Working Paper

HIV AND INCOME INEQUALITY:

IF THERE IS A LINK, WHAT DOES IT TELL US?

Working Paper number 54 April, 2009

Göran Holmqvist
Institute for Futures Studies, Stockholm
and Nordic Africa Institute, Uppsala

International Policy Centre for Inclusive Growth

International Policy Centre for Inclusive Growth (IPC - IG)
Poverty Practice, Bureau for Development Policy, UNDP
Esplanada dos Ministérios, Bloco O, 7º andar
70052-900 Brasilia, DF - Brazil
Telephone: +55 61 2105 5000

E-mail: ipc@ipc-undp.org ▪ URL: www.ipc-undp.org

The International Policy Centre for Inclusive Growth is jointly supported by the Poverty Practice, Bureau for Development Policy, UNDP and the Government of Brazil.

Working Papers are available online at www.ipc-undp.org and subscriptions can be requested by email to ipc@ipc-undp.org

Print ISSN: 1812-108X

HIV AND INCOME INEQUALITY: IF THERE IS A LINK, WHAT DOES IT TELL US?

Göran Holmqvist *

ABSTRACT

There is a striking variation in the prevalence of the human immunodeficiency virus (HIV) among countries and regions of the world, with a distinct geographical pattern. This paper explores the link between income inequality and HIV. It presents empirical evidence—a meta-study and additional cross-country regression results—that clearly support the argument that such a link exists. The interpretation of this link is an open issue. Four different hypotheses are discussed, each one pointing out a transit route from income inequality to HIV. The paper presents preliminary evidence on these routes and identifies potential areas for future research.

1 POINTS OF DEPARTURE

The global HIV prevalence map reveals striking contrasts between high-prevalence and low-prevalence countries. Africa is clearly the most affected continent, but within Africa there is a distinct geographical pattern (see Figure 1). A handful of southern African countries have prevalence indicators of between 15 and 35 per cent, while the western parts of Africa are within the range of 1 to 5 per cent. A few countries in eastern Africa are in an intermediate position, with rates of between 3 and 7 per cent (together with Ivory Coast in the west). Outside Africa, the Joint United Nations Programme on HIV/AIDS (UNAIDS) has not reported prevalence above 4 per cent for any country, but each continent seems to have its geographical HIV pattern. In the Western Hemisphere, the highest levels are found in countries in the Caribbean Basin (Haiti, Bahamas, Trinidad and Tobago, Belize, Guyana, Suriname and Honduras, where rates are between 1.5 and 3.8 per cent). In Asia, the highest prevalence rates have been reported for Papua New Guinea, Cambodia, Thailand and Myanmar, where rates are at 1.4 to 1.8 per cent. In Europe, a group of eastern European countries are the most affected (Ukraine, Estonia, Moldova and Russia, with rates of 1.1 to 1.4 per cent).

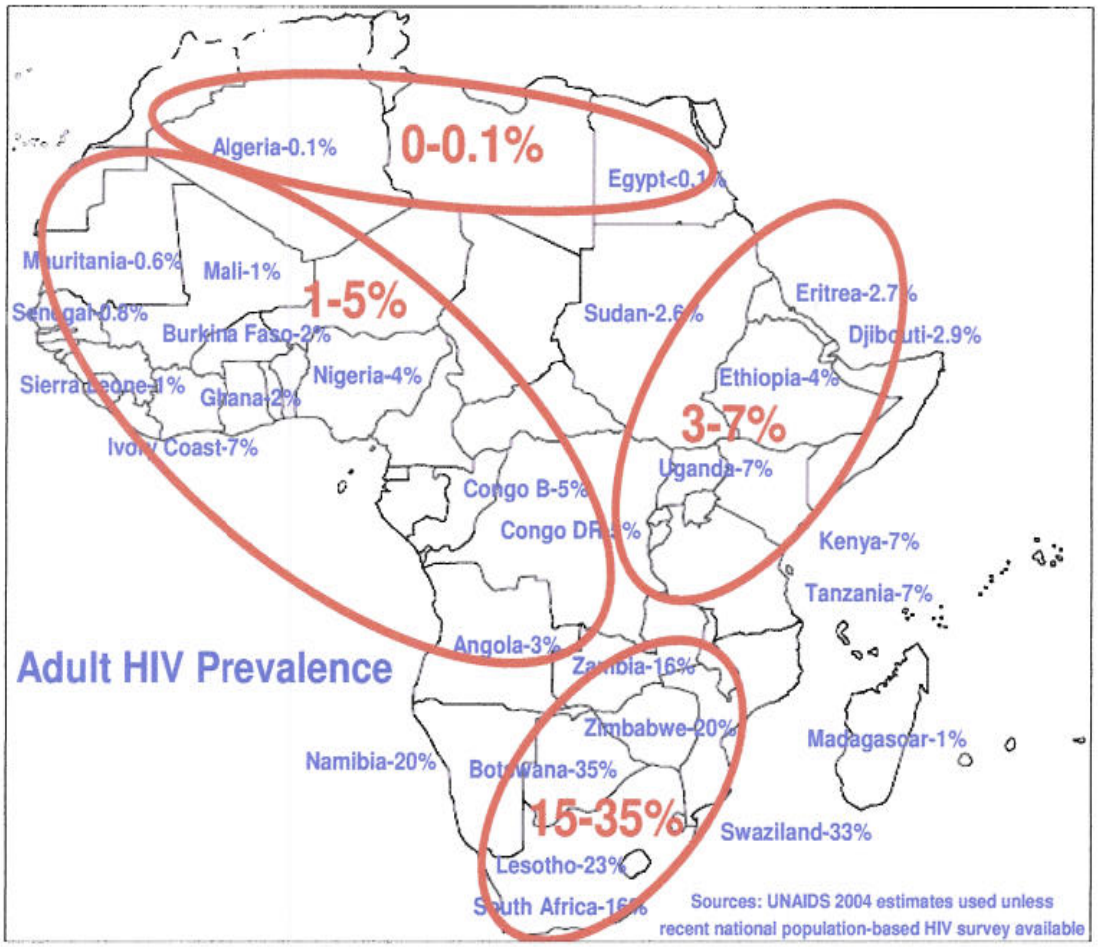
How is this variation in HIV rates to be explained? One might expect that with such a striking variation, particularly within Africa, it should be fairly easy to identify a distinct set of explanatory factors. The question demands an answer not only because it may offer some clues about the HIV epidemic and how to counteract it.[1] More generally, it may also reveal why some societies are more vulnerable than others to "new" infectious diseases—diseases that are expected to increase as a by-product of globalisation.

The issue has been debated, of course, but the results seem far from conclusive and interpretation of the evidence is still open to discussion. Several studies point out the link between HIV and income inequality. A purely statistical correlation is clearly present (see

* Institute for Futures Studies, Stockholm and Nordic Africa Institute, Uppsala.
A previous version of this working paper was produced for the Institute for Futures Study, Stockholm.

Figure 2). Can this link between income inequality and HIV prevalence be shown to be significant and robust? If so, why are less equal societies more vulnerable to HIV? This paper seeks to take some first steps towards addressing these two questions.

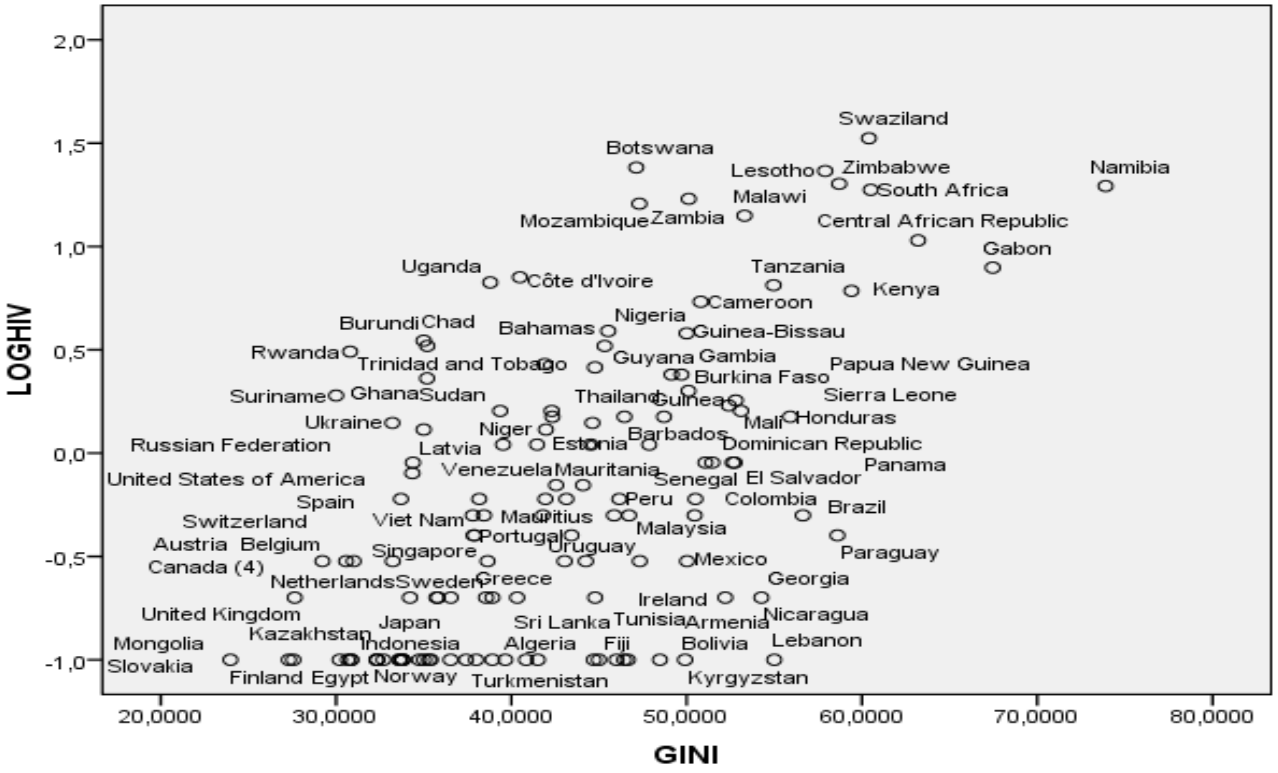
FIGURE 1



The paper is arranged as follows. Section 2 provides a short overview of what seem to be frequent and influential explanations of why HIV prevalence is so much higher in some countries and regions than others. Section 3 is a meta-study reviewing the results of a collection of recent analyses that have used cross-country regression techniques to explain variations in HIV prevalence. In Section 4, cross-country regressions similar to those presented in Section 3 are repeated, using data collected for the purpose of this study but altering the model specifications and samples. Some of the results are replicated, among them the significant relationship between income inequality and HIV; other links that have been reported as significant do not appear to be robust. Section 5 discusses the possible pathways from income inequality to HIV, and presents four alternative "stories". Each of them is confronted with some preliminary empirical evidence, and some areas for future research are identified. Section 6 presents the conclusions.

FIGURE 2

Income Distribution (GINI) and HIV Prevalence (LOGHIV), Global Sample



Source: See Annex 1.

2 CHIEF EXPLANATIONS OF THE VARIATION IN HIV PREVALENCE ACROSS COUNTRIES AND REGIONS

The potential determinants of HIV prevalence in a society are located along a complex causal chain involving various spheres that often interact. The links between HIV and different potential determinants in a given society may be portrayed as in Table 1, which is adapted from Barnett and Whiteside (2006).

