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Interaction between HIV Awareness, Knowledge, Safe Sex Practice and HIV Incidence: Evidence from Botswana[a]

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Abstract:
This paper makes methodological and empirical contributions to the study of HIV awareness, knowledge, incidence and safe sex practice in the context of Botswana, one of the most HIV prone countries in the world. While the focus is on Botswana, the paper presents comparable evidence from India to put the Botswana results in perspective. The results point to the strong role played by affluence and education in increasing HIV knowledge, promoting safe sex and reducing HIV incidence. The study presents African evidence on the role played by the empowerment of women in promoting safe sex practices such as condom use. The Botswana results show however that simply increasing HIV knowledge may not be effective in lowering HIV incidence unless people are also made fully aware of the lethal nature of the disease. The lack of significant association between HIV incidence and safe sex practice points to the danger of HIV infected individuals spreading the disease through multiple sex partners and unprotected sex. This danger is underlined by the result that females with multiple sex partners are at higher risk of being infected with HIV.

Key Words: HIV incidence, Female Empowerment, Safe Sex Methods, Finite Mixture Models, Principal Components Analysis.
JEL Classification: C01, D13, I15, I18, O55

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1. Introduction and Background

Notwithstanding significant progress in reducing the number of new HIV infections and in lowering the number of AIDS-related deaths, the disease continues to pose serious risks "as one of the leading causes of death globally and ... projected to continue as a significant global cause of premature mortality in the coming decades" [UNAIDS (2009)]. The threat posed by HIV/AIDS to our progress and very survival was considered sufficiently serious for the combating of this disease to figure explicitly as Goal 6 in the Millennium Declaration in 2000 [UN(2010)]. The efforts to contain this deadly disease and limit its consequences rest principally on a twin strategy of (a) prevention through greater awareness and a more sound knowledge of this disease combined with the empowerment of women and promotion of safe sex practice, and (b) reduction of deaths from HIV/AIDS through the increased availability of antiretroviral drugs.

The rate of HIV incidence varies sharply between regions, as do the reasons for the spread of this disease. The nature of the spread of the disease has changed over time from, for example, transmission through drug usage to heterosexual sex, sex between men and mother to child transmission. It is therefore important to target regions and devise region specific and time varying policies to have a global impact on limiting the spread of this disease. Sub-Saharan Africa is the region most heavily affected by HIV and Southern Africa has the worst statistics on HIV incidence within it. According to the estimates available in the latest AIDS epidemic update [UNAIDS (2009)], in 2008, sub-Saharan Africa accounted for 67 % of new HIV infections among adults, 91 % of new HIV infections among children and 72% of the world's AIDS related deaths. Within the region, and globally as well, Botswana has got one of the highest rates of HIV incidence. At 24.8 %, Botswana has the second highest rate of adult prevalence of HIV in the world, second only to Swaziland (25.9%).

HIV and AIDS had a devastating impact on Botswana. Life expectancy at birth in Botswana fell from 65 years in 1990-95 to less than 40 years in 2000-2005, a figure about 28 years lower than it would have been without AIDS (see http://www.avert.org/aids-botswana.htm). The deaths of working adults had serious micro and macro economic implications in Botswana with the loss of income pushing many families into poverty, and the economic output reduced by the loss of workers and their skills. The social implications have also been considerable. An estimated 93,000 children have lost at least one parent to the epidemic, and there are 80,000 orphans due to HIV/AIDS in Botswana. As reported in Sharma and Seleke (2008), “there have been projections that by 2010, more than 50 percent of the country’s children will be AIDS orphans and the average life expectancy will have fallen from 47 to 27 years”.

The first reported case of HIV/AIDS in Botswana was in 1985. However, it was not until the late 1990s that serious action was taken to prevent the spread of the disease. Since then, however, the authorities have seriously tried to address the problem developing a national strategic framework and implementing a series of initiatives to stem and reverse the tide of the HIV/AIDS epidemic. While the early focus was on preventive health care, the emphasis had switched, by 1993, to cure involving comprehensive medical and social care due to the HIV incidence registering rates upwards of 20 %. However, as pointed out by Sharma and Seleke (2008), “Botswana is still in a state of paralysis with the AIDS virus continuing as the deadliest enemy the country has faced” (p.322).

HIV incidence in Botswana is the subject matter of this study. Apart from the seriousness of the HIV/AIDS epidemic in that country, Botswana also stands out as being the most unlikely country for such dismal HIV statistics. A country with a stable political regime, the sparsely populated Republic of Botswana was once considered an African “success” story, recording one of the highest growth rates in the world. It is paradoxical for such a country to record the highest per capita incidence of HIV in the world. As noted by Brigaldino (2002), in http://www.opendemocracy.net/globalization-hiv/article_798.jsp, “in a country of about 1.65 million people, around 40 % are HIV positive....beyond this enormous human suffering and its impact on society, economic development is being hit hard by the epidemic”.

Uganda predates Botswana in the earliest known case of HIV incidence and, at one point, was at risk of being the most HIV infected country anywhere. However, that situation changed quickly and Uganda is now seen as the most dramatic African success story with the estimated HIV prevalence rate falling from about 15 % in 1992 to 5 % in 2001 [Schoepf (2003)]. So, why wasn’t this success story repeated in Botswana? Heald (2002, 2006) identifies some factors specific to Botswana that may have reduced the effectiveness of international efforts and policies to limit the spread of HIV, and may have even led to counterproductive results- such as Tsawana ideas of morality and illness that saw this disease as a purely local disease. The disease was shrouded in secrecy, and information campaigns to promote condom usage and ARV therapy were not as successful as elsewhere. Also, as Seidel (2003) has noted, there was a perception among the locals, NGO s, etc that " HIV interventions are donor driven...some international agencies appear to act on the basis of shallow knowledge" making it very difficult for global efforts at prevention and recovery to succeed in Africa as much as it could have been elsewhere.

The principal motivation of this study is threefold: (a) measure awareness and knowledge of HIV/AIDS in Botswana, (b) examine the interaction of knowledge, safe sex practice and HIV incidence with one another and, in particular, provide evidence on the question: do the adoption of safe sex practices lower the chance of being infected with the disease?; and (c) pay particular attention to the role of women's bargaining power in preventing HIV/AIDS and provide evidence on this issue. On (a), a significant feature of this study is the comparison of HIV awareness and soundness of knowledge between Botswana and India. These two countries provide a useful bilateral comparison since, while one (Botswana) has a high rate of HIV incidence but with low absolute numbers because of her smaller population base, the other (India) has a lower rate of HIV incidence but with much larger potential for absolute devastation simply because of her much larger population base. On (c), while female bargaining power and the role that women play in improving household outcomes has featured prominently in the economics literature [see, for example, Basu (2006), Lancaster, Maitra and Ray (2006)], the issue has been much less prominent in the context of HIV. There is, however, some evidence of the positive role that women's empowerment plays in increasing HIV awareness and condom awareness in the South Asian context- see, for example, Schuler and Hashemi (1994) for Bangladesh, and Bloom and Griffiths (2007) for India. There is no such evidence for Africa. The present study fills this gap by examining the evidence for Botswana in the interrelated contexts of safe sex practice and HIV incidence.

