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

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This paper assessed the effect of human capital on the relationship between income inequality and HIV prevalence. We used 1999 dataset on human capital dispersion which was measured by years of schooling, quality of school system and rates of return for 99 countries. Using regression analysis, linear dependence effect of human capital and income inequality on HIV prevalence was estimated. The linear dependence yielded a relatively bigger effect than the independent effects of human capital and income inequality. This calls for addressing productivity gaps as one of the interventions of HIV/AIDS.

Key words: HIV/AIDS prevalence, human capital, inequality, income, education.

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)¹. 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 sub-Saharan Africa (SSA), this houses about 67% of HIV cases. Although the pandemic has stabilized, the actual number of people infected is on the ascendancy (UNAIDS, 2008). While the risk of exposure to HIV has been associated with three broad factors namely: sociological and cultural, epidemiological, and economic, the thrust of this paper is skewed towards the later.

In the context of 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 et al., 2000; Theodore, 2001; Haacker, 2002) is wide spread. On the other hand, the reverse

causality posits channels through which the macro economy determines 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 et al., 2004; Tsafack and Bassolé, 2006; Sawers et al., 2008). While GNIpc and the 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 hypothesize that the joint effect of human capital and income inequality will lead to greater levels of HIV prevalence.

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 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; Morrisson and Murtin, 2007). Drawing from these three pillars, we provide

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¹Among the targets of MDG 6 is to have halted by 2015 and begun to reverse the spread of HIV/AIDS.

an explanation into a potential vicious cycle between inequalities in human capital and income and HIV prevalence. Intuitively, the vicious cyclicity between economic factors and HIV prevalence can be identified through the distributional effect between income and human capital. Based on the foregoing, 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 and Tang (2008) to estimate the effect of the relationship between income and human capital inequality on HIV prevalence. Data on 99 countries are 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 the least squares regression to assess the effect of income inequality. In this study, two regression models were run: the basic model is without the effect of human capital inequality and the second model is with the effect of human capital dispersion to enable comparison of the study's results. The sensitivity of the results is verified through the correction for variability in variance.

We observe that the effect of income inequality tends to be higher when the effect of human capital dispersion is taken into consideration. This finding confirms the hypothesis of the study. 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, and methods of study. The conclusion of the current study is preceded with results and discussion. While the evidence from the current study provides leads of the potential vicious cycle, further work based on recent data was identified 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, discourse for further study on the link between productivity gaps, income inequality and HIV prevalence is incited.

LITERATURE REVIEW

This paper is situated in the context of a possible convergence between three strands of recent literature emerging from both health and development economics

broadly. The sets of relationship are discussed here. Firstly, the state-of-the-art was explored 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, the emerging evidence of a positive relationship between income inequality and human capital inequality was discussed.

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; Greener et al., 2000) or in a reverse manner the effect of income inequality on HIV prevalence (Tsafack and Bassolé, 2006; Sawers et al., 2008). The former has been situated within the broader framework of the macroeconomic impact of HIV/AIDS and will be discussed subsequently. 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 increasing 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 the 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. However, 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 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, which is 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 an insufficient measure 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 (Glomm and Ravikumar, 1992; Saint-Paul and Verdier, 1993; 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 et al. (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. Secondly, although 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 (Castelló 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.

MATERIALS AND METHODS

Here, the study considers the data sources used for the analysis, the multiple regression models and the procedure for the estimation of human capital inequality.

Data sources

As an exploratory study, the empirical investigation was restricted to the countries selected in the earlier work of Lim and Tang (2008). Data for HIV prevalence in 1999 were accessed from UNAIDS. The

$$\text{Logithiv}_i = \beta_0 + \beta_1 \text{SOCECO}_i + \beta_2 \text{SOCCUL}_i + \beta_3 \text{EPID}_i + \beta_4 \text{INCGINI}_i * \text{HCGINI}_i + e_i \quad (2)$$

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.

$$\frac{\partial \text{Logithiv}_i}{\partial \text{INCGINI}_i} = \beta_1 + \beta_4 \text{HCGINI}_i \quad (3)$$

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, as 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 and Bassolé (2006) and Savers et al. (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 population and income gini) are expected to have a positive relationship with HIV prevalence.

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 least squares model

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; Jaccard and Turrissi, 2003). Aiken and West (1990) compare uncentred and centred variables in estimated equations and conclude that centred analysis should 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 rate 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.

$$\text{Logithiv} = \ln \left(\frac{\text{hiv}}{100 - \text{hiv}} \right) \quad (1)$$

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.

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 schooling² multiplied by the exponent - years of schooling (Lim and Tang, 2008). 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 the 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

² 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.