TABLE 1

Determinants			
Distal determinants		**Proximal determinants**	
Macro environment	**Micro environment**	**Behaviour**	**Biology**
Wealth	Mobility	Rate of partner change	Virus types
Income distribution	Urbanisation	Concurrent partners	State of infection
Culture	Access to healthcare	Sexual mixing patterns	Presence of STDs
Religion	Levels of violence	Breast feeding	Gender
Governance	Women's rights	Intergenerational sex	Male circumcision
Interventions			
Social policy	Social policy	Behavioural change	STD treatment
Legal reform	Economic policy	communication	Blood safety
Human rights	Employment legislation	Condom promotion	Antiretroviral drugs
Taxation		Counselling	Mother-child prevention

Source: Adapted from Barnett and Whiteside (2006).

What are the most important drivers among these potential determinants? A (still incomplete) review of the literature identifies the following four factors as those most frequently cited.

Male circumcision. There is an apparent correlation between HIV prevalence and male circumcision in Sub-Saharan Africa (SSA). There has been a debate about whether this reflects the impact of religion and social norms rather than the impact of circumcision on the transmission rate of the virus. Nonetheless, there seems to be convincing biological and epidemiological evidence (such as from trials with control groups) that circumcision does indeed provide some protection against HIV (Halperin and Epstein, 2007). UNAIDS has taken a clear stand in favour of circumcision in its recommendations (UNAIDS, 2007). Of course, this does not preclude the consideration that the statistical correlation stems to some extent from behavioural factors related to culture, religion, norms and historical legacies. Note also that circumcision cannot explain why HIV rates in southern Africa are so much higher than those in other regions of the world, such as India, Latin America and Europe, where circumcision is equally uncommon or even less common.

Social cohesion/social capital. Barnett and Whiteside (2006) present a theory whereby social cohesion is a key variable that defines different societies' susceptibility to HIV. The basic idea is that socially cohesive societies are better able to mobilise resources in pursuit of joint goals to avoid or control risk. The establishment of trust and shared norms facilitates the collective action needed. It is assumed that social inequality undermines social capital, and there is a good deal of empirical evidence supporting that claim. A social cohesion-HIV theory has its echo in different fields of the social sciences, such as public health (Wilkinson, 1996), the sociology of crime (Sampson and Groves, 1989), and theories on democracy and governance (Putnam, 2000).

Concurrent partnerships. The empirical evidence does not support the suggestion that Africans on average have more sexual partners during their lifetimes than do, for example, Americans. Indeed, the opposite seems to be the case. It is claimed, however, that the phenomena of multiple, long-term, concurrent partnerships is more common in Africa than elsewhere. Modelling has shown that the spread of HIV in a population is much higher in a system of long-term, concurrent relationships than with the serial-monogamy form of relationships common in the West, since concurrency leads to widespread sexual networks through which HIV may be more easily transmitted. The fact that infectivity is higher in the first weeks after infection, and that condom use is less frequent in long-term partnerships, gives additional force to this mechanism. Polygamy is a form of concurrent partnership but will not lead to the same kind of extensive sexual networks unless women also engage in multiple, long-term relationships. This is less likely to be the case in the Muslim countries of northern and western Africa, where polygamy is common but women's sexual behaviour tends to be strictly controlled; this may explain why these parts of Africa are less affected. In essence, these are the elements of the theory of concurrent partnerships (Halperin and Epstein, 2007). It has been described as the "hottest explanation of the high rates in [Sub-Saharan Africa]" (Beegle and Özler, 2006). An income inequality link has also been identified here, since there is often an element of transactional sex in these concurrent relationships, and economic inequalities overlapping with gender and age inequalities may provide fertile ground (Leclerc-Madlala, 2004).

Colonial legacy. The disorganisation of family structures and social norms—a by-product of white settlements, the resettlement of Africans and forced or "voluntary" labour migration—

is often mentioned as an important background factor in Africa's HIV crisis (Setel et al., 1999; Hargrove, 2007; Barnett and Whiteside, 2006; Brummer, 2002). A glance at the HIV map also reveals that the high-prevalence countries in Africa tend to be those where whites settled in greater numbers and where large-scale commercial farming, and particularly the mining industry (and apartheid in general), had a far-reaching impact on labour migration and family patterns. This produced dual economies and unequal societies, and did so more in southern and eastern Africa than elsewhere.

The vast literature on HIV and AIDS, of course, includes several additional suggestions as to why Africa is special and why southern Africa is so special within Africa. Economists using utility maximisation models of sexual behaviour have argued that poverty, which entails higher mortality risks due to a number of causes, makes people less inclined to engage in risk-reducing behaviour. This has been offered as an explanation of why sexual behaviour changed quickly among the US gay community as risk became apparent, while the change does not seem to have taken place in Africa (Oster, 2007). Traditional sexual practices are also mentioned sometimes as contributing to the spread of HIV. Others have argued that the focus on sexual behaviour is misleading in explaining high African HIV prevalence indicators. In addition to male circumcision, both cofactor infections (such as untreated sexually transmitted diseases [STDs], parasites or malaria) that increase susceptibility to the virus (Sawers et al., 2008) and unsafe healthcare (Broody and Deutchert, 2007) have been pointed out as important determinants.

Moreover, it is often claimed that the causes of the HIV epidemic are multiple and highly context-specific, sometimes linked to development and wealth, sometimes to poverty and backwardness, sometimes to armed conflicts, trade routes and specific processes of social change. Hence there may be limitations on the space available for the kind of generalisation involved in regression analysis. However, claiming that determinants are exclusively local and context-specific would be difficult to reconcile with the distinct geographical pattern revealed by the global HIV map.

The literature is thus rich in possible explanations, all based on causal mechanisms that sound more or less plausible. Some of these explanations are potentially compatible with each other, in the sense that they may be parts of the same causal chain (for instance, social cohesion as a determinant of certain behaviours). Others must be seen as alternative explanations, and it would be helpful if their respective weights were resolved.

3 A META-STUDY OF AVAILABLE EVIDENCE FROM CROSS-COUNTRY REGRESSIONS

There are a number of reasons why evidence from cross-country regressions should be interpreted with care. Several caveats should be kept in mind, such as measurement problems, the "omission of relevant variable" bias, and uncertain directions of causality. Furthermore, it is rarely known whether all the critical underlying statistical assumptions are fulfilled. Statistical relations are not necessarily causal, and a causal link does not necessarily indicate what the relevant intervention should be. As mentioned above, moreover, generalising may have serious limitations because a causal link in one context may not be present in another. These reservations should be kept in mind as we proceed. Whatever

can be learned from cross-country regressions should be seen as one piece of evidence to be combined with evidence from other sources.

Table A1 in Annex 3 gives the results of some recent studies of the determinants of HIV prevalence that have used some form of cross-country regression technique (this is not to claim that all relevant studies have been identified). They are thus limited to ecological studies (that is, the unit of observation is a population); studies that seek to explain the variation in HIV status among individuals have not been included. The studies are by scholars from different disciplines. Some have been published in journals and others are working papers. They vary substantially in quality and technical sophistication, though this does not seem to be determined by whether or not they have been published. The studies were carried out using different samples: global, developing countries only, SSA countries only, and some samples consisting of provinces/states within countries (the United States, China and Russia). Most studies derive from a model with a set of basic explanatory variables (typically GDP per capita and some measures of poverty, income inequality, urbanisation, and the percentage of Muslims in the total population); some specific variable, the main focus of the study, is then added. Only a few of these studies focused specifically on the HIV-income inequality link; rather, they have stumbled on that link while the focus has been on other issues.

Table A1 shows the main theme of the study, the sample, how the independent variable was defined (typically the LOG HIV-prevalence),[2] and the explanatory variables reported. Variables reported as significant in the study (at the 5 per cent level) are in bold. This is subject to some interpretation because most studies report on results from different model specifications, and thus the significance may vary. The last column makes some comments to qualify the results, as well as some remarks on findings related to income inequality. The result of the meta-study presented in Table A1 may be summarised as follows:

- Among the variables that appear in several studies, only two (in addition to regional dummies) can be described as consistently significant: income inequality and percentage of Muslims in the population. It is noteworthy that income inequality is significant in different model specifications, in global and SSA-only samples, as well as in some subnational studies (states/provinces in the United States and China).
- Some studies have applied regional dummies (SSA or southern Africa). Where they have been used they have remained highly significant, indicating that something is left unexplained. Sawers et al. (2008) is an exception to some extent.
- Results are inconsistent for a number of variables. Among them are the indicators related to per capita income, poverty, urbanisation, gender and ethnic fractionalisation, which have been reported as significant in some studies but not in others. Inconsistency may be the result of different model specifications and samples.
- Indicators of sexual behaviour, undeniably a key factor of interest in relation to the spread of HIV and AIDS, are largely absent from these studies. There are limitations in terms of the available indicators (leading to small samples), as well as problems of reverse causality, which limit their usefulness. One study has used median age at first sex for females in a global 45-country sample (reported as significant). Another study reports commercial sex workers/population as a significant variable.

- Only one study, applied to US states, used indicators of social capital (Holtgrave and Crosby, 2003) and this variable emerged as significant.

4 REPLICATING AND REFUTING RESULTS

Table A2 in Annex 3 reports on a series of experiments with regressions that to varying degrees correspond to those presented in Section 3 and Table A1, but in which model specifications and samples have been altered. The purpose is to check whether the significant results of previous studies may be replicated in a straightforward ordinary least squares (OLS) regression, and to obtain some indications of their robustness. This will also shed light on some of the inconsistencies among the results as revealed by the meta-study. The data used have been collected specifically for the purpose of this study (Annex 1 gives data sources and definitions).

As in most of the studies reported in Table A1, the logarithm of HIV prevalence among adults aged 15–49 (UNAIDS data for 2005) is used. We depart from a basic model with five variables: income inequality (measured by average Gini coefficients over three decades); level of economic development (measured by log of GDP per capita at purchasing power parity, or PPP); a poverty measure (adult literacy); urbanisation (measured by urban population growth 1990–1995); and percentage of the population that is Muslim. Since it might be expected that income inequality could affect HIV though income and/or poverty, it was essential to keep these two variables in the basic model. Urban growth was used rather than urban dwellers as a share of the population, since it fits better with any theory emphasising social change/ migration/mobility as a factor contributing to HIV (in bivariate analysis it also reveals a higher degree of correlation with HIV than urban share of the population).

Are problems of reverse causality reasonably under control in this basic model? HIV may obviously affect poverty levels, but the choice of literacy as a poverty indicator has the advantage that it has some built-in lags (literacy reflects historical poverty levels), which should mean that it is largely unaffected by present HIV levels. HIV may also affect income inequality, and the literature discusses the direction of that impact. Nonetheless, the Gini coefficients used here are based on averages for the last three decades (using a dataset provided by William Easterly; see Annex 1), which to some extent should lessen concerns about reverse causality. The impact of HIV on GDP is also discussed widely in the literature, and estimates of that impact differ considerably—see Glick (2007) for an overview. Reverse causality in relation to GDP per capita could be addressed using lagged variables or instrumental variable techniques. Tsafack Temah (2008, table 4.5) takes the latter approach without much impact on the overall results, at least as regards income inequality. We refrain from complicating the regressions here, and simply use log of GDP per capita. With respect to the percentage of Muslims in the population and urban growth in the period 1990–1995, it seems reasonable to assume that they are exogenous.