Though HIV has huge economic ramifications, the absence of empirical evidence on (a), (b) and (c), and the failure to apply the methodological developments in the economics/econometric literature in the HIV context reflects partly the lack of suitable data sets, and partly the lack of interest in the area among economists. Both of these are now changing with more information on HIV knowledge and incidence now available through questions asked of respondents on their knowledge and awareness of HIV, and blood testing done on the respondent’s HIV status. Moreover, the availability of information on HIV knowledge and incidence along with that on household characteristics has enabled the portrayal of the profile of an individual that is at particular risk from HIV and allowed the subject to receive greater scrutiny from applied economists. Botswana and India are the prime examples of countries that have, in recent years, made such integrated information on household characteristics, knowledge and incidence of HIV available in unit record form making the present study possible. Set in the context of a country (Botswana), which is one of the most HIV infected country in the world, it is difficult to exaggerate the policy importance of the results of this investigation. The study also shows the potential for wider application of some of the recent methodological developments in the applied economics/econometrics literature, especially in an area that is crying out for such applications.

The present study is an extension of Ray and Sinha (2010)’s study that proposed a methodology for quantifying the soundness of knowledge of HIV and applied it to India. Ray and Sinha (2010) had shown that the recent advances in the measurement of multi dimensional deprivation can be used to measure one’s understanding of the disease, and provided Indian evidence in support of the proposed methodology. The present study provides further support by providing comparable evidence from Botswana. Besides extending the study to Botswana, this paper follows up our earlier investigation by asking: (i) do the soundness of knowledge of HIV/AIDS matter in the adoption of safe sex practice? ; (ii) does the adoption of safe sex practice help to prevent HIV incidence in Botswana? On the way, and making use of the rich information base provided by the Botswana data, the present study shows how the technique of finite mixtures model can be used to provide evidence on the determinants of safe sex practices and soundness of one’s knowledge of HIV/AIDS.

The rest of the paper is organised as follows. The next section discusses the methodology that we adopt, and describes the data sets that are used. The results are presented and discussed in Section 3. We end on the concluding note of Section 4.

2 .Methodology and Data

2.1 The Measure of Knowledge

Following our earlier study, we distinguish between HIV awareness and knowledge. An individual may be aware of HIV but may not know much of the true nature of the disease. Further, an individual may have reasonably sound knowledge of aspects of the disease but may still be unaware of its lethal consequences. While awareness is easy to detect as a binary variable, measuring knowledge and giving it a cardinal number is less easy as the information is contained in multiple questions and in the individual respondents' responses.

Let n_j denote the number of households that gave incorrect answers to exactly j questions, $j \in \{1, \ldots, K\}$. Let the total number of households or individuals be denoted by n. Then, a measure of incorrect knowledge of HIV/AIDS is given by:

$$\pi_\alpha = \sum_{j=1}^{K} (j/K)^\alpha \; H_j \qquad (1)$$

where, $H_j = \frac{n_j}{n}, j \in \{1, \ldots, K\}$.

H_j denotes the proportion of respondents who gave incorrect answers to exactly j questions. π_α is a linear combination of the H_j s, and measures the lack of soundness of the respondent's knowledge, i.e., ignorance, of the true nature of HIV. In case of perfect knowledge, $H_j = 0$ for all j, and the measure of ignorance, $\pi_\alpha = 0$. At $\alpha=1$, π_α measures the total number of incorrect responses ($(\sum_{j=1}^{K} j n_j)$ as a proportion of the total number of responses by all the respondents (nK). The reader is referred to Ray and Sinha (2010) for further details. The parameter α, chosen a priori, reflects subjective judgement. As α increases from 1 to higher values, π_α gives greater weight to the ignorance rates of households that gave incorrect answers to more and more questions, *i.e.*, the more ignorant households and , at very high α values , π_α measures the magnitude of extreme ignorance. This is similar to the interpretation of α as an "inequality aversion" parameter in the Atkinson (1970) inequality measure. An important feature of the ignorance measure, given by (1), that we exploit is that the measure is decomposable between subgroups, for example, between rural and urban residents, or between men and women respondents. This enables us to calculate the subgroup's share of the whole country's ignorance of the disease, such that the shares add up to 100 across all the exhaustive set of subgroups. A comparison between a subgroup's ignorance share with that of its population share establishes if that subgroup is more or less ignorant of the disease than the others.

2.2 Unobserved Heterogeneity in Individual Sexual Behaviour: Finite Mixture Models

The technique of finite mixtures models is useful in data sets such as on HIV knowledge and sexual practices that involve a great deal of individual heterogeneity. As explained in a recent study that applies such a technique [Deb, et. al. (2009)] in analysing BMI and alcohol consumption, "the finite mixture model provides a natural and intuitively attractive representation in a finite, usually small, number of finite mixtures latent classes, each of which may be regarded as a ‘type’ or a ‘group’. Estimates of such finite mixture models may provide good numerical approximations even if the underlying distribution is continuous...the finite mixture approach is semi parametric - it does not require any distributional assumptions for the mixing variable – and under suitable regularity conditions is the semi parametric maximum likelihood estimator of the unknown density”. A particular advantage of the finite mixture model estimation in the present context is that it gives the policy maker some idea on how unobserved heterogeneity at individual level can influence sexual behaviour and knowledge of HIV/AIDS and how to devise differentiated and group specific policies on HIV prevention taking note of possible heterogeneity in the population so as to maximise their effectiveness. For reasons of space, we have not described the finite mixtures model and estimation in detail here- the reader is referred to Laird (1978), Deb and Trivedi (1997) and Deb, et. al.(2009) for such details.

The finite mixtures model estimation is preceded by simultaneous estimation of the determinants of (a) HIV awareness, (b) HIV knowledge, (c) condom used during last sex, and (d) HIV incidence, where the interaction between some of these variables is taken into account. Of particular interest in these results is the nature and magnitude of the impact of female bargaining power on condom usage, and that of condom usage and multiple sex partners on HIV incidence.

2.3 Construction of Wealth Index

Another feature of this study is the evidence that it provides on whether the wealthier individuals in Botswana exhibit significantly different HIV knowledge, condom usage, practice on multiple sex partners, and HIV incidence from the less affluent individuals. To investigate the wealth effect, we used the household data on asset and Principal Components Analysis (PCA) to construct a wealth distribution. PCA is a statistical technique based on the idea that an underlying latent variable is predictable on the basis of observed data. The objective of this technique is to use a set of observed data to reduce the number of variables in the dataset to extract orthogonal linear combinations of variables or components (referred to as first principal component, second principal component etc.) which most efficiently encompass the common information. Each component is a weighted average of the underlying indicators. Weights are chosen so as to maximize the explained proportion of the variance in the original set of indicators - see, for example, Vyas and Kumaranayake (2006) for further details. The wealth index constructed for the present analysis uses a set of household assets and dwelling characteristics that are available in the data set. These include the dwelling’s construction material i.e., type of flooring, type of walls, type of exterior walls, and type of roofing; the source of household's drinking water; availability of electricity in the household; type of toilet facility; per capita rooms in the house and ownership of fan, radio, sewing machine, refrigerator, bicycle, motorcycle and car. An important finding is the consistently strong wealth effect on all the principal aspects of HIV/AIDS that we consider, namely, awareness, knowledge, safe sex practice and HIV incidence.

