The joint effect of human capital and income inequalities on HIV/AIDS prevalence: An exploratory investigation

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Abstract

The evidence of higher income inequality leading to increased HIV prevalence through channels of coercion and migration has emerged. This coupled with previously established macroeconomic impact of HIV/AIDS connotes reverse causality that is likely to develop a cyclical effect. The plausible cyclicality can be identified through the mergence of a three stage relationship. Initially from income inequality to HIV prevalence; then from HIV prevalence to reduced human capital formation and subsequently generating human capital inequality via reduced investment in human capital of affected households and back to income inequality. We hypothesize that the effect of this plausible cyclicality is likely to increase the effect of income inequality on HIV prevalence. Our aim is to assess the effect of productivity gaps measured by human capital dispersion on the relationship between income inequality and HIV prevalence. Deriving 1999 dataset on human capital dispersion which is measured by years of schooling, quality of school system and rates of return for 99 countries, we estimate its linear dependence effect with income inequality on HIV prevalence. We find a more significant and increased effect of income inequality on HIV prevalence of more than three times. This study sets the platform for using current datasets and generates a policy discussion for addressing productivity gaps as one of HIV/AIDS interventions.

KEYWORDS: HIV/AIDS Prevalence, Human Capital, Inequality,Income and Education
JEL Code: I10 and I12

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Introduction

The HIV/AIDS pandemic continues to attract intense attention as a result of the varied response rates toward the achievement of Millennium Development Goal (MDG) Six[2]. In spite of the fall in new infection cases across the globe, some regions especially, Eastern Europe and Central Asia, have experienced increased HIV prevalence rates since 2001 (UNDP, 2009). Also in the sub-Saharan Africa (SSA), that houses about 67% of HIV cases, although the pandemic has stabilized, actual number of people infected is on the ascendancy (UNAIDS 2008). The risk of exposure to HIV has been associated with three broad factors namely; economic, sociological and cultural and epidemiological.

In the context of the economic effect, Bonnel (2001) observes the plausibility of a vicious development cycle between HIV prevalence and economic aggregates. The economic impact of HIV/AIDS on gross domestic product per capita (GDPpc), output growth rate, poverty and inequality (Greener, Jefferis and Siphambe, 2000 and Theodore, 2001 and Haacker, 2002) is wide spread. On the other hand, recently, emerging are outcomes of the socio-economic determinants of HIV prevalence. Three main factors; gross national income per capita (GNIpc), average human capital and income inequality have been shown to provide channels for transmitting HIV/AIDS (Over, 1998; Mahal, 2001; Drain, Smith, Hughes, Halperin & Holmes, 2004; Tsafack & Bassolé, 2006 and Sawers, Stillwaggon & Hertz, 2008). While GNIpc and average human capital posit an inverse relationship with HIV prevalence income inequality shows a positive relationship. With this backdrop of evidence coupled with recent findings of a positive relationship between income inequality and human capital dispersion, we indicate that a potential source of the vicious cycle is relationship between human capital formation and human capital dispersion.

In view of the forgoing, this study relies on three pillars. The first pillar is the emerging consensus of income inequality facilitating exposure to risky sexual behaviour predominantly, through channels of coercion and rural-urban migration. The second pillar relies on the potential reverse causality in the direction of HIV/AIDS reducing stock of human and physical capital. This causal relationship is

[2] Among the targets of MDG 6 is to have halted by 2015 and begun to reverse the spread of HIV/AIDS.

channelled through low savings and investment caused by HIV/AIDS morbidity and mortality related incidence. The third pillar draws on the growing evidence of a positive relationship between income and human capital inequality in which case the former depends on the latter (De Gregorio and Lee, 2002 and Morrisson and Murtin 2007). Drawing from these three pillars we hypothesize that the emerging evidence of a positive relationship between income inequality and HIV prevalence is dependent on the distribution of returns to education measured by human capital inequality. Intuitively, the vicious cyclicality between economic factors and HIV prevalence can be identified through the distributional effect between income and human capital. The aim of this paper is to assess the effect of productivity measured by human capital on the relationship between income inequality and HIV prevalence.