To this model we successively add several of the indicators used in previous studies. Variables reflecting sexual behaviour and social capital, where reverse causality is likely to be more problematic, are left for discussion in Section 5.

The large sample consists of all developing countries for which data are available (for a list of the countries, see Annex 1). In some cases, results are also reported for SSA only and for not-SSA samples. The results are grouped into sections, each of which seeks to shed light on a specific issue. Significant coefficients are in bold. In several cases, the significance of the variables is entirely dependent on the non-inclusion of a dummy variable for Africa. These are labelled non-robust, since their explanatory power seems to be exclusively the product of the overall variation in HIV levels between Africa and the rest of the world. Comments on the results of each section are given below.

ROUNDS 1–5. BASIC MODEL

The first five rounds replicate what seems to be a generalised finding from the meta-study: income inequality and percentage of Muslims are significant. This is the case with or without a SSA dummy and in the SSA-only sample, as well in the not-SSA sample. Significance falls slightly below the 5 per cent level in the SSA-only sample when a dummy for southern African countries is included.

The adult literacy indicator, which is reported as significant in some cases in the meta-study, is significant only in the large sample, with no dummy included. Africa has a high HIV prevalence and low levels of literacy, a circumstance that gives the literacy indicator some explanatory force. When a dummy is included, however, or when the sample is divided into SSA and not-SSA subsamples, this indicator loses its significance.

ROUNDS 6–9. ALTERNATIVE POVERTY MEASURES

Rounds 6–9 replace literacy by Poverty < 1USD. This reduces the sample size because of data availability, but Poverty < 1USD behaves more or less like the literacy variable: it is significant in the large sample but loses its significance when a regional dummy is included. Unreported in Table A2, tests were also carried out with some alternative poverty measures, such as access to an improved water source, with similar results.

A tentative conclusion is that HIV is not robustly related to poverty. Africa is poor and has high HIV prevalence, but neither within Africa nor among the non-African developing countries does poverty emerge as being significantly related to HIV.

A second tentative conclusion is that the link between income inequality and HIV is not intermediated by poverty. The beta coefficient of the Gini variable remains significant and largely unaffected when these different poverty measures are added to the equation.

ROUNDS 10–18. GENDER INEQUALITY MEASURES

Various gender-related variables are tested: female/male literacy; the gender power index of the United Nations Development Programme's human development index (HDI) rank minus gender-related development index (GDI) rank; and contraceptive use by married women. They are significant in some of the rounds, but again the significance is entirely dependent on the non-inclusion of a dummy variable for Africa, and in the case of female/male literacy it is also dependent on the non-inclusion of general literacy level. This could explain the inconsistency in some of the meta-study results in the area of gender inequality, where at least some models appear to suffer from the "omission of relevant variable" bias.

ROUNDS 19–21. ETHNIC FRACTIONALISATION

Ethnic fractionalisation is another variable with inconsistent results in the meta-study. It is significant in the large sample but loses all significance when an Africa dummy is included. It does not appear as significant in the SSA-only sample. Tsafack Temah (2008), with a more developed study, reached another conclusion for ethnic heterogeneity in an SSA-only sample.

ROUNDS 22-23. AGE OF EPIDEMIC

This indicator also has inconsistent results in the meta-study. The indicator is based on the first year an HIV case was reported. It is not significant in either of these rounds, but it comes closer to significance in the global sample without the dummy included (Africa's epidemic was earlier than those in other developing countries).

ROUNDS 24–29. MALE CIRCUMCISION

Is the link between HIV and the Muslim share of the population an issue of male circumcision, of norms and sexual behaviour, or both? Islam is clearly associated with male circumcision. It is also sometimes claimed to be associated with less alcohol consumption and stricter marital codes, but also with polygamy and a rejection of condom use, which might work in the opposite direction as regards HIV (Gray, 2003).

The meta-study identified few deliberate efforts to clarify this matter with quantitative analysis; Gray (2003) and Drain et al. (2006) are the most explicit attempts. Rounds 24–29 seek to shed some additional light on this issue (though the Islam-HIV link is not the main purpose of this paper). An advantage for the statistical analysis here is that the causal links should be straightforward: people do not become Muslim because of HIV or because they are circumcised. Moreover, at least until recently, people have been circumcised mainly for religious and cultural reasons and not because of the spread of HIV (this is likely to change in Africa after the UNAIDS recommendations and the introduction of new policies).

Inaccurate data are likely to be of greater concern. It has been possible to identify two measures of male circumcision. Available for the global sample was a classification of all countries in three groups: below 20 per cent, above 80 per cent and intermediate This is labelled MC1. For the SSA countries it was possible to identify more precise male circumcision rates, labelled MC2 (see Annex 1 for sources).

In the global sample without the SSA dummy (Round 24), male circumcision is not significant while the Muslim percentage of the population is. When an SSA dummy is added (Round 25), male circumcision is highly significant. Since African countries have comparatively high rates of male circumcision, this factor does not offer a strong explanation of the difference in HIV rates between Africa and the rest of the world. Nonetheless, allowing for a fixed effect for Africa (the dummy lets Africa have its own intercept), the result changes considerably. Then, male circumcision seems to add explanatory force in relation to the HIV pattern within Africa, but not to that between Africa and the rest of the world. In the SSA-only sample (Rounds 27–29), the use of both Muslim percentage of the population and male circumcision simultaneously, rather than successively, adds explanatory power to the equation (F-value up from 8.4 and 9.1 to 11.6). The two variables are clearly significant when combined. This may be interpreted as supporting the view that the Muslim factor has an effect on its own, one that is not expressed through male circumcision.

SUMMARY OF MAIN FINDINGS FROM REGRESSIONS AS PRESENTED IN TABLE A2

- As in the meta-analysis, two variables emerge as consistently significant (in addition to the regional dummies): the Muslim percentage of the population and income inequality.
- The income inequality variable behaves in a strikingly consistent manner, with a standardised coefficient at about 0.4 when the regional dummy is not included and 0.2 with the dummy. This variable apparently goes some way towards explaining why Africa is different and why there is a variation within (and outside) Africa. Income inequality's impact on HIV does not appear to emerge through poverty.
- The findings suggest that Islam is a factor that is expressed through the male circumcision factor, as well as through its own independent effect.
- A number of variables seem to be subject to what might be called an African reverse correlation paradox—that is, they are positively related to HIV in a global sample but unrelated or even negatively related to HIV within Africa. In short, globally HIV is associated with underdevelopment and poverty, but within Africa the relation is rather the opposite. This explains some of the inconsistencies revealed by the meta-study.

5 THE INEQUALITY-HIV LINK: WHICH THEORY DOES IT FIT?

The results above, therefore, clearly indicate that there is a link between inequality and HIV. The link between income inequality and HIV is further explored in Tsafack Temah (2008), using panel data for 29 African countries in the period 1997–2005. That study applies far more rigorous testing procedures than those outlined above, and income inequality still remains one of the strongest predictors of HIV.

While the income inequality-HIV link seems to have a relatively strong empirical support, its interpretation is more open to discussion. Why should there be such a link? Different hypotheses regarding the transit route from inequality to HIV may be constructed with elements from various disciplines of the social sciences. Four such hypotheses are described below. Figure 4 in Section 6 illustrates the position of these four hypotheses along the potential pathways from income inequality to HIV. Each of them has a disciplinary inspiration or affiliation, and to keep track of them here they have been labelled accordingly as the stories of the economist, the sociologist, the political economist and the historian.[3] Scholars in these disciplines are asked not to feel implicated or offended by the use of these labels. The accounts below are deliberately termed "stories", since it is not the aim of this exploratory paper to present fully developed and precise theories. For each story some preliminary evidence is presented, indicating possible areas for future research.

5.1 THE ECONOMIST'S STORY: INCOME INEQUALITY LEADING TO HIV THROUGH THE ECONOMICS OF SEXUAL BEHAVIOUR

Just as with the economics of crime, in the tradition of Gary Becker—whereby crime is modelled as a rational choice by a utility-maximising individual weighing the benefit of the

loot against the risk of getting caught times the punishment—we may construct an economic theory of sexual behaviour. Oster (2007) uses such a model of sexual behaviour to explain why poor people would be less inclined to adjust their behaviour when facing the risk of HIV, and hence why, for instance, members of the US gay community rapidly changed their sexual conduct as HIV became known while adaptation seems to have been much slower in Africa.

The intuition behind Oster's idea is simple: utility is maximised by an individual over two periods, and the chance of surviving to period 2 is determined by the risk of being infected with HIV in period 1, as well as by other mortality risks not related to HIV. Poor people are more exposed to a high risk of dying for reasons unrelated to HIV, a circumstance that decreases the expected loss associated with the risk of being infected by HIV. Correspondingly, being richer and having fewer mortality risks means that an individual places greater value on his life in period 2, and thus is less inclined to put it at risk.

Neither mentioned nor explicitly modelled in Oster's article, but an extension that can be added, is that there would also be a link between income inequality and risky sexual conduct if there were an element of economic transaction involved (not necessarily understood as prostitution). This would correspond to how theories of the economics of crime predict a link between income inequality and crime. Again, the basic intuition is simple: a utility-maximising individual engages in transactional sex as a "seller" if the utility of the benefits (transactional sex income) outweighs the expected utility lost, which is partially determined by the risk of being infected and therefore not surviving to period 2. The marginal utility of income is higher the poorer people are, so the transactional sex income has greater weight in the utility function of the poor. Being poorer also entails a higher mortality risk due to factors other than AIDS in period 2, and hence a lower expected loss from being infected in period 1. More poverty thus leads to more people being ready to engage in risky behaviour. On the other hand, people engage in transactional sex as a "buyer" if the pleasure they derive from it outweighs the lost utility from it, which in this case is determined by the "price" for transactional sex plus the expected utility loss from increased risk of not surviving to period 2. For the rich there are two forces at play here: being richer and having a greater chance of surviving to period 2 reduces the inclination to take risks, but being richer also means being able to afford more transactional sex. With higher levels of income inequality, therefore, it is expected that more poor people are ready to engage in transactional sex for a given price, and perhaps also that more rich people are able and ready to enter the transactional sex market as buyers. Annex 2 presents a sketch of a formalised economic model of sexual behaviour that illustrates this point, extending Oster's original model with the inclusion of a "transactional sex price".

As a portrayal of human behaviour this theory may appear crude and simplistic. Its basic elements, however, could easily be reconciled with the view that concurrent partnerships are a major driver of the HIV epidemic (see Section 2). Concurrent partnerships, not to be misunderstood as prostitution, are believed to contain varying degrees of transactional sex, the stereotype being the "sugar daddy" engaging in multiple partnerships with younger and economically dependent women (Leclerc-Madlala, 2004). Studies of the determinants of individual HIV status have also identified economic gender inequalities between young women and older/richer men as a clear risk factor (Beegle and Özler, 2006).

What would it take to give the economist's story empirical support in a cross-country analysis? To support it one would like to establish a link between income inequality and risky

sexual behaviour that involves some form of economic transaction, and between the latter and HIV. Determining the precise strength of the link between risk behaviour and HIV in ecological studies is demanding because of issues of both data availability and reverse causality. A number of studies have tried to establish the reverse link from HIV to behavioural change, and the methodological problems are recognised as challenging; for an overview, see Glick (2007: 28–34). It might be easier, however, to establish the link from income inequality to risky sexual behaviour, since income inequality could be seen as largely exogenous to sexual behaviour. Table 2 shows the partial correlations between income inequality and some indicators of risky sexual behaviour. Note that income inequality is positively correlated with most of these indicators of risk behaviour, and significantly so with some of them.