2.4 Data

The data for this paper was drawn from the Botswana AIDS Impact Survey (BAIS II, 2004) conducted in 2004. This survey was designed to generate a nationally representative population based estimate of HIV prevalence and to identify and measure factors, such as behavioural, knowledge, attitudes and cultural influences that are associated with the HIV epidemic in Botswana. BAIS which is Botswana's version of the Demographic Health Survey is a series of nationally representative demographic surveys of population aged 10-64 years, documenting knowledge, attitudes, behavior, and cultural factors that might influence HIV infection; prevention; and impact mitigation. The survey also included a component on voluntary HIV testing among population aged 18 months to 64 years, in order to generate a nationally representative population-based estimate of HIV/AIDS prevalence. The BAIS II survey used the 2001 Population Housing Census as a sampling frame, and was stratified by administrative districts and major population centers. The survey utilized household; individual; workplace and community questionnaires.

The Indian data set that enabled a comparison between India and Botswana on HIV awareness and knowledge is contained in the third National Family Health Survey (NFHS-3), that was carried out in 2005-6. NFHS-3 provided information on the respondents' awareness of HIV/AIDS (yes/no). Respondents, who showed awareness, were asked questions on various aspects of the disease. NFHS-3 had comprehensive coverage since it included all the constituent states of the Indian Union. It was therefore directly comparable in both quality and coverage with the Botswana data set, BAIS II. Also, both the data sets corresponded to almost contemporaneous years, 2004 for Botswana and 2005-6 for India. However, the NFHS-3 data set had very limited information on blood testing and respondents' HIV status restricting the information to only the most HIV prevalent states in India. In contrast, the Botswana data set provided comprehensive coverage of the information on the respondents' HIV status. Hence, the comparison between India and Botswana in this study is limited mostly to their HIV/AIDS awareness and knowledge. The Botswana data set allowed us to proceed with the study on HIV incidence. The set of questions on knowledge of HIV/AIDS that were asked in BAIS II, and used in construction of a nine point Incorrect knowledge index for the present analysis are as follows:

Can healthy looking person be infected with HIV/AIDS?

Can one reduce chances of HIV/AIDS by using condom correctly?

Can HIV/AIDS transmit through mosquito bites?

Can HIV/AIDS transmit by sharing meals with an HIV infected person?

Can one reduce chances of HIV/AIDS by having one sex partner only?

Can HIV/AIDS transmit from mother to child (MTC) during pregnancy, delivery or breastfeeding?

Can one get HIV because of witchcraft?

Should a teacher infected with HIV/AIDS continue teaching?

Would you buy vegetables from shopkeeper infected with HIV/AIDS?

Another advantage of using the data for Botswana is the information of respondent's sexual history which outlines the number of sexual partners that the respondent had in the last 12 months and whether condom was used with each sexual partner at last sex. This information along with actual incidence of HIV/AIDS is used to assess the underlying factors influencing individual's sexual behaviour using more than one indicator. Table 1 reports the list of all the variables used in the regression equations. The questions on HIV that were asked in BAIS II are very similar, but not identical, to those asked in NFHS-3. The reader is referred to Ray and Sinha (2010) for the latter.

2 Results

3.1 Awareness and Knowledge: Botswana and India

The estimates of lack of sound knowledge of HIV/AIDS, or knowledge deprivation, in Botswana and India, calculated using the multi dimensional ignorance measure [eq. (1)], are reported in Table 2. The left hand side presents the estimates for Botswana, the right hand side for India. The Indian estimates calculated from the National Family Health Survey (NFHS-3) data set for 2005-06, are presented for comparison between the two countries. This table reports the ignorance estimates for a variety of α values, and separately for rural and urban areas and for males and females.

There are some common features between the two countries. The rural areas display larger ignorance, both in terms of the measure, and their share of the whole country's ignorance, than the urban areas in both countries. The rural share of ignorance increases with α in both countries i.e., as we limit our calculations to the households who have given more and more incorrect answers. Again, in both countries, ignorance decreases with increasing affluence, i.e., as we move up the wealth distribution. A comparison of the population and deprivation shares shows that the lower wealth percentiles bear a disproportionately larger share of the country's ignorance of the disease, and that this disproportion increases with α in both countries. This is seen more clearly from the ratio of deprivation contribution to population shares at various α values of π_α reported in Table 2. A value of the ratio greater than unity suggests that a member of the corresponding sub group is relatively more ignorant than the "average" individual in that country. The advantage of these population share deflated deprivation contributions is that they help to profile an individual whose ignorance of the disease is so acute as to require targeted information campaigns. The values of this ratio confirm that in both countries the rural individual is less knowledgeable than the rest, and so is the individual in the bottom 20 percentile of the wealth distribution. There is, in fact, remarkable similarity between the relative magnitudes of ignorance or knowledge deprivation of HIV/AIDS of the rural population and that in the bottom 20 percentile between the two countries. In both countries, for example, an individual in the bottom 20 percentile exhibits ignorance of the disease that is approximately twice that of the average person. In contrast, there is no such agreement on gender, with females in Botswana showing greater knowledge of the disease than the males in sharp contrast to females *vis a vis* males in India.

There are other significant differences between Botswana and India. India displays larger ignorance of HIV than Botswana when we compare across wealth percentiles and across rural/urban areas. In fact, India's lack of understanding of the disease in relation to Botswana becomes more and more evident as we increase α. This largely reflects the fact that HIV has attracted much more media attention in Botswana than in India, has a higher profile in Africa than in Asia, and has a longer history of known incidence in the former. The awareness campaigns have been more effective in Botswana. Clearly, India has ground to cover to catch up with Botswana. At the aggregate country level, India stands out as one of the most ill informed countries in the world on HIV/AIDS, with less than 30 % of its women in the age group, 15-24 years, and between 30-40 % of its men in the same age group, having comprehensive correct knowledge of HIV over the period 2003-2008 [UN (2010, p. 41)]. However, Table 2 also shows that the picture is sharply reversed when we differentiate by gender, with females displaying much more ignorance than males in India, unlike in Botswana. Indeed, the male/female differential is so sharply reversed that males in Botswana are much more ignorant than their counterparts in India. This has got the significant two fold policy implication: (a) information campaigns in India which is sitting on a possible HIV epidemic need to be targeted at the women who have been widely reported as one of the most ill inf ormed on HIV in the world, and (b) given the increased knowledge of HIV by women *vis-a-vis* men in Botswana, households with greater female bargaining power and with greater say in decision making in that country are likely to be better protected from the disease. The latter is consistent with evidence from the regression equations estimates from Botswana presented below. The lesson for India is to target women - both in the awareness and information campaigns - and help them acquire greater say in making household decisions.