The paucity of data and complexity of measuring human capital as a result of the drift from education measured by years of schooling (Becker, 1962), to include post school investment (Mincer, 1974) and currently the use of rates of return to education dictates the choice of an exploratory study at this stage. We rely on human capital inequality data computed in the recent work of Lim & Tang (2008) to estimate the effect of the relationship between income and human capital inequality on HIV prevalence. Data on 99 countries is drawn from their study with 1999 as the reference point. Using the interaction procedure and relying on the three broad conventional factors that capture determinants of HIV prevalence, we estimate least squares regression to assess the effect of income inequality. We run two regression models; the initial basic model without the effect of human capital inequality and the second model with the effect of human capital dispersion to enable comparison of our results. The sensitivity of the results is verified through the correction for variability in variance.

We observe that the effect of income inequality increases by more than three-times when the effect of human capital dispersion is taken into consideration. This finding suggests that taken into consideration the plausible vicious cyclical relationship between economic and HIV prevalence the effect of income inequality is greater. The policy direction, implores the need to address the HIV prevalence through the minimization of productivity gaps in a country.

The rest of the paper follows with a review of the three main pillars of the hypothesis, discussion of data sources, requisite transformation and estimation procedures, presentation of results and finally conclusion. The next step beyond this paper is to access recent data on educational attainment from UNESCO to recalculate the human capital inequality for recent years. Recent data will enable the computation of country specific and trend level effects and changes which currently is insurmountable given the nature of our dataset. Although this inhibits concrete generalization of results emerging from the current study we generate discourse for further study on the link between productivity gaps, income inequality and HIV prevalence.

Context

This paper is situated in the context of a possible convergence between three strands of recent literature emerging from both health and broadly, development economics. The sets of relationship are discussed in this section. Firstly, we explore the state-of-the-art on the causality from income inequality and HIV/AIDS. Further to this, the reverse causality from HIV/AIDS to economic variables with reference to human capital is reviewed. Finally, we discuss the emerging evidence of a positive relationship between income inequality and human capital inequality.

HIV/AIDS and Income Inequality

Several empirical studies have used single equations to either show the effect of HIV/AIDS on income inequality (Bonnel 2001 and Greener et al., 2000) or in a reverse manner the effect of income inequality on HIV prevalence (Tsafack & Bassolé, 2006 and Sawers, Stillwaggon & Hertz, 2008) . The former has been situated within the broader framework of the macroeconomic impact of HIV/AIDS and will be discussed immediately after this sub section. In the case of a functional dependence of HIV prevalence the income gini coefficient is used to measure income inequality. Consistent finding of a positive relationship indicating that in societies where income distribution is high the probability of exposure to risky sexual behaviour is enhanced thereby increased the incidence of HIV infection.

The primary reason attributed to this causal relationship is that wealth inequality in the context of desired sexual habits engenders coercion from the wealthier and weak resistance from the poor. Another channel through which the effect of income

inequality has impacted adversely on the incidence of HIV is increased urbanization rate. Rural exodus has been accompanied by acts of desperation, dependency and in particular created an avenue for sexual exploitation.

The link from income inequality to HIV prevalence has been robust even in the context where other socio-economic covariates including poverty, income per capita, human development index, gender inequality and urbanization are controlled. These findings have generated discussion on the extent to which HIV/AIDS is associated with poverty relative to inequality. While these evidence outpour, the exact effect of income inequality on HIV prevalence in terms of magnitude remains unknown. Wide differences in terms of the extent to which HIV prevalence changes with respect to a marginal change in income inequality exist. Although the variation can be attributed to the process of transforming HIV prevalence, that is either taking the logarithmic or logit, the exact effect is essential for any policy design.