TABLE 2

Partial Correlations between Gini and Sexual Behaviour Indicators

Behaviour indicator	Partial correlation with Gini	Number of countries
High-risk sex female[1]	**0.47**	25
High-risk sex male	**0.51**	22
First sex female age	**- 0.36**	50
First sex male age	**- 0.54**	32
Young female (15–24) having premarital sex last year	**0.38**	43
Multiple partners female[2]	0.20	29
Multiple partners male	0.21	28
Female commercial sex workers, prevalence	**0.52**	42
Had commercial sex last year (males)	0.33	22

Sample consists of developing countries, a substantial share of them in Africa.

Significant correlations at 5% in bold.

1. High-risk sex defined as share of respondents (aged 15–49) who had sex with a non-marital and non-cohabiting partner during the previous 12 months.
2. Multiple partners defined as share of respondents (among sexually active aged 15–49) who had sex with more than one partner during the previous 12 months.

Source: See Annex 1.

Moving a step further to multivariate analysis, using the basic model from Table A2 but substituting HIV for an indicator of risk behaviour as a dependent variable, income inequality is confirmed as a significant predictor of the indicators of sexual risk behaviour. The results are reported in Table 3. Gini emerges as a significant explanatory variable for three of the four indicators of sexual risk behaviour, and is just below the 5 per cent significance level in the case of commercial sex worker prevalence.

Establishing the link between income inequality and risky sexual behaviour more rigorously could be an area of useful future research. Even if the links in Table 3 could be established with greater certainty, however, it is still not clear if it supports the theory of the economist rather than some other theory. As revealed by Tables 2 and 3, income inequality seems to be associated with most of the measures of risky behaviour, not just with those that could mainly be expected to involve elements of economic transactions.

The economist's story, as presented here, is a theory that works solely on the assumption that each individual is a utility-maximising agent, without any references to social interaction, the creation of norms, stigma or public sector interventions. The sociologist's story is different.

TABLE 3

Explaining Sexual Risk Behaviour with Variables of the Basic Model (significant beta coefficients in bold; t-value below)

Explanatory variables	Dependent variable			
	First sex female age	First sex male age	Young female premarital sex	Commercial sex worker prevalence
Gini	**-0.35**	**-0.50**	**0.29**	0.26
	-3.09	-2.63	2.23	1.83
logGDP/cap	-0.07	-0.15	-0.12	0.19
	-0.66	-0.87	-0.91	1.48
Adult literacy	**0.45**	0.14	0.06	0.14
	2.75	0.48	0.25	0.51
Urban growth	0.07	0.13	-0.06	0.38
	0.51	0.63	-0.35	1.69
% Muslim	0.14	0.15	-0.13	-0.15
	1.12	0.70	-0.75	-1.18
SSA dummy	**-0.33**	-0.01	**0.64**	**0.53**
	-2.23	-0.06	3.79	2.62
R2	0.47	0.16	0.35	0.51
F-value	8.29	2.03	4.73	6.98
N=	49	31	42	35

5.2 THE SOCIOLOGIST'S STORY : INCOME INEQUALITY LEADING TO HIV THROUGH A REDUCTION IN SOCIAL CAPITAL

There are numerous ways of defining social capital but the elements usually included in the definitions are trust, norms, reciprocity and cooperation among members of a social network, enabling collective action in pursuit of shared goal. It is often pointed out that social capital in a given society does not express itself in one dimension alone. Strong social capital within one sub-group does not necessarily reflect social capital in society as a whole (the example of the Mafia in Sicily may illustrate the point). Moreover, a distinction is often made between vertical and horizontal expressions of social capital (for instance, trusting the government versus trusting people in general).

Various indicators have been used to measure social capital. In quantitative analysis, the most common are indicators of generalised trust: public surveys asking "in general, do you think most people can be trusted?" Other indicators used are measures of participation in different social networks, or groups and indicators reflecting vertical trust (trust in various public institutions).

Barnett and Whiteside (2006), a frequently cited source on the AIDS epidemic, argues that there is a link between social cohesion/social capital and HIV. Socially cohesive societies are assumed to be better able to mobilise resources in pursuit of joint goals and to avoid or control risk. But what, more precisely, does "social capital" contain that would facilitate the mobilisation of collective action against HIV? Just as the concept of social capital is vague, a number of different links may be at work here. It could be a matter of establishing common norms in a community to uphold certain rules of sexual behaviour. It could also have something to do with shared values being lost as a result of social divides, and mutual support mechanisms being undermined. Or could it reflect the absence of vertical and horizontal relations of trust that are needed in a society to pass on a warning that leads to behavioural change? The vast literature on the relationship between social capital and public health in general is rich in suggestions for possible linkages (Kawachi et al., 1999).

Is it possible to give empirical support to an income inequality-social capital-HIV link? The link between social capital and income inequality is quite well established empirically and reference is often made to it. A recent study, using a global sample, identified income inequality as one of the few determinants of generalised horizontal trust (as measured in the World Values Survey) that remained robust using various model specifications and tests (Bjornskov, 2006).

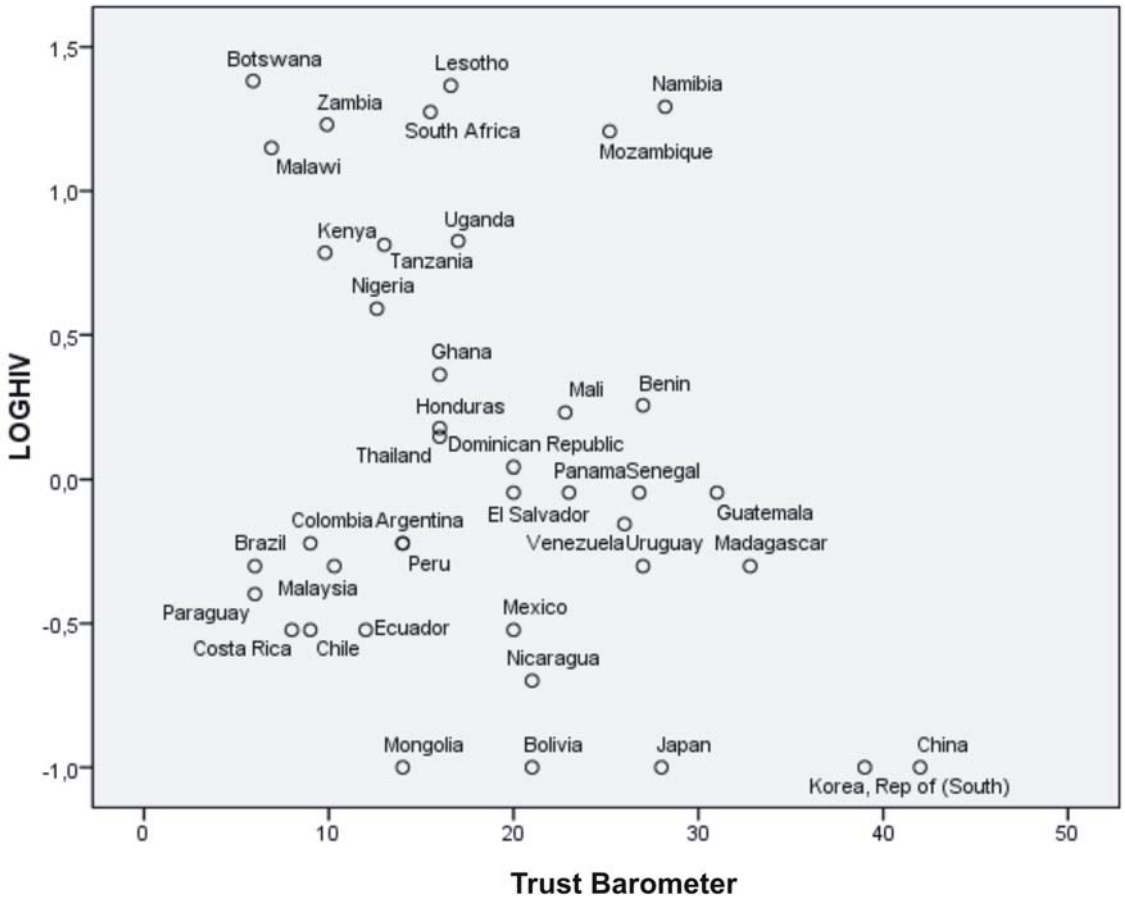
The link between social capital and HIV is more problematic. As with sexual behaviour, the causal relationship is likely to work in both directions. Indeed, one of the few identified studies to have conducted cross-country regressions involving HIV and social capital (generalised trust) tries to determine the impact of HIV on social capital rather than the other way round (David, 2007). It concludes that there is such an impact, though it acknowledges having used an instrumental variable for HIV that is of dubious quality.[4] Ecological studies based on US states have confirmed a social capital-HIV link. In South Africa, studies of the determinants of individuals' HIV status have tested the social capital hypothesis, using indicators of membership of different kinds of groups and social networks; the results have been mixed, depending on the character of the group or network (Campbell et al., 2002).

The World Values Survey is the most frequently used data source for the indicator of generalised trust—that is, the "most people can be trusted" question. A limitation of the World Values Survey is that it includes relatively few developing countries, particularly countries in Africa where there is the greatest variation in HIV prevalence. Trust is also measured by a similar question in the regional barometers (Afrobarometer, Latinobarometer and Asiabarometer), now combined under the heading of the Global Barometer. This has a sample of 38 developing countries (8 Asian, 17 Latin American and 13 African). Figure 3 shows the relationship between HIV prevalence (LogHIV) and this measure of trust. The correlation is perhaps not impressive, but it is clearly there (R2 adjusted = -0.29, just above significance at the 5 per cent level).

How does the trust variable behave when inserted into a regression analysis (while acknowledging small sample size and possible reverse causality bias)? Table 4 reports the results. When "trust" is inserted into the basic model from Section 4 of this paper, its beta coefficient has the expected sign (negative) and is close to significant at the 5 per cent level. But the insertion of social capital just slightly reduces the beta coefficient of the Gini variable, which would indicate two independent effects. When a dummy for Africa is included, the pattern remains the same, but with lower levels of significance. In the last round a dummy

for Latin America is also included (Latin America is an outlier continent in terms of inequality and trust), and both inequality and trust reach significant levels again.

FIGURE 3



Source: See Annex 1.

A number of caveats should be noted here. The sample size is small; it is unknown if the right dimension of social capital is being measured; and the reverse causality bias has not been addressed. A cautious conclusion from this analysis is that at least the data do not clearly contradict the sociologist's story on the income inequality-HIV link. Social capital should be kept on the list of suspects.

What path might future research take to ensure more stringent testing of the inequality-social capital-HIV hypothesis? Ideally, larger samples and access to a wider range of indicators of social capital should be available, in addition to instrumental variables or time series data to address the issue of direction of causality.

One option would be to break down HIV prevalence figures to African provinces and then combine those with data from Afrobarometer. The latter contains a wide range of indicators, including those on various dimensions of social capital. Some exploratory attempts have been made in this direction while preparing this study, reaching a sample of some 150 African provinces, but the results are not ready to be reported yet.