3.2 Association between Knowledge, Safe Sex Practice, and HIV Incidence

Table 3 presents the strength of association between incorrect knowledge, safe sex practice, and HIV incidence by reporting the pair wise correlation for Botswana and (where available) for India. The Indian evidence, which is reported for comparison, is limited since information on HIV incidence is available in only a few states where testing was done and HIV status reported in the NFHS-3 data set. Note, also, that for religious and cultural reasons, the practice of multiple sex partners is much less prevalent in India than in Botswana. Both countries provide evidence of statistically significant and positive association between incorrect knowledge, defined as greater than 3 incorrect answers, and no condom usage in last sex. This result points to the role played by increasing knowledge of the disease in promoting condom use. Note, however, that, both in terms of the correlation magnitude and the level of significance, the evidence is not overwhelming for either country. In other words, simply improving knowledge will not ensure safe sex practice. This result is consistent with the observation of Dinkelman et. al. (2006), also based on Botswana data, that "it may be overly optimistic to hope for reductions in risky behaviour through the channel of HIV- information provision alone". Part of the reason lies in the nature of the questions that were asked, none of which directly tested the individual's awareness of the lethal consequences of HIV that can be caused by unsafe sex practice. In both countries, however, the strength of association is higher among females than among males and higher in the rural areas than in the urban. The evidence from Botswana supports the idea that females with multiple sex partners are at increased risk from HIV, and this is true of the rural and the urban female. The higher correlation between incorrect knowledge and HIV incidence, in both size and significance, in Botswana than in India reinforces the point made earlier that HIV has a longer history and a more visible profile in Botswana than in India, and the link between knowledge and incidence is therefore somewhat stronger in the former.

3.3 Mixed Process Estimation of HIV Awareness, Knowledge, Safe Sex Practice and Incidence

Table 4 presents the results of the joint estimation of a four equation model which models Awareness of HIV/AIDS, Incorrect Knowledge, Condom used at last sex with all sex partners and incidence of HIV/AIDS as a binary, multinomial logit, probit and logit respectively. The model was estimated recursively where these categorical dependent variables of interest were estimated as a function of a set of individual and household characteristics. The BAIS II survey was designed to ask knowledge questions to respondents only if they were aware of the disease. Therefore estimating a model with incorrect knowledge only would result in sample selection bias. This issue is addressed by estimating a Heckman two stage model to get a correction factor (Inverse Mills Ratio) for sample selection bias, which is included in the equation of incorrect knowledge equation along with other covariates. The presentation of the estimates side by side allows a convenient comparison of the nature and magnitude of the effect of the household and regional characteristics of the respondents. For example, the respondent's age has non linear but reverse effects on her/his awareness and lack of knowledge of the disease. The relationship is inverted U shaped for the former and U shaped for the latter. The magnitude of the age-squared coefficient suggests that awareness (i.e., "heard") peaks at around 48 years and, among those who have heard of the disease, the extent of ignorance of the nature of the disease troughs at around 34 years. Older individuals are less likely to use condoms. The risk of HIV incidence increases with age, reaching a maximum at around 36 years, and then starts to decline. This is an important result that suggests that individuals in the age group 35-40 years are at highest risk from being infected with the disease. Radio, rather than TV, is a more accessible source of information in a developing country that explains why individuals without access to radio are less likely to be aware of the disease and less likely to use condoms. This does not, however, have any effect on HIV incidence. Education, at varying levels, has an effect on HIV awareness and knowledge as also on condom usage and HIV incidence that makes it a powerful tool in stopping the spread of the disease. Individuals who have received higher secondary education are more knowledgeable of the disease, marginally more likely to use condoms, and display much lower incidence of HIV than others. Wealth has the strongest effect on awareness, condom usage and incidence. Relatively affluent individuals, namely, those in the 50-100 wealth percentile, are more likely to use condoms and less exposed to infection. Married individuals and those living together are less likely to use condoms. However, while the former are less likely to be infected, there is no similar evidence for those living together.The latter result, including the weaker size of the coefficient of condom usage for unmarried couples, may be explained by the fact that the group of individuals "living together" includes both heterosexual and same sex couples. Moreover, married couples are more likely to be aware of their partner's HIV status than the non-married/separated/divorced couples and consequently are less likely to use condoms. The lack of knowledge of their partner's HIV status denies that "living together" protection from HIV, that the married couples enjoy, as Table 4 confirms. *Ceteris paribus*, men are more likely to use condoms and less likely to be infected with HIV. Consistent with the weak correlation between knowledge and condom usage and between knowledge and incidence, the knowledge variable has no discernible effect on either. This reinforces the point made earlier that simply educating individuals on some aspects of the disease without stressing its lethal consequences may not have much of an effect in preventing the spread of the disease.

Of particular interest, is the effect of female bargaining power, as measured by the two binary variables denoting whether the respondent believe that a female can protect herself from STD from her partner and whether she is allowed to get condom for the male, on condom usage and incidence of HIV. It is interesting to note the strong positive impact of female bargaining power on condom usage. For example, those who believe that females should be able to buy condoms for their male partners are more likely to use condoms. However, controlling for the adoption of safe sex practice, female bargaining power has no further effect on incidence. This suggests that greater say by the females in household decisions works exclusively through the adoption of condom usage and has no direct effect on incidence.

Of further interest in these results is the effect of unsafe sex practice, namely, no condom usage and multiple sex partners, on HIV incidence. To check on the robustness of the evidence, we estimated two alternative specifications of the HIV incidence equation which differ only with respect to condom usage by the female. These have been referred to as "HIV Positive (A)" and "HIV Positive (B)" in Table 4. Specification A considers only condom usage by the male, while Specification B allows condom usage by both males and females. The two sets of estimates are presented side by side. The results are striking and interesting. Individuals with multiple sex partners are at increased risk from HIV, with the higher risk mainly affecting females, not the males. The gender interaction coefficient is negative and cancels out the coefficient of multiple sex partners suggesting that the effect is negligible for males. Both sets agree that females with multiple sex partners are at increased risk from HIV infection. This result is robust to the introduction of female condom usage in the HIV incidence equation. The nature and size of the coefficient of male condom usage is robust to the introduction of the variable denoting female usage of the condom. In either case, the evidence suggests that males are protected from HIV by condom usage. However, on allowing female usage of condoms, the results suggest that, ceteris paribus, condom using females are more exposed to HIV. This suggests that females who use condoms are likely to pick up HIV from other channels that we have not controlled for in these equations. These gender asymmetric results on the effects of unsafe sex practices on incidence have significant policy implications.

3.4 Finite Mixtures Model Estimates

The strategy to prevent HIV rests on (a) increasing knowledge of the disease, and (b) promoting safe sex practices such as condom usage and reduce the number of multiple sex partners. The study has already presented evidence of significant association between safe sex practice and HIV incidence. To add to the earlier evidence, we examine the determinants of (a) and (b) taking note of the heterogeneity in the respondents. While lack of knowledge is measured by the percentage of incorrect responses, safe sex practice is measured by (i) the number of sex partners, and (ii) the number of times condom was used in the previous sexual encounters. More than in other data sets, the data set on HIV related issues covers a heterogeneous set of respondents that vary in their individual characteristics, sexual practice and in the nature of the possible transmission of HIV to and from others. Such heterogeneity may give rise to an aggregated picture that may give misleading representation of the heterogeneous components.