HIV/AIDS, Economic Growth and Development and Human Capital Formation

Despite well over two decades of intensive efforts, the HIV/AIDS epidemic continues to spread rapidly in the developing world, threatening to halt or even reverse years of hard-won human and economic development progress in numerous countries. Though usually thought of as an issue of health-care and delivery, HIV/AIDS is equally an issue of economic development. While the literature on HIV/AIDS and economic growth is far from irrefutable on the enormity of impact and the relative importance of the various channels through which this impact might occur, one central conclusion does emerge from the analyses performed to date: the long duration of the pandemic is crucial. The impact of HIV/AIDS on economic growth is not being overemphasized. Conceptually the spread of HIV/AIDS epidemic can hinder social and economic development. HIV/AIDS influences economic development by affecting directly two sources of output growth--capital accumulation and the addition to the labour force, and indirectly technical progress. The rate of capital accumulation can be reduced by HIV/AIDS since it dampens the level of domestic and foreign savings.

The HIV/AIDS epidemic can affect the economy in a number of ways: the AIDS epidemic will slow or reverse growth in the labour supply, and savings and investments of families will be reduced owing to the increase in HIV/AIDS related

health expenditures. The AIDS epidemic may also divert public spending from investments in physical and human capital to health expenditures, leading over time to slower growth of the gross domestic product. Foreign and domestic private investment might also decline if potential investors become convinced that the epidemic is seriously undermining the rate of return to investment. The HIV/AIDS epidemic may also deepen the poverty of the most affected countries by decreasing the growth rate of per capita income and by selectively impoverishing the individuals and families that are directly affected.

There are many channels through which HIV/AIDS may affect the economy some of these channels include: the production channel; the allocation channel; the distribution channel; and the regeneration channel. The production channel refers to the mechanisms through which HIV/AIDS affects the main factors of production—labour and capital—causing the production process to be less fruitful than it would have been in the absence of HIV/AIDS. The second channel through which HIV/AIDS may affect the economy is the allocation channel. One of the most important functions of the economic system is to ensure an efficient allocation of resources. HIV/AIDS reroutes some of those resources to medical expenses and away from other productive uses. The third assumed channel through which HIV/AIDS affects the economy is the distribution channel, specifically, the distribution of income. In the face of an epidemic that increases health expenditures and weakens the income base, the lowest income groups may fare the worst. While the rich may have other assets—savings, land or capital—often the only productive asset of the poor is their own labour, which HIV/AIDS attacks. The upper in-come groups, though they are also affected, may be better placed to protect themselves and better able to afford treatment. Thus, the HIV/AIDS epidemic has the potential not only to affect all groups but also to widen the gap between different social strata. The fourth channel, the regeneration channel, refers to the investments in human capital, physical capital and new technology that are needed to keep the economy growing. If the HIV/AIDS epidemic compromises the saving capacity and the human capital of the economy, it will undercut the process of economic development (Theodore, 2001).

Income Inequality and Human Capital Dispersion

In recent times emerging permission claims not only that income variation has adverse effects on economic growth in general, but also that differences in human capital dispersion and inequality across the world are responsible for the completely different economic performances in some parts of the world. However, income inequality may be insufficient measures of wealth inequality since other variables such as human capital are also important determinants of wealth and growth. Thus, in some models that analyze the relationship between inequality and economic growth, the role played by human capital endowment is very important if not crucial, since the distribution of income is mainly given by the distribution of human capital. For instance, empirical studies including; (Glomm and Ravikumar (1992); Saint-Paul and Verdier (1993) and Galor and Tsiddon (1997) present models in which the source of inequality is mainly determined by the distribution of human capital. But, at the same time, inequality affects human capital accumulation. In fact, some of the more interesting theories of how inequality affects growth are based on the interaction between imperfect credit markets, asset inequality and human capital accumulation (Castelló, and Doménech, 2002).