TABLE 4

Regression Results, Social Capital/Trust Added to Basic Model (significant beta coefficients in bold; t-value below)

Explanatory variables	Dependent variable LOGHIV				
	1	2	3	4	5
Gini	**0.30**	**0.28**		**0.23**	**0.297**
	2.23	2.19		2.44	2.987
Trust		-0.23	**-0.26**	-0.15	**-0.188**
		1.87	-1.95	-1.65	-2.053
logGDP/cap	0.04	-0.02	0.02	-0.09	-0.089
	-0.28	-0.16	0.12	-1.01	-1.001
Adult literacy	-0.33	**-0.43**	**-0.46**	-0.16	-0.132
	-1.54	-2.06	-2.08	-0.09	-0.735
Urban growth	**0.43**	**0.39**	**0.46**	0.02	-0.039
	2.68	2.44	2.78	0.16	-0.294
% Muslim	-0.26	-0.30	-0.33	-0.26	-0.35
	-1.50	-1.78	-1.82	-2.13	-2.676
SSA dummy				**0.82**	**0.599**
				5.33	2.969
LAC dummy					-0.267
					-1.672
R2	0.45	0.73	0.42	0.73	0.75
F-value	6.78	6.69	6.31	15.03	14.31
N=	36	36	36	36	36.00

5.3 THE POLITICAL ECONOMIST'S STORY: INCOME INEQUALITY LEADING TO HIV THROUGH POOR PUBLIC SECTOR PERFORMANCE

The literature frequently discusses the link between inequality and health. Inequality is associated with lower tax revenue and hence lower public expenditures, and possibly also their quality, since their distribution is sub-optimised. One hypothesis could be that an inequality-health link operates through a weakened public sector performance in delivering social services. See Kawachi et al. (1999) and Kaplan et al. (1996) for a discussion of this mechanism in relation to the more general income inequality-health link.

TABLE 5

Partial Correlations between HIV Prevalence and Various Health Sector Performance Indicators in Sub-Saharan Africa (significant correlations at the 5% level in bold)

Health sector performance indicator	Partial correlation with HIV prevalence	N
Immunisation rate measles	+0.18	38 SSA only
Immunisation tuberculosis	+0.28	38 SSA only
Child mortality (<5)	**-0.33**	38 SSA only
Public health expenditures	**+0.65**	38 SSA only

Source: Human Development Report, 2007.

Does this story also fit the pattern of HIV? For instance, a weak public health system might be less able to organise efficient HIV testing, to treat STDs, and to manage successful public awareness campaigns, all of which are believed to be important in counteracting the spread of HIV. If this were the case, one would expect HIV to follow a pattern similar to that of other health indicators whose links to public sector performance are less disputed. Immunisation or child mortality could be cases for comparison. Table 5 gives the partial correlations between HIV prevalence and four health system indicators in Africa: child mortality (<5 years), public health expenditures per capita, and immunisation rates for measles and tuberculosis. However, the table shows that all the signs are the opposite of what would be expected in the political economist's story. African countries with high HIV prevalence tend to have lower child mortality (despite the fact that HIV itself increases child mortality), better immunisation programmes and higher public spending on health (though the latter circumstance could also be an effect of the HIV epidemic itself). It seems difficult to reconcile the correlations revealed by Table 5 with the political economist's story.

Rather than following the pattern of health system performance indicators, HIV prevalence seems to follow the pattern of "social diseases" such as crime and homicide rates. Table 6 shows the correlation between HIV prevalence and indicators of crime and homicide rates in Africa (and also for a global sample as regards homicide rates). Here the correlations are all positive and surprisingly strong. In fact, replacing HIV prevalence with the homicide rate as the independent variable in the basic model in Table A2 gives a strikingly similar result; the Gini coefficient and the percentage of Muslims in the population emerge as the only significant variables. Future research could explore how the tools and approaches developed in criminology might be applied to research on HIV. The economics of crime and social capital/social disorganisation are two theories that compete to explain the established link between economic inequality and crime (Holmqvist, 2000).

TABLE 6

Partial Correlations between HIV Prevalence and Indicators of Crime/Violence (significant correlations at the 5% level in bold)

Crime indicator with HIV prevalence	Partial correlation	N
Homicide rate/100,000	**0.31**	102 (global sample)
Homicide rate/100,000	**0.61**	26 (SSA only)
Crime rate	**0.79**	22 (SSA only)

Source: See Annex 1.

5.4 THE HISTORIAN'S STORY: HISTORY AND THE COLONIAL LEGACY, LEADING TO BOTH INEQUALITY AND HIV, HAVE CREATED A SPURIOUS LINK

Could the relationship between crime and economic inequality be spurious? Poverty and/or urbanisation could be suspected of creating such a spurious link, but the results in Sections 3 and 4 did not support that hypothesis. The main candidates for such a link are probably among factors related to history and the colonial legacy. Within SSA it is apparent that the countries most affected by HIV share some historical traits. Compared to the rest of SSA, the high-prevalence countries in southern Africa and parts of eastern Africa had greater exposure to phenomena such as European settlements, apartheid, a large-scale mining industry, migration (forced and voluntary) and, consequently, possibly also a greater disruption of traditional

values and family patterns. The greater presence of European settlers probably also contributed to a more limited presence of Islam (and to less circumcision). These colonial roots helped create dual societies and gave rise to the economic inequality that is particularly pronounced in these parts of Africa. In all of this it is not obvious how causal and spurious links may be distinguished from each other.

The literature frequently refers to the colonial legacy as an important factor in understanding the geographical pattern of the HIV epidemic (Setel et al., 1999; Hargrove, 2007; Barnett and Whiteside, 2006; Brummer, 2002). Can an impact of the colonial legacy on HIV be documented statistically? It is not easy to find historical data that may be used for quantitative analysis, but one indicator of the colonial legacy is readily available: the year of independence from external domination. Within SSA, the year of independence is clearly associated with the degree to which European settlers were present in the country and hence with the extent of colonial penetration (more settlers are associated with later independence). An indicator was constructed for all developing nations in our sample. A zero was given to countries without a colonial past, or which attained independence before 1900, and a two-digit number corresponding to the independence year was given to the rest. Newly established states in the former Soviet Union and former Yugoslavia were categorised as lacking a colonial past. The independence years of Zimbabwe, South Africa, Botswana, Lesotho and Swaziland were defined as the point when white rule ended (Botswana, Lesotho and Swaziland combined with South Africa here, since they were largely ruled under the apartheid system in social and economic terms).

TABLE 7

Regression Results, "Year of Independence" Added to Basic Model

Explanatory variables	**Dependent variable LOGHIV**					
	AllDev 1	**AllDEV 2**	**AllDev 3**	**AllDev 4**	**SSAonly 5**	**NotSSA 6**
Gini	**0.37**	**0.28**	**0.20**	**0.20**	0.21	**0.28**
	4.44	4.18	3.29	3.45	1.69	2.50
Independence year		**0.58**		**0.29**	**0.44**	**0.31**
		6.94		3.49	3.12	2.31
logGDP/cap	0.00	-0.02	-0.08	-0.07	**-0.21**	0.06
	0.03	-0.27	-1.41	-1.30	-2.05	0.42
Adult literacy	**-0.48**	**-0.26**	-0.08	-0.07	-0.26	-0.16
	-4.24	-2.75	-0.83	-0.75	-1.49	-1.00
Urban growth	0.11	-0.07	-0.02	-0.08	**0.04**	-0.21
	1.05	-0.78	-0.25	-1.06	0.40	-1.39
% Muslim	**-0.43**	**-0.45**	**-0.38**	**-0.40**	**-0.62**	**-0.59**
	4.85	-6.24	-5.90	-6.58	-3.91	-5.07
SSA dummy			**0.73**	**0.55**		
			9.01	6.00		
R2	0.48	0.67	0.73	0.77	0.64	0.37
F-value	17.75	31.00	42.29	42.80	10.867	6.45
N=	90(=AllDev)	90 (=AllDev)	90 (=AllDev)	90 (=AllDev)	33 (=SSAonly)	56 (=notSSA)

Table 7 gives the results following the inclusion of this indicator in the basic model. It remains significant with and without a dummy for Africa, for a SSA-only sample and, perhaps

most surprisingly, also for a sample consisting only of non-African countries. The indicator tends to reduce the beta coefficient of the Gini variable somewhat, and substantially reduces the coefficient of the SSA dummy.

The results given in Table 7 indicate that historical factors related to the colonial legacy might be important determinants of today's geographical pattern of HIV. A hypothesis could be that prolonged rule by foreign elites created inequalities, disrupted the social fabric of a society and undermined its ability for collective action. Further research might document this more solidly, and might identify more precise indicators than the one used here.

Nonetheless, even if colonial-legacy factors seem to be associated with both economic inequality and HIV, there is still nothing in Table 7 to support the argument that this is a case of a spurious link. The historian's story might be half-true, but the claim that the link is spurious would need far more solid evidence.

6 CONCLUDING REMARKS

This paper sprang from two questions: (i) is there a significant and robust link between income inequality and HIV? and (ii) if there is such a link, why should unequal societies be more vulnerable to HIV?

The answer to the first question was in the affirmative; the link is there. It is confirmed consistently by a number of studies, as shown by the meta-study. The cross-country regression results in this paper have provided further support for the existence of such a link**.**

It has not been possible, however, to answer the second question conclusively. Four different hypotheses have been presented as to why a link between income inequality and HIV might be expected: (i) the economics of sexual behaviour; (ii) social capital; (iii) public sector performance; and (iv) history and the colonial legacy creating a spurious relationship.

Figure 4 gives an overview of the different pathways at play, and the position of these four hypotheses (the bolded boxes) in relation to them**.**

The right-hand side of Figure 4 illustrates that any factor with an impact on HIV prevalence would work at some point through sexual or possibly non-sexual transmission (two boxes are labelled accordingly). Biological cofactors may affect the "transmission rate" (male circumcision, untreated STDs and so forth).

The lines leading from the "feedback" box in the upper-right corner illustrate the various reverse causality mechanisms mentioned in the text. Rising HIV prevalence might have feedback effects in terms of AIDS mortality (reducing prevalence), more or less spontaneous behavioural adaptations, various kinds of public health interventions, and a number of other possible repercussions on society as a whole, including altered social relations that affect social capital. The determinants of HIV prevalence discussed here may affect the initial conditions that make a society vulnerable to HIV, as well as its ability to adapt once the epidemic becomes apparent (that is, influencing the force of the feedback mechanisms). It should be noted that linear regression analysis might not always capture the complexities and dynamics that Figure 4 attempts to illustrate.