To tackle the issue, we performed estimation of finite mixtures models based on latent variable analysis to split the heterogeneous sample into homogenous components. The latent variable analysis for the number of condoms used in previous sex encounters assumed normal distribution of the two latent classes, while the Poisson distribution was assumed in case of the number of sex partners and the number of incorrect responses. The results of the three finite mixture estimations are presented in Table 5. The results of the traditional estimation of the three dependent variables, namely, Poisson for number of sexual partners and the number of incorrect answers, and OLS for the number of condoms used in the previous sexual encounters are also presented in Table 5 for comparison. To simplify the calculations, we restricted the estimations to the case of two components.

The last row in Table 5 reports the probability of an observation being a member of the two components in case of each of the three dependent variables. The membership is almost equally split between the two components in case of the knowledge variable but, in the other two cases, Component 1 dominates overwhelmingly. There are several examples of heterogeneity between the estimates. For example, there is positive association between the number of sex partners and HIV incidence in the dominant Component 1 in the first latent regression, but not in component 2, nor in the Poisson estimates. This result points to the danger of the disease spreading due to the tendency of HIV positive individuals to have multiple sex partners. The danger is further underlined by the statistical insignificance of the coefficient estimate of HIV status in the regression equation of the number of condoms used in the previous sexual encounters. This shows that there is no evidence to suggest that HIV infected individuals are using condoms in their sexual encounters. Couples who are married or are living together will have fewer number of sex partners and, also, will use condoms less frequently. This reflects the familiarity of the partners with another, though less so for unmarried couples. These results are robust between the two components in each case. Consistent with the results of Table 4, the magnitude of the estimates are smaller for couples who live together compared with the estimates for the married couples. Consistent with the earlier results, the dominant Component 1provides evidence that suggests that greater empowerment of women leads to increased use of condoms, though there is no similar evidence to suggest that it has a significant effect on the number of multiple sex partners. The component densities of the three latent regression dependent variables, along with the summary statistics, are presented in Figures 1a-1c. They provide further evidence of heterogeneity between the components. Fig.1b shows, for example, that Component 1 involves individuals with fewer multiple sex partners than Component 2, as confirmed by their respective means. Fig.1a shows that Component 1 members use condoms less frequently than Component 2 members, while Fig.1c shows that Component 1 members are more knowledgeable of the disease (i.e., have less percentage of answers that are incorrect) than those in Component 1. These are confirmed by the Component means reported next to each figure.

4. Summary and Conclusion

This paper makes both methodological and empirical contributions to the study of HIV/AIDS awareness, knowledge, incidence and use of safe sex practice in the context of Botswana, which has the second highest rate of adult prevalence of HIV in the world, second only to Swaziland.

While the focus of this study is on Botswana, the paper presents comparable evidence from India, where available, to put the Botswana results in perspective. The paper shows how the principal components methodology can be used to construct a wealth variable that allows us to investigate the effect of household affluence on HIV knowledge, safe sex practice and HIV incidence. The paper also shows how the estimation of finite mixtures models can be used to tackle the problem of unobserved heterogeneity in individual sexual behaviour to give sharper results based on homogeneous samples that can be of significant policy use. The paper also fills a gap in the literature by providing African evidence, in the form of results from Botswana, on the positive role that women's empowerment can play in stopping the spread of HIV/AIDS in Africa.

The paper extends our earlier exercise [Ray and Sinha (2010)] and shows the usefulness of the knowledge measure proposed there in comparing knowledge of the disease between Botswana and India. This comparison is of much interest since while one (Botswana) has a high rate of HIV incidence but with low absolute numbers because of her smaller population base, the other (India) has a lower rate of HIV incidence but with much larger potential for absolute devastation simply because of her much larger population base. The lower awareness and knowledge of the disease in India than in Botswana is a significant result, and points to the lessons that Asia can learn from Africa's longer experience with HIV and her information campaigns on the disease. The Botswana/India comparison brings out several similarities and differences between the knowledge base of HIV in the two countries. A prominent feature of the differences is that while the female is better informed of the disease than the male in Botswana, the reverse is the case in India. This paper also presents evidence that points to the role played by affluence and education in increasing knowledge, promoting safe sex and reducing HIV incidence in Botswana. The study also presents evidence from Botswana on the positive role played by empowering women in promoting safe sex practices such as condom use.

The results on the interaction between knowledge of HIV and adoption of safe sex practice is not as strong as one might expect, nor is the nature of the effect of safe sex practice on HIV incidence always in the expected direction. The former result suggests that greater awareness and knowledge of the disease may not suffice in encouraging HIV preventive sexual practices unless one is also made aware of the lethal nature of the disease. With respect to the latter, the paper produces evidence that show the vulnerability of females with multiple sex partners to infection with HIV/AIDS. The recent success of ART in helping HIV infected people live longer with the disease may have had counterproductive consequences by instilling a sense of complacency, as reflected in the absence of evidence that people with HIV are adopting safe sex practices in order to prevent the further spread of the deadly disease (Garnett and Anderson, 1996). The increased availability of ART treatment needs to be accompanied by information campaigns that drive home the message that prevention is better than cure. By using the information on HIV status of the respondents, the present study illustrates the usefulness of such information and underlines the importance of regular testing for HIV and on a wider scale. As more information becomes available, especially on HIV incidence, the subject will allow further research in an area of such policy importance. Countries such as India need to follow the example of Botswana in integrating the results of HIV testing with household attributes and other health related information. More generally, the study points to policy aspects in tackling HIV in which Asian countries such as India have much to learn from Africa, where HIV has a higher profile and a longer history.

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Table 1: Description of Regression Variables