Due to the lack of available data on human capital inequality, little attention has been devoted to the influence of human capital distribution on economic growth in empirical studies. Some exceptions are Birdsall and Londoño (1997), and López, Thomas and Wang (1998). This first study analyzes a sample of 43 countries and uses the standard deviation of years of education as the measure of human capital inequality. The problem with the standard deviation, however, is that it is an absolute measure of dispersion thus it does not control for differences in the mean of the distribution. The second study uses a wider range of human capital inequality indicators but focuses on a reduced number of 12 Asian and Latin American countries. Two main findings are obtained. First, the variability of human capital inequality indicators is greater across countries than within each country.

Nevertheless, as a result of a general reduction in human capital inequality, a process of convergence in human capital equality has taken place. Second, whereas the negative effect of income inequality on economic growth rates is not robust to the inclusion of regional dummies to the set of regressors, the cross-country and pool

regressions suggest that there is a negative effect of human capital inequality on economic growth rates. (Castellóα and Doménech, 2001). In short, their findings indicate that education inequality is associated with lower investment rates and, consequently, lower income growth. Countries that in 1960 showed greater inequality in the distribution of education have experienced lower investment rates than countries which showed less inequality. These lower investment rates have in turn meant lower income growth rates. Policies, therefore, conducted to promote growth should not only take into account the level but also the distribution of education, generalizing the access to formal education at different stages to a wider section of the population

Data and Estimation

As an exploratory study, we restrict our empirical investigation to the countries selected in the earlier work of Lim and Tang (2008). Data for HIV prevalence in 1999 is accessed from UNAIDS. The other covariates; income inequality, GNIpc, health care expenditure per capita, contraceptive use, Muslim and rural population were accessed from multiple sources including; World Bank, UNESCO and the World Institute for Development Economics Research.

The traditional least squares approach is applied to test the hypothesis of a more significant and greater effect of income inequality on HIV prevalence through the interaction term (human capital inequality X Income inequality). Applying the interaction term in least squares has been fraught with interpretational complications (Aiken and West, 1990 and Jaccard and Turrissi, 2003). Aiken and West (1990) compare uncentred and centred variables in estimated equations and conclude that centred analysis be employed as it facilitates a more intuitive interpretation for interacted variables.

Over (1998) suggests the need to transform the non-linear characteristic of HIV prevalence prior to imposition of the linearity assumption underlying least squares regression. Similar to any other contagious disease, the number of people infected follows an S-shaped curve three stages of development; initially increasing at a decreasing rate; followed by increase at an increasing and finally stabilising prior to a

possible reduction. Equation 1, shows the transformation procedure that allows for the application of least squares to the non-linear characteristic of the dependent variable.

$$Logithiv = \ln\left(hiv / 100 - hiv\right) \qquad 1$$

We specify the least squares regression in equation 2 to include the three main broad determinants of HIV prevalence and add to the basic model the interaction term.

$$Logithiv_i = \beta_0 + \beta_1 SOCECO_i + \beta_2 SOCCUL_i + \beta_3 EPID + \beta_4 INCGINI * HCGINI_i + e_i \qquad 2$$

Where logithiv is the transformed HIV prevalence, SOCECO is the vector for socio-economic factors; SOCCUL is the vector for socio-cultural factors, EPID is the vector for epidemiological factors and INCGINI*HCGINI is the interaction for the centred variables of human capital inequality multiplied by the income gini.

$$\partial Logithiv_i / \partial INCGINI_i = \hat{\beta}_1 + \hat{\beta}_4 HCGINI \qquad 3$$

Equation 3 facilitates the interpretation of the interaction term. The vector of socio-economic factors includes income inequality as a unit variable and the derivative of the interaction term with respect to income gini yields the last term on the right-hand side of equation 3. Using the centred values the coefficient of the interacted term signals the significance of the main variable income inequality and its magnitude is estimated by equation 3.