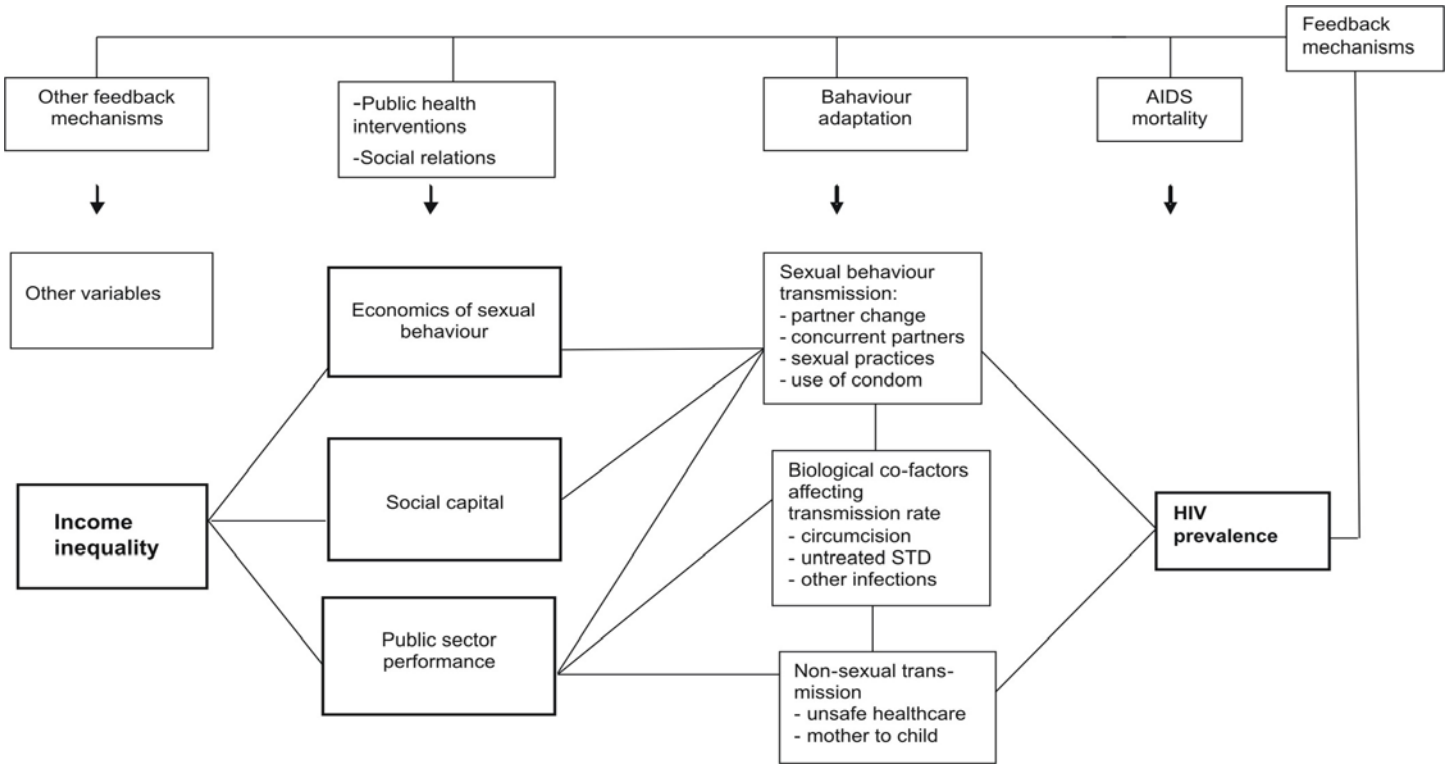
Confronting the four hypotheses with some preliminary empirical evidence, there is no support for the idea that the link between income inequality and HIV arises from a weakening

of public sector performance. In SSA, at least, HIV tends to be associated with a comparatively better public health performance rather than a poorer one, which is what that hypothesis would predict.

As regards the other hypotheses, there is some empirical evidence to support them but it is not conclusive and we cannot determine their respective weight. Income inequality seems to be associated with riskier sexual behaviour, as the economics of sexual behaviour would predict. Income inequality is also associated with lower levels of social capital, and social capital seems to be negatively associated with HIV, as predicted by the social capital hypothesis. It has also been possible to show that even such a crude indicator of history and the colonial legacy as "year of independence" is a strong determinant of the variation in HIV prevalence today, globally as well as within Africa. The existence of this colonial legacy factor, however, is far from enough to underpin a claim that the income inequality-HIV link is spurious. The economics of sexual behaviour and social capital theory, apparently, remain our two main suspects. The paper has indicated some ideas for future research that could help clarify the matter further.

Is the issue relevant enough to merit additional research? Simply knowing that there is a statistical link between income inequality and HIV is not something that might lend itself to clear policy conclusions. If we can show more precisely how this link works, however, more useful policy conclusions may follow. Beyond the HIV epidemic itself, there is also an interest in understanding why highly unequal societies should be more vulnerable to new infectious diseases of this kind, in which the epidemiology has strong ingredients of human behaviour and social relations. If it is correct to say that we will see more of these diseases in the future, as a by-product of globalisation and human mobility, then there is a need for a better understanding of these mechanisms.

FIGURE 4



ANNEX 1. DATA, SOURCES, SAMPLE

DATA AND SOURCES

HIV
HIV prevalence among adults aged 15–49. UNAIDS, *Global Report, 2006*: http://www.unaids.org/en/KnowledgeCentre/HIVData/GlobalReport/.

Gini
Downloaded from William Easterly's dataset, used to explain the impact of income inequality on growth. Easterly's data are from WIDER (2000), but have been improved by adjusting for possible methodological biases. They are averages for the period 1960–1998, to the extent that data are available. As a sufficiently large Africa sample is essential for this study, Easterly's dataset has been complemented with a few additional countries now available in the WIDER dataset. Link for Easterly's dataset: http://www.nyu.edu/fas/institute/dri/Easterly/Research.html.

LogGDP/capita
GDP/capita in PPP terms. UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Adult literacy
1995–2005. UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/

Urban growth
1990–1995. World Bank (1997). *Confronting AIDS*, Statistical Appendix, Table 2: http://www.worldbank.org/aids-econ/confront/confrontfull/tables.html.

% Muslim
Wikipedia: http://en.wikipedia.org/wiki/Islam_by_country.

Poverty < 1 USD
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Female/male literacy
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Gender empowerment index
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

HDI-GDI rank
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Contraceptive use, married women
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Ethnic fractionalization
Easterly 2007: http://www.nyu.edu/fas/institute/dri/Easterly/Research.html.

Age of epidemic
Year of first reported AIDS case. World Bank (1997). *Confronting AIDS*, Statistical Appendix, Table 2: http://www.worldbank.org/aids-econ/confront/confrontfull/tables.html.

Male circumcision
MC1: Drain (2006): http://www.biomedcentral.com/content/pdf/1471-2334-6-172.pdf.

MC2: Williams et al. (2006): http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0030262.

High risk sex
Demographic Health Surveys provided by USAID, downloaded from: http://www.measuredhs.com/.

First sex
Demographic Health Surveys provided by USAID, downloaded from: http://www.measuredhs.com/.

Young having premarital sex last year
Demographic Health Surveys provided by USAID, downloaded from: http://www.measuredhs.com/.

Multiple partners
Demographic Health Surveys provided by USAID, downloaded from: http://www.measuredhs.com/.

Female commercial sex workers
Vandepitte et al. (2006): http://sti.bmj.com/cgi/content/abstract/82/suppl_3/iii18.

Had commercial sex last year
Demographic Health Surveys provided by USAID, downloaded from: http://www.measuredhs.com/.

Trust
Globalbarometer with links: http://www.globalbarometer.net/objectives.htm.

Immunisation rates measles
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Immunisation rate Tuberculosis
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Child mortality < 5
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Public health expenditures
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Homicide rates/100.000
UNDP, *Human Development Report* 2007/2008: http://hdr.undp.org/en/statistics/.

Crime rate SSA
Indicator constructed from classification of African countries in five categories according to assessed crime rate. UNODC (2005): http://www.unodc.org/pdf/African_report.pdf.

Independence year
Adjustments made as explained in the main text. Wikipedia: http://en.wikipedia.org/wiki/Independence_Day.

SAMPLE. 90-COUNTRY SAMPLE OF BASIC MODEL

Algeria	Macedonia
Argentina	Madagascar
Armenia	Malawi
Azerbaijan	Malaysia
Bangladesh	Mali
Belarus	Mauritania
Bolivia	Mauritius
Botswana	Mexico
Brazil	Moldova
Bulgaria	Mongolia
Burkina Faso	Mozambique
Burundi	Myanmar
Cambodia	Namibia
Cameroon	Nepal
Central African Republic	Nicaragua
Chad	Niger
Chile	Nigeria
China	Pakistan
Colombia	Panama
Costa Rica	Papua New Guinea
Côte d'Ivoire	Paraguay
Dominican Republic	Peru
Ecuador	Philippines
Egypt	Romania
El Salvador	Russian Federation
Estonia	Rwanda
Ethiopia	Senegal
Gabon	Sierra Leone
Gambia	Slovenia
Georgia	South Africa
Ghana	Sri Lanka
Guatemala	Sudan
Guinea	Swaziland
Guinea-Bissau	Tanzania
Honduras	Thailand
India	Trinidad and Tobago
Indonesia	Tunisia
Jamaica	Turkmenistan
Kazakhstan	Uganda
Kenya	Ukraine
Kyrgyzstan	Uruguay
Lao People's Dem Rep	Venezuela
Latvia	Viet Nam
Lebanon	Zambia
Lesotho	Zimbabwe
Lithuania	

ANNEX 2. A SKETCH OF AN INCOME INEQUALITY-SEXUAL RISK BEHAVIOUR MODEL

Let an individual maximise the following utility function over two periods:

$$U= U^1 (Y^1, p)+m(y)(1-rp)U^2 (Y^2, q) \quad (1)$$

with

$$Y^1= y + tp$$

$$Y^2= y + tq$$

where

U = total utility

U^1 = utility period 1

U^2 = utility period 2

p = number of "transactional sex" partners period 1

q = number of "transactional sex" partners period 2 (not of interest here)

Y^1 = total income period 1

Y^2 = total income period 2

y = income excluding cost/income from transactional sex, assumed to be the same both periods

t = a fixed monetary cost/income of engaging in transactional sex (some individuals sell, others buy, with t negative for buyers and positive for sellers)

$m(y)$ = non HIV-related expectancy to survive to period 2 (supposed to be increasing with income)

r = risk of contaminating HIV from an additional transaction sex partner, contamination assumed to lead to non-survival period 2.

Standard properties of the utility function are assumed (second-order partials negative, cross partials zero or negligible, no corner solution). The individual will choose the number of transactional sex partners in period 1 that satisfies—that is, equation (1) differentiated with respect to p:

$$tU^1_Y + U^1_p - m(y)\, r\, U^2 = 0 \Rightarrow p^* \quad (2)$$

Differentiating (2) with respect to income y gives:

$$tU^1_{Yy} + U^1_{pp}dp/dy - [rU^2 dm/dy + m(y)rU^2_y] = 0 \quad (3)$$

or

$$dp/dy = [rU^2\, dm/dy + m(y)rU^2_y - tU^1_{Yy}] / U^1_{pp} \quad (4)$$

rich buyer (t<0):	+	+	-	-
poor seller (t>0):	+	+	+	-

The poor "seller" of transactional sex will unambiguously reduce the number of partners with increasing income ($dp/dy < 0$): increased income means higher expected non HIV-related survival ($dm/dy > 0$) and increased utility period 2 ($U^2_y > 0$), and hence less willingness to take the risk of being infected. Increased income also reduces the marginal utility of the additional income derived from transactional sex ($tU^1_{Yy} < 0$).

For a "buyer", the value of dp/dy depends on a trade-off: higher income means higher expected survival and a greater utility period 2, and hence less willingness to take the risk of being infected and not surviving. But being richer also means that the marginal utility loss from paying "t" is lower—that is, transactional sex becomes more affordable. If the latter effect dominates, increasing income means more "buyers".