Variables	Description
Accessibility	
No access to radio	1 if household does not own a radio; 0 if it owns.
No access to television	1 if household does not own television; 0 if it owns.
Demographic Variables	
Age	Age of the respondent
Age Squared	Quadratic age
Urban	1 if respondent resides in urban areas; 0 if rural
Christian	1 if religion of respondent is Christian; 0 otherwise.
Gender	1 if respondent is male; 0 if females.
Education (Base case: Primary education)	
No formal schooling	1 if respondent had no formal schooling; 0 otherwise
Secondary education	1 if respondent had completed secondary schooling; 0 otherwise
Higher secondary education	1 if respondent completed higher secondary education; 0 otherwise
Occupation (Base case: Other Occupation)	
Occupation-Professional/Service	1 if occupation of respondent is: Legislators, administrators, managers, professional, clerks, service and sales professional; 0 otherwise.
Occupation-Elementary	1 if elementary occupation; 0 otherwise.
Occupation - Other	1 if skilled agriculture, craft and trade, plant and machine operators and assemblers.
Marital Status (Base case: Other)	
Married	1 if respondent is married; 0 otherwise.
Living Together	1 if respondent is living together; 0 otherwise.
Other	1 if respondent is separated, divorces, widowed or never married; 0 otherwise.
Wealth Index (Base case: 0-20 percentile)	
Wealth Index (0-20%)	1 if respondent belongs to 0-20th percentile of wealth distribution; 0 otherwise.
Wealth Index (20-50%)	1 if respondent belongs to 20-50th percentile of wealth distribution; 0 otherwise.
Wealth Index (50-100%)	1 if respondent belongs to 50 to 100th percentile of wealth distribution; 0 otherwise.
Empowerment Beliefs	
Protect herself STD	1 if respondent believes that a female can protect herself from getting STD from partner; 0 if she cannot protect herself by either refusing sex, insisting use of condom or other.
Female can get Male Condoms	1 if respondent believes that a female should be allowed to get male condoms; 0 if not allowed.
Incorrect Knowledge	1 if respondents answer more than 30 percentage of questions incorrectly; 0 otherwise.
Sexual Practice	
Condom used last sex	1 if respondent used condom at last sex with all sex partners.
Condom used last sex*Males	1 if male respondents used condom with all sex partners; 0 otherwise.
Multiple sex partners	1 if respondent had more than 1 sexual partners in last 12 months; 0 otherwise
Multiple sex partners*Males	1 if male respondent had more than 1 sexual partners in last 12 months; 0 otherwise.
HIV/AIDS Risk factors	
STD symptoms	1 if respondent had any symptom of sexually transmitted disease in last 12 months; 0 otherwise.
HIV Positive	1 if respondent was tested HIV positive; 0 if HIV negative.
HIVAIDS care programs	
Available PLWHA	1 if the program Person living with HIV/AIDS program (PLWHA) is available; 0 otherwise. This program assists people living with HIV/AIDS to reduce their risk of re-infection or infecting others.
Available Orphan Care	1 if Programs available for care for orphans whose parents died of HIV/AIDS. This program started in 1999 provides food baskets, psychological counselling and facilitate wavering of school fee for orphans.
Available Home based care	1 if Home based care available for people suffering with HIV/AIDS; 0 otherwise. This program provides support to enable families who have volunteered to care for people with AIDS and orphaned children access to quality care, counselling, psychosocial and spiritual support to patients and their carers.
Available Destitute Care	1 if for destitute support available in line the National Destitute Policy; 0 otherwise.
Available ARV	1 if Anti Retro Viral treatment available; 0 otherwise. This program provides medications for the treatment of infection by retroviruses, primarily HIV.
Available PMTCT	1 if prevention of mother-to-child transmission (PMTCT) program available; 0 otherwise. Introduced in 2002, PMTCT program is aimed at preventing new child infections and deaths among adults and children. HIV positive mothers are given antiretrovirals to reduce risks of transfer to child.
Available IPT	1 if Ionized preventive therapy (IPT) is available to respondent; 0 otherwise. IPT is one of the key interventions recommended by WHO in 1998 to reduce the burden of TB in people living with HIV; yet implementation of IPT has been very low. Only 25,000 people living with HIV worldwide were reported to have received it in 2005. During this time hundreds of thousands of people were infected with or died from preventable Tuberculosis (TB).

Table 2: Multi Dimensional Measure of HIV Ignorance in Botswana, India

	Population Share[a]	Measures of Multidimensional Ignorance[b]				Deprivation contribution to population share[c]				Population Share[a]	Measures of Multidimensional Ignorance[b]				Deprivation contribution to population share[c]			
		π_0	π_1	π_3	π_{10}	π_0	π_1	π_3	π_{10}		π_0	π_1	π_3	π_{10}	π_0	π_1	π_3	π_{10}
	Botswana									**India**								
Wealth Index	Rural									Rural								
0-20%	0.1748	0.893	0.384	0.108	0.005	2.003	2.307	2.590	2.266	0.1770	0.962	0.210	0.114	0.097	2.025	1.552	1.753	1.944
		(0.350)	(0.403)	(0.453)	(0.396)						(0.358)	(0.275)	(0.310)	(0.344)				
20-50%	0.3041	0.887	0.330	0.083	0.005	1.145	1.140	1.145	1.296	0.2964	0.926	0.291	0.148	0.117	1.164	1.282	1.360	1.402
		(0.348)	(0.347)	(0.348)	(0.394)						(0.345)	(0.380)	(0.403)	(0.415)				
50-100%	0.5211	0.769	0.238	0.048	0.003	0.579	0.480	0.382	0.403	0.5266	0.797	0.264	0.106	0.068	0.563	0.656	0.544	0.457
		(0.302)	(0.250)	(0.199)	(0.210)						(0.297)	(0.345)	(0.287)	(0.240)				
All Females	0.5380	0.804	0.264	0.058	0.003	0.915	0.873	0.823	0.750	0.5252	0.907	0.264	0.137	0.109	1.000	0.960	1.093	1.197
		(0.492)	(0.470)	(0.443)	(0.403)						(0.525)	(0.504)	(0.574)	(0.629)				
All Males	0.4620	0.828	0.298	0.073	0.004	1.099	1.148	1.207	1.291	0.4748	0.820	0.260	0.101	0.064	0.999	1.045	0.897	0.782
		(0.508)	(0.530)	(0.557)	(0.597)						(0.475)	(0.496)	(0.426)	(0.371)				
Rural	0.4379	0.814	0.279	0.064	0.004	1.235	1.354	1.502	1.482	0.5028	0.866	0.262	0.120	0.088	1.085	1.049	1.149	1.197
		(0.541)	(0.593)	(0.658)	(0.649)						(0.546)	(0.527)	(0.578)	(0.602)				
Wealth Index	Urban									Urban								
0-20%	0.2377	0.815	0.272	0.057	0.002	1.571	1.785	2.032	1.955	0.1828	0.849	0.292	0.134	0.103	2.037	2.092	2.409	2.654
		(0.373)	(0.424)	(0.483)	(0.465)						(0.372)	(0.382)	(0.440)	(0.485)				
20-50%	0.2828	0.739	0.217	0.039	0.002	1.198	1.198	1.166	1.224	0.2702	0.790	0.277	0.111	0.076	1.283	1.345	1.353	1.322
		(0.339)	(0.339)	(0.330)	(0.346)						(0.346)	(0.363)	(0.366)	(0.357)				
50-100%	0.4795	0.628	0.152	0.022	0.001	0.600	0.494	0.391	0.395	0.5470	0.641	0.194	0.059	0.033	0.514	0.465	0.355	0.288
		(0.288)	(0.237)	(0.187)	(0.189)						(0.281)	(0.254)	(0.194)	(0.158)				
All Males	0.4517	0.711	0.203	0.038	0.003	1.136	1.168	1.242	1.491	0.5014	0.683	0.214	0.066	0.038	0.945	0.906	0.754	0.647
		(0.513)	(0.528)	(0.561)	(0.674)						(0.474)	(0.454)	(0.378)	(0.324)				
All Females	0.5483	0.675	0.182	0.030	0.001	0.888	0.862	0.801	0.595	0.4986	0.759	0.257	0.109	0.079	1.055	1.095	1.247	1.355
		(0.487)	(0.472)	(0.439)	(0.326)						(0.526)	(0.546)	(0.622)	(0.676)				
Urban	0.5621	0.691	0.191	0.033	0.002	0.817	0.725	0.609	0.625	0.497	0.721	0.235	0.088	0.058	0.914	0.951	0.849	0.801
		(0.459)	(0.407)	(0.342)	(0.351)						(0.454)	(0.473)	(0.422)	(0.398)				

[a] Share of population in subgroup of Wealth Index, gender, sector.

[b] Deprivation contribution ($\pi i/\sum \pi i$) by sugbroups of Wealth Index, gender and sector in parenthesis.