Three of the covariates selected for this paper; GNIpc, contraceptive use and Muslim dominated countries are expected to have an inverse relationship with HIV prevalence. These expectations are intuitively sound and consistent with previous empirical studies. For instance, (Over, 1998; Tsafack & Bassolé, 2006, and Sawers, Stillwaggon & Hertz, 2008) all show that the log of GNIpc irrespective of the dataset and estimation rigour tends to reduce HIV prevalence as it increases. The evidence of Muslim dominated countries driving down HIV prevalence is a bit wishy-washy. The

remaining three covariates, log of per capita expenditure, rural population and income gini are expected to have a positive relationship with HIV prevalence.

Estimation of Human Capital Inequality

Lim and Tang (2008) measure human capital inequality based on Mincer formulation. In contrast to the use of number of years of schooling they model the productivity of a person with 'X' number of years of schooling relative to one with no schooling for the same country. Human capital stock in their model is dependent on the quality of schooling[3] multiplied by the exponent - years of schooling (see Lim and Tang 2008 for an extensive discussion). Attached to each cut-off of number of years of schooling are the world social rates of return derived from Psacharopoulos and Patrinos (2004).

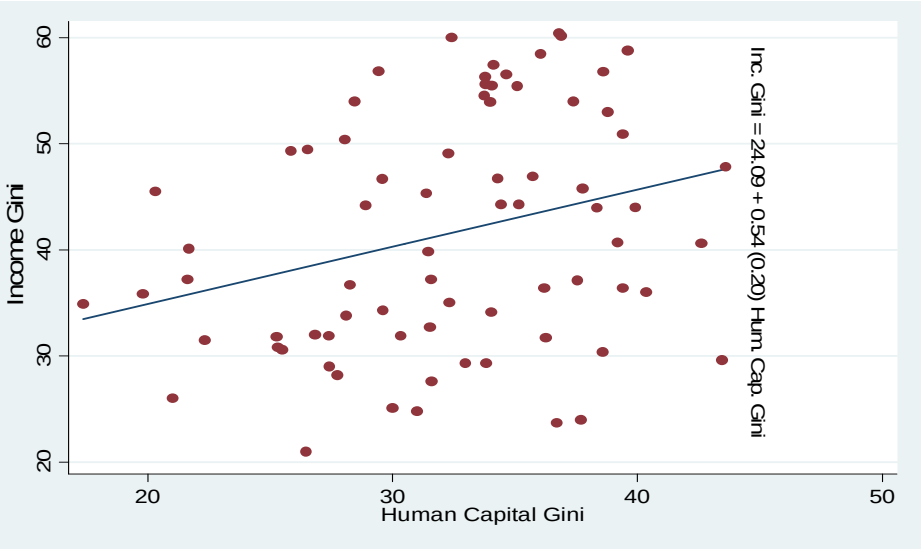
The computation of human capital inequality is time-invariant and fails to capture within country variation in quality of education. In spite of this limitation their approach provides a platform for this exploratory study on the plausible linear dependence between income inequality and human capital dispersion on HIV prevalence.

Results and Discussion

The motivation for the study is enhanced by an initial exploration of the dependence of income inequality on human capital. Figure 1, shows a positive and significant relationship between human capital dispersion and income inequality. The standard error (in parenthesis) shows that the linear relationship and dependence is significant. Two caveats are worth pointing out from figure one. The observed positive association between human capital inequality and income inequality is interpreted with caution in view of its sensitivity to the robustness of the world rates of return. Also, a non-linear relationship between income inequality and human capital inequality is plausible, for an initial exploratory work, we assume linear dependence.

[3] Quality of education data is derived from Hanushek and Kimko (2000). Although they are able to capture difference in quality between countries their work is constrained by the inability to capture difference within counties and over time.

Figure 1: Dependence of Income Inequality on Human Capital Dispersion



In table 1, we observe that although data human capital inequality was sourced from 99 countries extracting data for the other variables was constrained by different survey periods for each country. For instance, data on income inequality mainly sourced from the World Institute on Economics Research (WIDER) was limited to only 74 countries as a result of the variation in survey dates for each country. Table 1, shows more unequal distribution from an income perspective than human capital. Precedent on the observed dependence from figure 1, this suggests that beyond the effect of human capital dispersion, factors such as role of policy through social expenditure are likely to affect income distribution (De Gregorio and Lee, 2002).