Higher income inequality means that there will be more of both rich and poor people, so there will be more potential sellers of transactional sex, and possibly also more buyers. Adding a price mechanism (that is, let "t" be a function of supply and demand so that price goes down as more sellers enter the market) would reinforce the basic point of this model further, as demand from rich "buyers" would react to the price effect.

ANNEX 3

TABLE A1

Study (author/journal)	Main theme	Sample	Independent variable	Explanatory variables ("significant" in bold)	General remarks and specific findings concerning income inequality
Tsafack Temah (2008) PhD dissertation, University d'Auvergne	HIV and income inequality HIV and gender inequality	SSA 29 countries pooled data 1997–2005	Logit HIV =ln[hiv/(C-hiv)]	**Inequality/Gini (+)** Female economic participation **Female/male school enrolm. (-)** Maternal leave benefits Log GNI/cap **Poverty(water+malnutrition) (-)** Access to healthcare Adult literacy (+) **Muslim % (+)** **Ethnic fractionalisation (+)** Log TV sets (-) **Contraceptive prevalence (-)** Urbanisation rate Conflict Voice and accountability **Southern/Eastern Africa (+)** Prevalence border country	*Income inequality remains robust for various tests, such as using instrument for GNI/cap, allowing for interaction variables, making HIV binary, etc. It is estimated that income inequality adds 30% explicative power to the model. *The HIV-inequality link is not explicitly tested but some potential transmission mechanisms mentioned (such as material deprivation, psychosocial, social cohesion). *Some but not all gender variables shown to be robust. *Most results, including on income inequality, also remain significant when, in a smaller sample, HIV prevalence rate is replaced by HIV incidence.
Sawers et al. (2008) *AIDS Care*	HIV and cofactor infections	Global 80 countries	LOG HIV	**Inequality/GINI (+)** LogGNI/cap (PPP) **Adult literacy (+)** Urban % Age of epidemic **Muslim % (+)** **Southern Africa (+)** Contraceptive use **Cofactor infections (STI, parasites, etc.) (+)** **Age first sex females (-)**	Median age for first sex is tested in a smaller sample (45 countries) and is significant as an explanatory variable. In this sample and model specification, the Gini variable loses its significance.

Broody/Deuchert (2007) *Annals of Epidemiology*	HIV and unsafe healthcare	Global 54 develop. countries	HIV prevalence	**Inequality/Gini (+)** GDP per capita Health expenditures Literacy Vaccination Physicians/cap **Urban share (-)** **Muslim %** Female/male literacy **Female economic activity (-)** Age of epidemic **SSA dummy (+)** **LAC dummy (-)** Asia dummy Eastern Europe dummy **No-use autodisable syringe (+)**	*Non-use of autodisable syringes significantly related to HIV, indicating transmission through unsafe healthcare. *In a SSA-only sample tetanus immunisation coverage is also significantly and positively related to HIV, also indicating healthcare transmission.
Talbott (2007) *PLoS ONE*	HIV and commercial sex workers	Global 77 countries	HIV prevalence	**Inequality/Gini (+)** **Female illiteracy rate (-)** **Muslim % (+)** **Commercial sex workers (+)** GDP/capita	*Inequality robust for all model specifications. *Significance of "Muslim" not robust for inclusion of commercial sex worker.
Drain et al. (2006) *Epidemiology and Social Science*	HIV determinants	Global 122 devel. countries	LOG HIV	Examine 81 different socioeconomic variables Strong predictors were: **Male circumcision (-)** **Regional dummies** **Female illiteracy (-)** **Age structure (+)** **Immunisation (-)** **Age of epidemic (+)**	Unclear methodology. Not reported how inequality was used in multivariate model, but reported as significant correlate in bivariate analysis.

Gray (2003) *Soc Science and Medicine*	HIV and Islam	SSA 38 countries	HIV prevalence	**Muslim % (+)** **GDP/cap (+)** Population density Urban % Age of epidemic	Also contain meta-study of findings on Islam and HIV, where all but one reporting Islam leading to less HIV. Potential pathways indicated as male circumcision, restrictive norms on alcohol and marital codes. Ambiguous evidence of Islam being related to less risky sexual behaviour.
McIntosh (2007) *Univ. of California Working Paper*	HIV and mortality, increased preval. from better healthcare	SSA 31 countries	HIV prevalence	Population density Road network 1990 GDP/cap **Female mortality 1980 (-)**	High female mortality in 1980s negatively related to HIV prevalence. Good healthcare leading to reduced mortality could increase prevalence, claimed to explain why richer African countries have higher prevalence.
Sutherland (2007) *Nottingham University Conference Paper*	HIV and income inequality	China 30 provinces		**Inequality urban/rural (+)** Female literacy Various others (not reported)	The inequality variable remains robust for inclusion of a set of 15 different explanatory variables (details not given).
Crosby and Holtgrave (2003) *Sexually Transmitted Infections, STI online*	HIV income inequality and social capital	US states 48 states	AIDS case rate	**Inequality richest/poorest deciles (+)** **Social capital (index of 14 measures) (-)** **Poverty**	
Moran and Jordaan (2007) *Int. Journal of Health Geographics*	Determinants of regional prevalence	Russia 78 regions	HIV prevalence	GDP/capita **Mobility/number of cars (+)** **Urbanisation (+)** **Teenage crime (+)** Healthcare/hospital beds **Far East dummy (+)**	No income inequality measure used.
Nepal (2007) *World Health and Population*	HIV and equity, governance, gender	Global 100 countries	HIV prevalence	**Inequality/Gini (+)** GDP/cap **Gender development index (-)** Good governance	

TABLE A2

Dependent variable: LOGHIV

Table report standardised regression coefficients with t-statistics below. Significance at 5% level in bold.

Round	Sample[1]	GINI	LogGDP/ capita	Adult Literacy 1995-05	Urban Growth 1990-95	Muslim %	SSA dummy[2]	Poverty indicators	Gender inequality indicators	Ethnic fractionalisation	Age epidemic	Male circum-cision[3]	F-value	R-squared, adjusted
1–5 Base model														
1	AllDev	**0.36**	0.00	**-0.48**	0.11	**-0.43**							17.75	0.482
	n=90	4.44	0.03	-4.24	1.05	-4.85								
2	AllDev	**0.20**	-0.08	-0.08	-0.02	**-0.38**	**0.73**						42.29	0.734
	n=90	3.29	-1.41	-0.83	-0.25	-5.90	9.01							
3	SSA	**0.34**	-0.22	-0.89	0.10	**0.67**							8.46	0.531
	n=33	2.58	-1.81	-0.46	0.79	-3.72								
							S. Afr. dummy							
4	SSA	0.22	-0.16	-0.18	0.04	**-0.57**	**0.40**						10.541	0.634
	n=33	1.82	-1.44	-1.05	0.31	-3.54	2.99							
5	NotSSA	**0.24**	0.05	-0.30	-0.18	**-0.53**							6.145	0.315
	n=56	2.06	0.32	-2.00	-1.17	-4.50								
6–9 Alternative poverty indicators								Poverty <1USD						
6	AllDev	**0.40**	-0.04		0.14	**-0.23**		**0.38**					19.129	0.525
	n=82	4.66	-4.86		1.34	-2.85		3.76						
7	AllDev	**0.26**	-0.08		-0.17	**-0.31**	**0.76**	-0.02					41.374	0.747
	n=82	4.03	-1.36		-0.22	-5.18	8.28	-0.26						
8	SSA	**0.40**	-0.13		0.02	**-0.56**		-0.04					5.796	0.48
	n=26	2.72	-0.87		0.12	-3.77		-0.30						
							S. Afr. dummy							
9	SSA	0.16	-0.05		-0.06	**-0.27**	**0.65**	0.03					14.838	0.762
	n=26	1.44	-0.47		-0.58	-2.37	5.08	0.32						

10–18 Gender inequality								Female/male literacy		
10	AllDev	**0.42**	-0.03		**0.20**	**-0.39**		**-0.33**	14.996	0.449
	n=86	4.76	-0.31		2.02	-4.09		-3.07		
11	AllDev	**0.22**	-0.08	-0.12	-0.04	**-0.36**	**0.71**	0.06	34.19	0.73
	n=86	3.41	-1.47	-0.70	-0.48	-5.39	8.71	0.40		
12	AllDev	**0.39**	-0.01	-0.55	0.08	**-0.40**		0.11	14.087	0.477
	n=86	4.44	-1.03	-2.33	0.70	-4.36		0.51		
								Gender empowerment index		
13	AllDev	**0.39**	0.27	-0.36	0.06	-0.30		0.08	6.261	0.407
	n=46	2.89	1.98	1.99	0.34	-1.85		0.50		
14	AllDev	**0.30**	0.11	-0.14	0.03	-0.28	**0.44**	0.04	8.34	0.528
	n=46	2.41	0.83	-0.79	0.23	-0.20	3.35	0.31		
								HDI-GDI rank		
15	AllDev	**0.39**	0.00	**-0.50**	0.08	**-0.42**		0.04	13.347	0.47
	n=85	4.51	0.04	-3.97	0.73	-4.36		0.53		
16	AllDev	**0.23**	-0.07	-0.09	-0.04	**-0.38**	**0.73**	-0.01	33.83	0.73
	n=85	3.62	-1.28	-0.91	-0.52	-5.55	8.85	-0.12		
								Contraceptive use married women		
17	AllDev	**0.37**	-0.02	-0.15	0.07	**-0.44**		**-0.45**	18.856	0.555
	n=86	4.82	-0.30	-1.13	0.70	-5.20		-3.77		
18	AllDev	**0.21**	-0.08	-0.04	-0.01	**-0.38**	**0.69**	-0.08	35.283	0.736
	n=86	3.25	-1.46	-0.33	-0.08	-5.80	7.49	-0.74		
19–21 Ethnic fractionalisation										
19	AllDev	**0.32**	-0.01	**-0.40**	0.09	**-0.43**		**0.18**	12.426	0.449
	n=84	3.73	-0.08	-3.16	0.78	-4.56		2.03		

20	AllDev	**0.20**	-0.09	-0.07	-0.03	**-0.39**	**0.73**			**-0.01**		28.893	0.699
	n=84	3.03	-1.45	-0.65	-0.36	-5.53	8.11			-0.11			
21	SSA	**0.34**	**-0.29**	-0.05	0.10	**-0.60**				-0.19		5.824	0.55
	n=27	2.26	-2.10	-0.21	0.66	-2.94				-1.28			
22–24 Age of epidemic													
22	AllDev	**0.35**	-0.19	**-0.10**	0.12	**-0.63**					-0.18	6.955	0.438
	n=84	2.59	-1.48	-0.50	0.93	-3.18					-1.30		
23	AllDev	**0.16**	-0.09	-0.07	-0.02	**-0.39**	**0.74**				-0.03	30.428	0.71
	n=84	2.55	-1.53	-0.73	-0.19	-5.24	8.62				-0.40		
24–28 Male circumcision													
24	AllDev	**0.37**	0.00	**-0.48**	0.11	**-0.39**						-0.06	14.682	0.477
	n=90	4.40	0.05	-4.24	1.09	-2.93						-0.43		
25	AllDev	**0.23**	-0.08	-0.03	-0.01	-0.10	**0.83**					**-0.36**	45.022	0.774
	n=90	4.06	-1.53	-0.39	-0.09	-1.06	10.55					-4.00		
26	AllDev	**0.24**	-0.08	0.00	0.00		**0.85**					**-0.43**	52.264	0.774
	n=90	4.33	-1.52	0.01	-0.02		11.40					-7.47		
27	SSA	**0.34**	-0.22	-0.09	0.10	**-0.67**							8.462	0.531
	n=33	2.58	-1.81	-0.46	0.79	-3.72								
28	SSA	**0.37**	-0.19	-0.11	-0.02	**-0.51**						**-0.37**	11.644	0.67
	n=33	3.16	-1.87	-0.66	-0.15	-3.11						-2.78		

Data sources: See Annex 1.