[c] ($\pi i/\sum \pi i$)/Population share.

Table 3: Correlation between Incorrect Knowledge and Risky Sexual Practices in Botswana and India

Pairwise Correlation		Botswana (2004)		India (2005-06)	
		Males	Females	Males	Females
Incorrect Knowledge of HIV/AIDS[a]	No use of Condom last Sex[b]				
	Rural	0.1812*	0.1934*	0.0901*	0.1221*
	Urban	0.1206*	0.1222*	0.0338*	0.0740*
	More than one Partner[c]				
	Rural	-0.0002	-0.0128	N/A	N/A
	Urban	0.0148	-0.0128	N/A	N/A
Incidence of HIV/AIDS (Positive)	No use of Condom last Sex[b]				
	Rural	0.0193	-0.0857*	0.0162*	-0.0025
	Urban	0.0470	0.0014	0.0122	0.0101
	More than one Partner[c]				
	Rural	-0.0135	0.0671*	N/A	N/A
	Urban	-0.0408	0.0458*	N/A	N/A
Incorrect Knowledge[a]	HIV Incidence(positive)				
	Rural	0.0502*	0.0888*	0.0039	0.0032
	Urban	0.0328	-0.0021	0.0094	0.0042

* Significant at 5 percent level of significance.

[a] Incorrect HIV/AIDS knowledge is a binary variable which is 1 if incorrect knowledge index is greater than 3 (i.e., more than three questions out of nine were answered incorrectly by the individual) and 0 if incorrect knowledge index is less than or equal to 3.

[b] Risky sexual behaviour is represented by a binary variable which takes the value 1 if condom was not used by the individual at last sex and 0 otherwise.

c Risky sexual behaviour is represented by a binary variable which takes the value 1 if person has more than 1 sex partner in last 12 months and 0 otherwise.

Table 4: Joint Estimation of HIV/AIDS Awareness, Knowledge, Condom Use and Incidence in Botswana

Variables	Heard of HIV/AIDS	Incorrect Knowledge	Condom used last sex partner	HIV Positive (A)	HIV Positive (B)
No Access to radio	-0.1363***	-0.0217	-0.1582***	-0.0609	-0.0105
	(0.0521)	(0.0282)	(0.0508)	(0.0619)	(0.0603)
No Access to TV	-0.0641	0.0200	-0.0337	-0.0090	-0.0027
	(0.0531)	(0.0240)	(0.0433)	(0.0513)	(0.0490)
Age	0.0964***	-0.0340***	-0.0412***	0.1434***	0.1477***
	(0.0076)	(0.0055)	(0.0120)	(0.0120)	(0.0116)
Age Squared	-0.0011***	0.0005***	0.0001	-0.0018***	-0.0017***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
No formal Schooling	0.2470	0.0112	-0.1082	-0.4584**	-0.3718**
	(0.2564)	(0.1020)	(0.1534)	(0.1885)	(0.1810)
Secondary Education	0.8226***	-0.5390***	0.2096**	-0.0056	-0.0686
	(0.0522)	(0.0384)	(0.0836)	(0.0656)	(0.0631)
Higher Secondary Education	0.5168***	-0.8806***	0.2102*	-0.4023***	-0.4424***
	(0.1177)	(0.0412)	(0.1092)	(0.0869)	(0.0817)
Christian	0.1194**	-0.0731***	-0.0965*	0.0701	0.0906*
	(0.0558)	(0.0257)	(0.0466)	(0.0555)	(0.0530)
Gender	0.0445	0.1158***	0.2806***	-0.0568	-0.1221*
	(0.0425)	(0.0190)	(0.0368)	(0.0755)	(0.0720)
Occupation-Professional/Service	0.1723**	-0.1732***	0.1140**	0.0230	-0.0232
	(0.1036)	(0.0280)	(0.0459)	(0.0526)	(0.0511)
Occupation -Elementary	-0.0068	0.0487	0.0569	0.0667	0.0413
	(0.0812)	(0.0329)	(0.0522)	(0.0604)	(0.0580)
Married	-0.1682*	-0.0581*	-0.8519***	-0.4047***	-0.0915
	(0.0935)	(0.0326)	(0.0500)	(0.0630)	(0.1040)
Living together	0.0251	0.0246	-0.4464***	0.0220	0.1548***
	(0.0762)	(0.0267)	(0.0412)	(0.0478)	(0.0564)
Wealth Index (20-50%)	0.2347***	-0.0517	0.1434**	-0.1699**	-0.1962***
	(0.0577)	(0.0315)	(0.0575)	(0.0664)	(0.0632)
Wealth Index (50-100%)	0.4255***	-0.2229***	0.2835***	-0.2716***	-0.3321***
	(0.0625)	(0.0349)	(0.0675)	(0.0726)	(0.0696)
Urban	0.2811***	-0.2356***	0.1845***	-0.0597	-0.1095**
	(0.0469)	(0.0238)	(0.0503)	(0.0494)	(0.0482)
Empower: Protect herself STD			0.2035***	0.0317	-0.0324
			(0.0590)	(0.0714)	(0.0696)
Female can get Male Condom			0.3411***	0.0961	-0.0241
			(0.0519)	(0.0649)	(0.0680)
Condom used last sex					0.9424***
					(0.2058)
Condom used last sex*Males				-0.1791**	-0.1809**
				(0.0896)	(0.0840)
Multiple Sex Partners				0.2301**	0.2024**
				(0.0949)	(0.0890)
Multiple Sex Partners*Males				-0.2687**	-0.2372**
				(0.1258)	(0.1180)
Incorrect Knowledge			-0.0022	-0.0188	-0.0198
			(0.0060)	(0.0787)	(0.0726)
STD symptom last 12 months				0.1431**	0.1313***
				(0.0522)	(0.0485)
Availability PLWHA			0.0559		
			(0.0428)		
Availability Orphan Care			0.1038*		
			(0.0554)		
Available Home based Care			0.0304		
			(0.0497)		
Available Destitute Care			-0.0863		
			(0.0544)		
Available ARV			-0.0662		
			(0.0484)		
Available PMTCT			0.0145		
			(0.0518)		
Available IPT			0.0081		
			(0.0440)		
Inverse Mills Ratio		1.4874***			
		(0.2210)			
Constant	-0.7203***		0.9716**	-2.8572***	-3.4621***
	(0.1320)		(0.3987)	(0.2988)	(0.2872)

Standard errors in parenthesis. * p<0.10, ** p<0.05, ***p<0.01.