Consistent with the wide spread patterns of the pandemic across the globe, HIV prevalence depicts the highest variability. The wide gap between the average 5.0 per cent in Africa compared to less than 1 per cent across the regions (UNAIDS, 2008) explains the 2.145 coefficient of variation for HIV prevalence. The observed gap between the median of HIV prevalence and the mean value generates concern for generalization of results on the pandemic based on the mean value. Although some studies have attempted disaggregating countries into high and low prevalent rates much comprehensive analysis such as quantile regression using the entire sample is likely to overcome problems in the use of sub-samples.

With regards to use of any method of contraceptive the coefficient of variation shows that the mean value of 50 per cent is second to HIV prevalence. This raises concern for the effectiveness of the third component of the abstinence, be faithful and condom (ABC) advocacy for minimizing the spread of HIV/AIDS.

Table 1

Descriptive Statistics

Variables	**N**	**Mean**	**Median**	**SD**	**CV**
Logit of HIV Prevalence	84	-5.131	-5.517	1.750	-0.342
HIV Prevalence	84	2.840	0.400	6.091	2.145
Income Gini	74	41.503	40.350	11.079	0.267
Log of GNI per capita	92	8.486	8.540	1.357	0.160
Log of Health Expenditure per capita	96	4.968	4.934	1.953	0.393
Contraceptive Use	88	52.209	57.400	23.310	0.446
Muslim	98	0.173	0.000	0.381	2.190
Rural Population	96	43.239	41.000	23.946	0.554
Human Capital	99	32.930	33.791	5.824	0.177

SD – Standard Deviation and CV – Coefficient of Variation

The multivariate analysis relied on a lesser number of observations as a result of the variations in missing data points for the each variable per country. Table 2, presents the results for three different regressions. Column 2, shows the coefficients without the effect of the interacted and column 4, is a sensitivity test that verifies the robustness of our coefficients using the bootstrap approach. In column 3, we include both the human capital index and the interaction term. To facilitate an interpretable effect of the interaction term we use the centred values of the moderating variable, human capital.

Using equation 3 the coefficient of income inequality increases from 5.73 to 8.98 depicting an upward change of about 3.6 times and with a significance level is 1 per cent in both scenarios. This shows the additional effect that as a result of taken into consideration the linear between human capital dispersion and human capital inequality. Although an obvious problem of multicollinearity emerges the estimation

suffices the Ramsey specification test of omitted variables and indicates a good fit test. A couple of estimation limitations are inevitable due to the single cross section characteristic of our dataset. An obvious problem is endogeneity arising from reverse causality between income inequality and HIV prevalence as mentioned earlier. The second concern source endogeneity can be traced to a potential measurement error of human capital dispersion which is likely to affect its linear dependence with income inequality. Though the effect of these limitations is insurmountable with this exploratory work, we generate the discourse of a likely down bias in income inequality coefficient of previous studies. The use of more rigour estimation techniques in recent studies (Tsafack & Bassolé, 2006) fail to address the dependence of root causes such as human capital on proximate factors (income inequality) initially indicated by Mahal (2001).

Other explanatory variables show results that are consistent with our expectations and/or previous studies. Contraceptive use shows an inverse relationship and significant at 1 per cent for all three estimation. Countries with higher rates of rural population have higher HIV prevalence. Per cent of rural population is used as a proxy for poverty in the model and shows that poverty levels correlates with HIV prevalence. Earlier researchers have used variables such as urban percentage and urbanization rate. The results appear mixed and sometimes contradictory since each variable connotes a different meaning. For instance, in using urban percentage (Sawers, Stillwaggon & Hertz, 2008) showed positive and insignificant results as opposed to a negative and also insignificant by Deuchert and Brody (2007). In another instance using urbanization rate (Tsafack & Bassolé, 2006) showed varied results based on type of estimation technique.

