likewise, the coefficient of calorie intake and total health expenditure (private and public) to GDP ratio are positively associated with health capital.

Next, we attempt to address endogeneity of HIV in the health equation since a worsening health condition among adults, by lowering immunity to infections, can make them vulnerable to HIV and other diseases. While anyone can contract HIV, and a lack of testing fuels its spread, the disease has been traditionally claimed to rise with homosexual life style.[1] A relevant instrument for homosexual practices that is not directly correlated with residuals in the health equation but should be correlated with HIV is economic activity in the male-dominated mining sector. We therefore use the percentage of mining value added to per capita GDP as our instrument for HIV. Our exercise produced unreliable results. The mining to GDP ratio fails the usual test of statistical significance when we control for total health expenditure in the regression. Thus we drop mining to GDP ratio from our health equation.

As noted above, the effect of HIV on economic growth is estimated via its effects on life expectancy. Both our health and investment equations allow us to estimate a recursive model where per capita growth is a function of the lagged values of those two variables, among others. The result for the generalized 2SLS regression is given in Table 2.

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[1] A recent study reports homosexual practices in the U.S. accounting for 66 percent of the new HIV infections in 2010 (Center for Disease Control (2012)).

Growth: Table 2 shows our regression for the growth of per capita real GDP. The investment rate exerts a positive impact on growth and its effect is statistically significant at the 1 percent significance level. Nearly a 7 percent increase in investment-GDP ratio (for instance, from 30 percent to 32 percent) is required to lead to a 1 percent growth in per capita income which suggests an incremental capital-output ratio of two. This seems to be lower than an estimated ratio of 3.5 for all of sub-Saharan Africa which includes several countries that have much to build in the aftermath of internal conflicts (Ansu, 2012; World Bank, 2013a).

Population growth and education variables turn up insignificant in Table 2. We realize the human capital variable as proxied by education could suffer from serious measurement problems as is reported in the literature whereas the population growth is found to be insignificant in much of the growth literature as well.

Among other important findings, an improvement in health raises the rate of per capita growth. However, an interaction between changes in health and education is found to be negatively associated with growth. This indicates that because health remains a fundamental growth-enhancing factor, mere accumulation of education will not cause income growth to pick up in the face of a severe health constraint. This is our major policy implication for countries with a high incidence of HIV, and is consistent with Knowles and Owen (1995) and McDonald and Roberts (2006). Knowles and Owen (1995), for instance, find that the coefficients on education capital are insignificant after controlling for health capital and that in one case education provides negative effect on growth. [2]

We also estimate a modified growth equation to see if our health variable is subject to diminishing returns on growth. Inclusion of a square term ($\Delta health^2$) has the expected negative coefficient but its statistical significance is low. Our investment variable remains highly significant and continues to provide large impact on growth.[3]

Geography: Next, we study whether geography has played a role in growth variation across countries. We construct, following Jamison *et al.* (2005) a dummy variable (*dum75*) if 75 or a greater percentage of a country's land area is within 100 miles of the nearest sea. Similarly, we also construct *dum50* and *dum25* taking the value 1 if 50 to 75 percent or 25 to 50 percent (respectively) of the land area is within 100 miles from the coast[4]. The base dummy, *dum0*, refers to a country that is fully or mostly landlocked, that is, a country that has less than 25 percent of the area within 100

[2] Cervellati and Sunde (2011). use demographic transitional theory to show that the nature of relationship between health (life expectancy) and growth can be subject to major health episodes in the world economy. For example, to study health and growth relationships Acemoglu and Johnson (2007). Identified distinct pre- and post-1940 periods as fertility declined substantially in the latter period following mortality drop. Life expectancy affected growth negatively in the first but positively in the second period.

[3] Because of insignificance of the square health term, the result for this regression is shown in Appendix 3.

[4] Swaziland and Lesotho are in 50-75% category and South Africa, Namibia and Angola are in 25-50% category.

miles from the coast [5]. The 2SLS regression result with geographical dummies and square of our health variable is shown in Table 3.

We find that only *dum75* is statistically significant with a positive sign which shows that a better access to sea improves growth. In comparison, having less than 50 percent of the land area within 100 miles of the coast does not provide much advantage in growth over a country that has little or no direct access to the sea. Joint significance of all the dummies based on the F-test is high which allows us to reject the null that geography plays no role on growth.

Summary: The main thrust of our argument comes from the strikingly different results for health and education capital variables. Our results clearly indicate the desirability of separating health from education in a growth study. The debilitating growth prospects in countries with a high incidence of HIV/AIDS and tuberculosis indicate that a greater payoff would be available from spending an extra dollar on health improvements over school enrollments. This conclusion compares well with the story explained by Knowles and Owen (1995) who found the effect of education capital to be either insignificant or negative when they controlled for the health capital. McDonald and Roberts (2006) also find support for such a result.