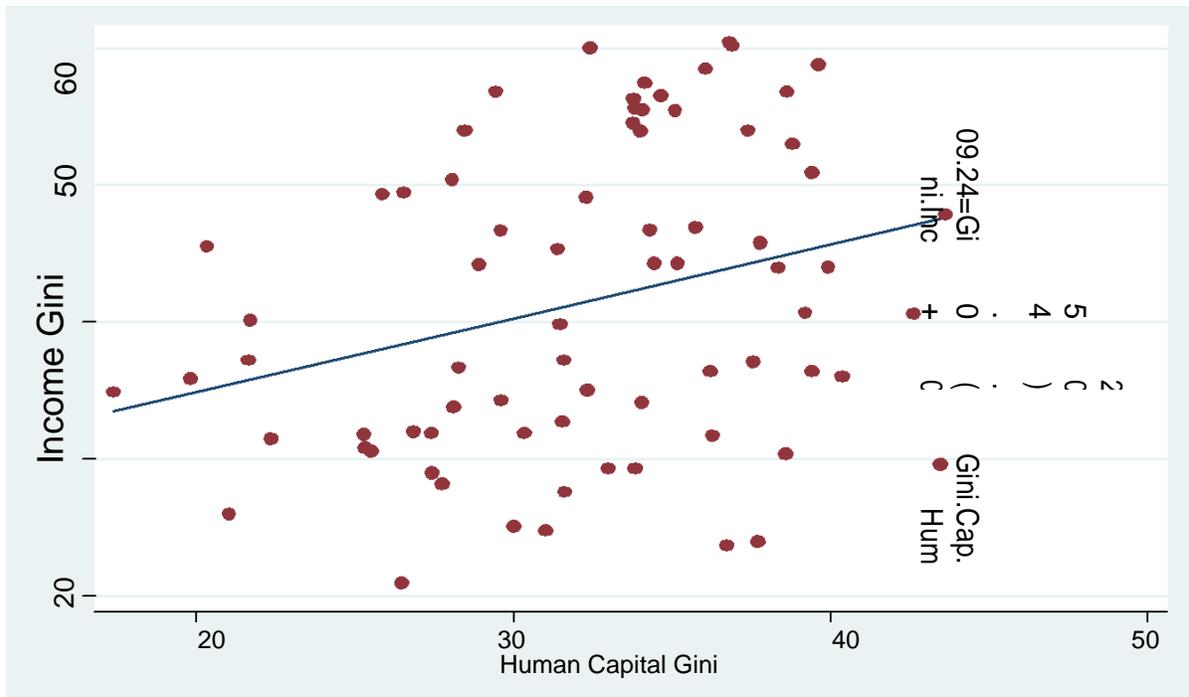


Figure 1. Dependence of income inequality on human capital dispersion.

Table 1. Summary statistics of the socio-economic variables.

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; CV – Coefficient of variation.

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 1. 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; as such, for an initial exploratory work, linear dependence was assumed.

In Table 1, we observe that although the data for human capital inequality were 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) were 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

Table 2. Estimates of Logit of HIV prevalence.

Explanatory variable	Dependent variable: Coefficients and 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 ²	0.75	0.76	0.76
Number of Obs.	57	57	57

*** significant at one percent; ** significant at five percent; * significant at ten percent.

(De Gregorio and Lee, 2002).

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

Here, the results from Tables 1 and 2 are discussed. 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% in Africa compared to less than 1% 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 the use of any method of contraceptive, the coefficient of variation shows that the mean value of 50% 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. Using Equation 3, the coefficient of income inequality increases from 5.75 to 5.93 ($20.85025 \pm ((-45.30783) * 0.3293077)$). This shows the additional effect (even in a cross sectional context) that arises by taking into consideration the linearity between human capital dispersion and human capital inequality. Though the empirical evidence corroborates the hypothesized larger effect of the dependence between income and human capital inequality, the current state of

the paper only suggests exploratory evidence as the robustness of our estimation which requires further scrutiny. Two broad issues are: (i) use of more recent and larger sample and (ii) careful examination of the issue of endogeneity.

Potential endogeneity arise from reverse causality between income inequality and HIV prevalence as mentioned earlier. The second concern source of endogeneity can be traced via 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, the current findings serve as a platform for further research. Comparatively, this paper incites another perspective as other recent studies (Tsafack and Bassolé, 2006) fail to address the dependence of the 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 this study's expectations and/or previous studies. Contraceptive use shows an inverse relationship and significance at 1% for all three estimations. 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 et al. (2008) showed positive and insignificant results as opposed to a negative and also insignificant result by Deuchert and Brody (2007). In another instance using urbanization rate, Tsafack and Bassolé (2006) showed varied results based on the type of estimation technique. Intervention that targets the life course of individuals at an early stage before they join the risky stage of HIV infection would be an effective way to maintain low levels of HIV infection and spatial diffusion of the epidemic.

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 HIV prevalence from the perspective of human capital and 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 paper investigates the potential of cyclical effect between income inequality and HIV prevalence through low human capital formation and distribution.

The main finding of this study upholds the hypothesis of an underestimation of the effect of income inequality on HIV prevalence. This finding signals the need to revisit the approach in addressing the effect of economic indicators on 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 GNIpc both emerged to reduce HIV prevalence.

Due to the use of a fairly old dataset and cross sectional 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 a perspective which shows that country level differences and changes over time can be assessed with panel data.

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