Table 2

Regression Results

Dependent Variable: *Logit of HIV Prevalence* ***Explanatory Variables***	***Coefficients & Robust Standard Errors***		
	(1) Basic Model	**(2) Interaction Model**	**(3) Bootstrapped Results [1000 Reps]**
Log of GNI per capita	-1.248 *(0.57)***	-1.445 *(0.55)****	- 1.445 *(0.59)***
Log of Health Expenditure per capita	1.228 *(0.31)****	1.216 *(0.31)****	1.216 *(0.34)****
Contraceptive Use	- 0.044 *(0.01)****	-0.039 *(0.01)****	- 0.039 *(0.01)****
Income Gini	5.734 *(1.43)****	5.930 *(1.43)****	5.930 *(1.53)****
Muslim	- 0.784 (0.44)**	- 0.930 *(0.44)***	- 0.930 *(0.53)***
Rural Population	0.044 *(0.01)****	0.035 *(0.01)****	0.035 *(0.01)****
Human Capital	-	15.252 *(8.58)***	15.252 *(9.42)*
Human Capital X Income Gini	-	- 45.308 *(21.07)***	- 45.308 *(23.80)***
R-Squared	**0.75**	**0.76**	**0.76**
Ramsey's Specification Test	**5.37(0.002)**	**4.43 (0.008)**	
Number of Obs.	**57**	**57**	**57**

**** Significant at one percent; ** Significant at five percent * Significant at ten percent*

Conclusion

The growing literature on the determinants of HIV prevalence provides depth of knowledge on the reasons for the varied patterns and policy intervention response rates of the epidemic in different countries. This study adds to the discourse of

minimizing exposure to risky sexual behaviour with a review of the intensity of the effect of income inequality. In view of the numerous studies that have found a positive relationship between wider gaps of income distribution and HIV prevalence, this study appeals to a plausible downward bias in the coefficients of the previous studies. The thrust of the paper is a potential of cyclical effect between income inequality and HIV prevalence through low human capital formation and distribution.

Our main finding upholds the hypothesis of an underestimation of the effect of income inequality on HIV prevalence. This initial finding signals the need to revisit the approach in addressing the effect of economic indicators of HIV prevalence. Three recommendations emerge from this finding. First, from an *ex post* perspective, providing productivity capacity for different members of households with an HIV infected person appears imperative. Secondly, reflecting on the relationship between economic factors and HIV prevalence from a cyclical perspective requires the need to prevent a vicious cycle through *ex ante* strategies such as adjusting educational rates of returns in HIV concentrated areas to absorb the effect of the disease. Lastly the need to provide alternative savings and investment opportunities for capacity building at the household level is apparent.

Other contemporary economic, socio-cultural and epidemiological determinants of HIV prevalence showed consistent results with earlier studies. Typically, contraceptive use and the log of countries with higher GNIpc both emerged to reduce HIV prevalence.

Due to the use of a fairly old dataset and cross section in nature, generalization at this stage is modest. The way forward beyond this study, is the generation of recent human capital inequality which takes into consideration the effect of variations in quality over time and within country differences in school quality. UNESCO's current platform of rich data variability and easy acquisition, places the second phase of this research in perspective as country level differences and changes over time can be assessed with through a panel data.

References

Aiken , L. S., & West, S. G. (1990). Multiple Regression: Testing and interpreting interactions. Newbury Park, CA: Sage Publications.

Becker, Gary S., (1962). "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy LXX: 9 - 49.*

Birdsall, N. and J. L. Londoño (1997): `Asset Inequality Matters: An Assessment of the World Bank's Approach to Poverty Reduction *American Economic Review,* vol. 87, no. 2, pp. 32-7.

Bonnel, R., (2001). Does it Increase or Decrease Growth in Africa? AIDS Campaign Team. World Bank, Washington, D.C.

Castelló, A. and R. Doménech (2002): "Human Capital Inequality and Economic Growth: Some New Evidence". *Economic Journal*, 112 (478), 187-200.