5. CONCLUSION

The objective of this paper is to examine empirically the impact of HIV/AIDS on economic growth of southern African countries. The paper applies an augmented Solow growth model for 10 countries in southern Africa using data for the period 1990 to 2009. We assume that health capital is one component of human capital that influences economic growth distinctly from the effect of the other major component of human capital, education. Our findings, based on generalized least squares estimation of our panel models, suggest HIV/AIDS substantially and adversely affects the accumulation of human capital and thereby retards income growth significantly. While human capital remains crucial for growth across countries, the effectiveness of policy might depend on whether its focus is on the particular component of human capital, such as health for southern Africa, which serves as the more binding constraint on the growth of an economy.

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[5] Countries with a small percentage of area near sea form the base group consisting of Botswana, Zambia, Malawi and Zimbabwe.

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Table-1. GLS Results for Investment and Health Equations

	Investment	**Health capital**
	(2)	(3)
Δlngnp	0.179	
	(0.388)	
rintt-1	-0.002***	
	(0.000)	
Corrfree	-0.017***	
	(0.004)	
Polity	0.013*	
	(0.007)	
Rulaw	0.519***	
	(0.102)	
Invfree	0.001	
	(0.003)	
lngdppct-1		0.074***
		(0.009)
Prehiv		-0.003***
		(0.001)
Lnkcal		0.216***
		(0.080)
lntb		-0.243***
		(0.031)
hlthexpgdp		0.016***
		(0.004)
constant	3.632***	1.899*
	(0.207)	(1.081)
Observations	115	142
Number of countries	9	10
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Table-2. 2SLS Regression of the Per Capita Growth

Dependent variable: Δlngdppc	
$\ln(I/Y)_{t-1}$	0.067***
	(0.016)
lneduc_{t-2}	-0.006
	(0.008)
popgrth	-0.003
	(0.006)
Δhealth	2.265**
	(1.070)
edu*Δhealth	-0.565**
	(0.284)
constant	-0.156***
	(0.060)
Observations	98
Number of countries	9
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1	

Table-3. 2SLS Regression of Growth with Geography and Square of Health Per Capita

Dependent variable: Δlngdppc	
$ln(I/Y)_{t-1}$	0.039***
	(0.011)
$lneduc_{t-2}$	0.016
	(0.011)
Popgrth	0.003
	(0.006)
Δhealth	1.640
	(1.074)
edu*Δhealth	-0.421
	(0.286)
$\Delta health^2$	-8.398
	(5.262)
dum75	0.054***
	(0.020)
dummy50	0.001
	(0.010)
dummy25	-0.004
	(0.009)
Constant	-0.166***
	(0.054)
Observations	98
Number of countries	9
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Appendix-1. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	No. of Obs.
lngdppc	6.621	1.061	4.817	8.366	200
$ln(i/y)_{t-1}$	2.929	0.539	0.693	4.340	190
$rint_{t-1}$	19.144	78.328	-94.220	605.440	177
polity	2.005	6.258	-10.000	9.000	200
rulaw	-0.426	0.669	-1.914	0.802	140
invfree	48.867	17.931	10.000	70.000	150
corrfree	34.593	13.943	10.000	70.000	150
prehiv	13.798	8.438	0.300	28.900	200
lnkcal	13.571	0.142	13.265	13.903	200
lntb	5.968	0.332	3.912	6.698	200
hlthexpgdp	5.784	2.185	0.007	10.041	142
$lneduc_{t-2}$	3.470	0.717	1.645	4.555	180
popgrth	2.101	0.846	-0.143	3.791	200
Δhealth	-0.001	0.020	-0.057	0.059	132
edu*Δhealth	-0.005	0.073	-0.256	0.175	132
$\Delta health^2$	0.000	0.001	0.000	0.003	132
dum75	0.100	0.301	0.000	1.000	200
dum50	0.200	0.401	0.000	1.000	200
dum25	0.300	0.459	0.000	1.000	200

Appendix-2. Map of Southern Africa

Appendix-3. 2SLS Regression of Growth with Square of Health Per Capita

Dependent variable: Δlngdppc	
$lngfcf_{t-1}$	0.056***
	(0.013)
$lnedca_{t-2}$	-0.004
	(0.006)
popgrth	0.001
	(0.006)
Δhealth	2.602**
	(1.132)
edu*Δhealth	-0.654**
	(0.301)
$\Delta health^2$	-4.737
	(5.148)
constant	-0.136***
	(0.050)
Observations	98
Number of countries	9
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	