Software: SPSS 16.0.

1. AllDev = All developing countries with data available; SSA = Sub-Saharan Africa; NotSSA = All developing countries excluding SSA.

2. Dummy is for SSA countries except in SSA-only equations, where it refer to countries in southern Africa, as indicated.

3. Note difference in male circumcision indicator for SSA-only sample; see main text and Annex 1.

REFERENCES

Barnett, T. and A. Whiteside (2006). *AIDS in the Twenty-First Century*. London, Palgrave Macmillan.

Beegle, K. and B. Özler (2006). *Young Women, Rich(er) Men and the Spread of HIV*. Mimeographed document. International Food Policy Research Institute Website <http://www.ifpri.org/themes/gender/Presentation/BeegleK.ppt>.

Bjornskov, C. (2006). 'Determinants of Generalized Trust: A Cross-Country Comparison', *Public Choice* 130, 1–21.

Broody, S. and E. Deuchert (2007). 'Lack of Autodisable Syringe Use and Health Care Indicators Are Associated with High HIV Prevalence: An International Ecological Analysis', *Annals of Epidemiology* 17 (3), 199–207. Circumcision Information and Resources Website <http://www.cirp.org/library/disease/HIV/deuchert1/>.

Brummer, D. (2002). *Labour Migration and HIV/AIDS in Southern Africa*. Pretoria, International Organisation for Migration. Southern African Regional Poverty Network Website <http://www.sarpn.org.za/documents/d0000587/index.php>.

Campbell, C., B. Williams and D. Gilgen (2002). 'Is Social Capital a Useful Conceptual Tool for Exploring Community Level Influences on HIV Infection? An Exploratory Study from South Africa', *AIDS Care*, 14 (1), 41–54.

David, A. C. (2007). 'HIV/AIDS and Social Capital in a Cross-Section of Countries', *Policy Research Working Paper* 4263. Washington, DC, World Bank. World Bank Website <http://econ.worldbank.org/external/default/main?pagePK=64165259&theSitePK=469372&piPK=64165421&menuPK=64166093&entityID=000016406_20070621101825>.

Drain, P. K. et al. (2004). 'Correlates of National HIV Seroprevalence. An Ecological Analysis of 122 Developing Countries', *Journal of Acquired Immune Deficiency Syndrome* 35 (4), 407–420.

Drain, P. K. et al. (2006). 'Male Circumcision, Religion and Infectious Diseases: An Ecologic Analysis of 118 Developing Countries', *BMC Infectious Diseases* 6 (1), 172. Biomed Central Website <http://www.biomedcentral.com/1471-2334/6/172>.

Easterly, W. (2007). 'Inequality Does Cause Underdevelopment', *Journal of Development Economics* 84 (2), 755–776.

Gillespie, S. and R. Greener (2006). *Is Poverty or Wealth Driving the HIV Epidemic?* PowerPoint presentation prepared for UNAIDS expert consultation on the prevention of sexual transmission of HIV. 22-25 September. UNAIDS Website <http://data.unaids.org/pub/Presentation/2007/gillespiegreener20060922_en.pdf>.

Glick, P. (2007). *Reproductive Health and Behaviour, HIV/AIDS, and Poverty in Africa*, Report prepared for the African Economic Research Consortium, Cornell University. Cornell University Website <http://www.cfnpp.cornell.edu/images/wp219.pdf>.

Gray, P. (2003). 'HIV and Islam: Is HIV Prevalence Lower among Muslims', *Social Science and Medicine* 58 (9), 1751–1756.

Halperin, D. and H. Epstein (2007). 'Why is HIV Prevalence So Severe in Southern Africa: The Role of Multiple Concurrent Partnerships and Lack of Male Circumcision: Implications for

AIDS Prevention', *The Southern African Journal of HIV Medicine* 26, 19–23. Harvard Center for Population and Development Studies Website <http://www.harvardaidsprp.org/research/halperin&epstein-why-is-hiv-prevalence-so-severe.pdf>.

Hargrove, J. W. (2007). *Migration, Mines and Mores: The HIV Epidemic in Southern Africa*. Stellenbosch, South Africa, Stellenbosch University. Stellenbosch University Website <http://www0.sun.ac.za/sacema/publications/Hargrove%20Migration%20Mines%20and%20Mores.pdf>.

Holmqvist, G. (2000). 'Latin American Crime and the Issue of Inequality', *Iberoamericana – Nordic Journal of Latin American and Caribbean Studies* 30 (2), 23–54.

Holtgrave, D. R. and R. A. Crosby (2003). 'Social Capital, Poverty and Income Inequality as Predictors of Gonorrhoea, Syphilis, Chlamydia and AIDS Case Rates in the United States', *Sexually Transmitted Infections* 79, 62–64. STI Website <http://sti.bmj.com/cgi/reprint/79/1/62?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=Holtgrave&andorexactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&resourcetype=HWCIT>.

Jeonghoon, A. (2002). 'Beyond Single Equation Regression Analysis, Path Analysis and Multi-Stage Regression Analysis', *American Journal of Pharmaceutical Education* 66, 37-42. AJPE Website <http://www.ajpe.org/legacy/pdfs/aj660105.pdf>.

Kaplan, G. A. et al. (1996). 'Inequality in Income and Mortality in the United States: Analysis of Mortality and Potential Pathways', *British Medical Journal* 312 (7037), 999–1003.

Kawachi, I., B. P. Kennedy and R. G. Wilkinson (1999). *Income Inequality and Health*, *The Society and Population Health Reader* Vol. 1. New York, New Press.

Leclerc-Madlala, S. (2004). 'Transactional Sex and the Pursuit of Modernity', *Social Dynamics* 29 (2), 1–21. Healthdev Website <http://www.healthdev.org/eforums/Editor/assets/accelerating-prevention/Transactional_sex_and_the_pursuit_of_modernity.pdf>.

McIntosh, C. (2007). 'Has Better Health Care Contributed to Higher HIV Prevalence in Sub-Saharan Africa?' Mimeographed document. University of California at San Diego Website <http://irps.ucsd.edu/assets/015/6810.pdf>.

Moran, D. and J. Jordan (2007). 'HIV/AIDS in Russia: Determinants of Regional Prevalence', *International Journal of Health Geographics* 6 (22). IJHG Website <*http://www.ij-healthgeographics.com/content/pdf/1476-072X-6-22.pdf*>.

Nepal, B. (2007). 'Prosperity, Equity, Good Governance and Good Health: Focus on HIV/AIDS Pandemic and its Feminization', *World Health and Population* 9 (3).

Oster, E. (2007). 'HIV and Sexual Behaviour Change: Why Not Africa?' Mimeographed document. University of Chicago Website. <http://home.uchicago.edu/~eoster/hivbehavior.pdf>.

Piot, P., R. Greener and S. Russell (2007). 'Squaring the Circle: AIDS, Poverty and Human Development', *PloS Med* 4 (10), 1571–1575. PLoS Website <http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0040314&ct=1>.

Putnam, R. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York, Simon & Shuster.

Sampson, R. J., and W. B. Groves (1989). 'Community Structure and Crime: Testing Social Disorganization Theory', *American Journal of Sociology* 94, 774–802.

Sawers, L., E. Stillwaggon and T. Hertz (2008). 'Cofactor Infections and HIV Epidemics in Developing Countries: Implications for Treatment', *AIDS Care* 20 (4), 488–494. American University Website <http://nw08.american.edu/~hertz/cofactor%20infections%20and%20HIV%20epidemics%20final%20version%20with%202006%20data.pdf>.

Setel, P., M. Lewis and M. Lyons (1999). *Histories of Sexually Transmitted Diseases and HIV/AIDS in Sub-Saharan Africa*. Westport, Conn., Greenwood press.

Sutherland, D. (2007). *Exploring the Economic and Social Terrain of Epidemic Disease in China: Income Inequality and HIV/AIDS – Is There a Relationship? Conference Papers*, Warwick, United Kingdom, University of Warwick. Centre for the Study of Globalisation and Regionalisation Website <http://www2.warwick.ac.uk/fac/soc/csgr/activitiesnews/conferences/2007/hivaids/papers/sutherland.doc>.

Talbott, J. R. (2007). 'Size Matters: The Number of Prostitutes and the Global HIV/AIDS Pandemic', *PLoS ONE* 2 (6). PLoS Website <http://www.plosone.org/article/info:doi%2F10.1371%2Fjournal.pone.0000543>.

Tsafack Temah, C. (2008). *The Role of Income and Gender Inequalities in the Spread of the HIV/AIDS Epidemic: Evidence from Sub-Saharan Africa*. Doctoral dissertation, University d'Auvergne.

UNAIDS (2006). *2006 Report on the Global AIDS Epidemic*. UNAIDS Website <http://www.unaids.org/en/KnowledgeCentre/HIVData/GlobalReport/>.

UNAIDS (2007). *New Data on Male Circumcision and HIV Prevention. Policy and Programme Implications*. UNAIDS Website <http://data.unaids.org/pub/Report/2007/mc_recommendations_en.pdf>.

UNODC (2005). *Crime and Development in Africa*. UNODC Website <http://www.unodc.org/pdf/African_report.pdf>.

Vandepitte, J. et al. (2006). 'Estimates of the Number of Female Sex Workers in Different Regions of the World', *Sexually Transmitted Infections* 82, 18–25. STI Website <http://sti.bmj.com/cgi/content/abstract/82/suppl_3/iii18>.

Wilkinson, R. (1996). *Unhealthy Societies: The Affliction of Inequality*. London, Routledge.

Williams, B. G. et al. (2006). 'The Potential Impact of Male Circumcision on HIV in Sub-Saharan Africa', *PLoS Medicine* 3 (7). PLoS Website <http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0030262>.

NOTES

1. The usefulness of cross-country analysis, however, should not be overestimated. It has clear limitations, in particular as regards guiding interventions.

2. The log transformation is rarely given a theoretical justification in the literature. Its impact is to improve the statistical properties of the variable, "flattening out" the outliers.

3. In the literature on income inequality and health, an additional transmission mechanism often discussed is the psychosocial one (that is, negative health effects from feelings of stress and alienation in an unequal society). This transmission mechanism seems less plausible with regard to HIV and has not been included here.

4. To address the direction of causality, male circumcision was used as an instrument for HIV prevalence. But the validity of male circumcision as an instrument is doubtful because it is likely to correlate with country or cultural characteristics. See Glick (2007: 29).

International Policy Centre for Inclusive Growth (IPC - IG)
Poverty Practice, Bureau for Development Policy, UNDP
Esplanada dos Ministérios, Bloco O, 7º andar
70052-900 Brasilia, DF - Brazil
Telephone: +55 61 2105 5000

E-mail: ipc@ipc-undp.org ▪ URL: www.ipc-undp.org