De Gregorio, J., and Lee J., (2002). Education and Income Inequality: New Evidence from Cross Country Data. *Review of Income and Wealth.* Series 48(3).

Deuchert, E. and Brody A.S., (2007). Lack of Autodisable Syringe Use and Health Care Indicators Are Associated With High HIV Prevalence: An International Ecologic Analysis. *Annals of Epidemiology*, 17, pp. 199-207.

Drain P.K, Smith J. S, Hughes J. P, Halperin D. T, Holmes K. K., (2004). Correltes of National HIV Seroprevalence. An Ecologic Analysis of 122 Developing Countries. *J Acquir Immune Defic Syndr* April 1, 35,4.

Galor, O. and D. Tsiddon (1997): `The Distribution of Human Capital and Economic Growth.' *Journal of Economic Growth,* vol. 2, no. 1, pp. 93-124.

Glomm, G. and B. Ravikumar (1992): `Public versus Private Investment in Human Capital: Endogenous Growth and Income Inequality.' *Journal of Political Economy,* vol. 100, no. 4, pp. 818-34.

Greener, R., Jefferis, K. and Siphambe, H., (2000). The Impact of HIV/AIDS on Poverty and Inequality in Botswana. *South African Journal of Economics* Vol. 68(5), pp. 393-404.

Jaccard, J. & Turrisi, R., (2003). Interaction Effects in Multiple Regression. (2nd ed). Sage University Papers Series on Quantitative Applications in the Social Sciences, 07-072. Thousand Oaks, CA: Sage.

Haacker, M., (2002). Modeling the Macroeconomic Impact of HIV/AIDS, IMF Working Paper, WP/02/195.

Lim, A. S. K., and Tang, K. K., (2008). Human Capital Inequality and the Kuznets Curve. *The Developing Economies,* XLVI-1: pp. 26-51.

López, R., V. Thomas and Y. Wang (1998): `Addressing the Education Puzzle. The Distribution of Education and Economic Reforms.' World Bank Working Papers 2031.

Mahal, A., (2001). The Human Development Roots of HIV and Implications for Policy: A Cross Country Analysis. *Journal of Health & Population in Developing Countries;* 4(1): 43-60.

Mincer, J., (1974). Schooling, Experience and Earning. New York, NBER.

Morrisson, C. and Murtin, F., (2007). Education Inequalities and the Kuznets curves: A Global Perspective since 1870. Paris School of Economics Working Paper No. 2007-12.

Over, M., (1998). The Effect of Societal Variables on Urban Rates of HIV infection in developing countries: An Exploratory Analysis., in Ainsworth M, Fransen L and Over M. (eds), *Confronting AIDS: Evidence from the Developing World*, European Communities, Luxembourg, 1998, pp. 39-51.

Psacharopoulos, G and Patrinous, H. A., (2004). Returns to Investment in Education: A Further Update, *Education Economics* 12, (2). pp. 111-134.

Saint-Paul, G. and T. Verdier (1993): `Education, Democracy and Growth.' *Journal of Developmen Economics,* vol. 42, no. 2, pp. 399-407.

Sawers, L., Stillwaggon, E. and Hertz, T. (2008). *Cofactor infections and HIV epidemics in developing countries: implications for treatment* ; Washington DC, USA; Department of Economics, Gettysburg College, Gettysburg PA, USA Vol. 20, No. 4, April 2008, 488 – 494

Theodore, K., (2001). HIV-AIDS in the Caribbean: Economic Issues-Impact and Investment Response. CMH, Working Paper Series, Paper N0. WGI:1, WHO, Geneva.

Tsafack, C. & Bassolé, L., (2006). Income Inequality and HIV/AIDS epidemic in sub-Saharan Africa. Working Paper, CERDI-CNRS, Université d' Auvergne, France.

United Nations Development Programme, (2009). The Millennium Development Goals Report, New York.

UNAIDS, (2008). Report on the global AIDS epidemic, Joint United Nations Programme on HIV/AIDS (UNAIDS), Geneva.