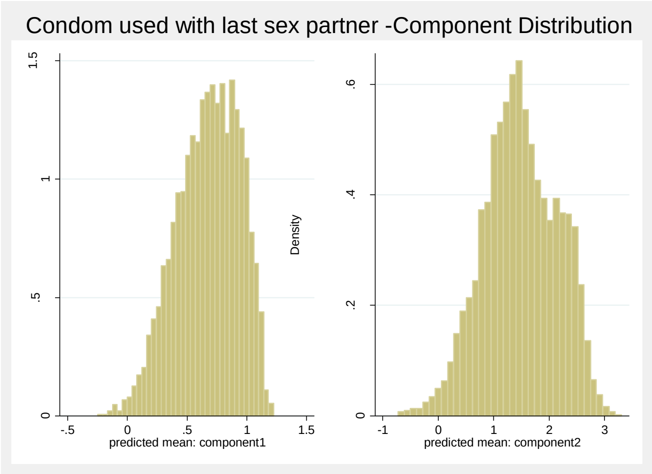
Table 5: OLS. Poisson and Finite Mixture Model Estimates

Latent Variable	Number of Sexual Partners (more than one)			Condom Used Last Sex with sex partner			Incorrect Knowledge		
		Latent Variable		OLS	Latent Variable			Latent Variable	
	Poisson	Comp1	Comp2		Comp1	Comp2	Poisson	Comp1	Comp2
HIV Positive	0.097	0.269*	-0.031	0.014	0.006	0.110	0.0150	-0.00482	-0.00446
	90.082)	(0.148)	(0.145)	(0.020)	(0.019)	(0.087)	(0.0198)	(0.0407)	(0.0159)
Incorrect Knowledge	0.065	0.128	-0.076	0.0002	-0.020	0.026	.	.	.
	(0.056)	(0.100)	(0.101)	(0.001)	(0.013)	(0.065)	.	.	.
Age	-0.0550**	0.118	-0.036	-0.0253***	-0.021***	-0.027	-0.00768**	-0.0139**	-0.00146
	(0.024)	(0.096)	(0.037)	(0.005)	(0.005)	(0.019)	(0.00388)	(0.00615)	(0.00299)
Age Squared	0.0003	-0.003*	0.00029	0.000162**	0.00012**	0.000034	0.000117**	0.000183**	1.85e-05
	(0.00035)	(0.002)	(0.001)	(0.000)	(0.000061)	(0.00025)	(5.03e-05)	(7.79e-05)	(4.01e-05)
No Access to Radio	0.204**	0.112	0.134	-0.0473*	-0.080***	0.170	0.0180	0.0220	0.00925
	(0.101)	(0.187)	(0.178)	(0.027)	(0.025)	(0.113)	(0.0232)	(0.0490)	(0.0174)
No Access to TV	0.060	0.266*	-0.064	-0.005	-0.002	0.002	0.0276	-0.0505	0.00155
	(0.086)	(0.149)	(0.175)	(0.022)	(0.021)	(0.097)	(0.0221)	(0.0427)	(0.0164)
No Formal Education	-1.963*	-13.826	-1.419	-0.029	0.021	-0.269	0.0295	0.0147	-0.0344
	(1.004)	(734.14)	(1.187)	(0.077)	(0.072)	(0.392)	(0.0560)	(0.265)	(0.0718)
Secondary School	0.068	-0.042	0.032	0.0917***	0.087***	0.072	-0.323***	-0.692***	-0.279***
	(0.103)	(0.192)	(0.190)	(0.025)	(0.023)	(0.112)	(0.0221)	(0.0561)	(0.0193)
Higher Secondary	0.339***	0.450*	-0.114	0.150***	0.112***	0.132	-0.630***	-0.740***	-0.411***
	(0.125)	(0.233)	(0.225)	(0.032)	(0.030)	(0.140)	(0.0378)	(0.0696)	(0.0329)
Christian	-0.099	-0.350**	0.131	-0.0642***	-0.067***	-0.066	-0.0323	0.00983	-0.0235
	(0.079)	(0.137)	(0.149)	(0.023)	(0.022)	(0.096)	(0.0231)	(0.0450)	(0.0170)
Wealth Index (20-50%)	0.002	0.189	-0.260	0.0837***	0.076***	0.134	-0.0815***	0.0229	-0.0410**
	(0.116)	(0.206)	(0.208)	(0.029)	(0.028)	(0.128)	(0.0243)	(0.0625)	(0.0190)
Wealth Index (50-100%)	0.163	0.420**	-0.194	0.130***	0.110***	0.299**	-0.181***	-0.156**	-0.0592**
	(0.121)	(0.213)	(0.230)	(0.031)	(0.029)	(0.145)	(0.0276)	(0.0789)	(0.0244)
Urban	0.118	0.386**	0.004	0.0753***	0.074***	0.132	-0.164***	-0.116**	-0.0522***
	(0.082)	(0.159)	(0.139)	(0.020)	(0.019)	(0.086)	(0.0196)	(0.0506)	(0.0174)
STD Symptoms	0.736***	0.828***	0.568**	0.0456**	-0.041*	0.434***	0.0285	0.0588	0.00817
	(0.075)	(0.135)	(0.137)	(0.023)	(0.022)	(0.086)	(0.0228)	(0.0460)	(0.0180)
Gender (Males)	1.210***	1.063***	1.285**	0.205***	0.101***	0.898***	0.0719***	0.0319	0.0212
	(0.076)	(0.143)	(0.144)	(0.018)	(0.019)	(0.089)	(0.0178)	(0.0346)	(0.0136)
Occupation-Professional	0.160*	-0.122	0.399**	0.0440**	0.029	0.293***	-0.163***	-0.154***	-0.0609**
	(0.086)	(0.172)	(0.146)	(0.022)	(0.021)	(0.097)	(0.0267)	(0.0595)	(0.0253)
Occupation-Elementary	0.267***	0.476***	0.038	0.0483*	0.026	0.139	0.0310	-0.0250	0.00574
	(0.102)	(0.174)	(0.201)	(0.026)	(0.026)	(0.110)	(0.0237)	(0.0503)	(0.0177)
Married	-0.907***	-1.009***	-0.802**	-0.344***	-0.303***	-0.464***	-0.0391	0.00531	-0.0411*
	(0.144)	(0.366)	(0.240)	(0.027)	(0.025)	(0.135)	(0.0255)	(0.0499)	(0.0211)
Living Together	-0.523***	-0.775	-0.392**	-0.200***	-0.174***	-0.333***	0.00963	-0.0152	-0.0254
	(0.086)	(0.180)	(0.144)	(0.021)	(0.020)	(0.085)	(0.0207)	(0.0467)	(0.0159)
Female protect herself	-0.053	-0.179	0.057	0.0582*	0.063**	0.066	-0.306***	-0.604***	-0.236***
STD	(0.117)	(0.219)	(0.213)	(0.030)	(0.028)	(0.126)	(0.0217)	(0.0919)	(0.0313)
Female can get Male	0.156	0.351	0.002	0.138***	0.107***	0.341***	-0.245***	-0.426***	-0.185***
Condoms	(0.121)	(0.249)	(0.213)	(0.027)	(0.026)	(0.122)	(0.0206)	(0.116)	(0.0363)
Constant	-1.443***	-4.269***	0.210	1.083***	0.998***	1.213***	4.196***	3.943***	4.255***
	(0.428)	(1.262)	(0.756)	(0.100)	(0.095)	(0.419)	(0.0745)	(0.157)	(0.0585)
π_i^a		0.901	0.099		0.880	0.120		0.4706	0.5294
	4,676	(0.017)	(0.017)	4,670	(0.016)	(0.016)	5,752	(0.0082)	(0.0082)

[a] probability that the observation lies in Component *i.* Robust Standard errors in paranthesis.

Figure 1: Predicted Mixture Density of Sexual Behaviour and Knowledge and Summary Statistics

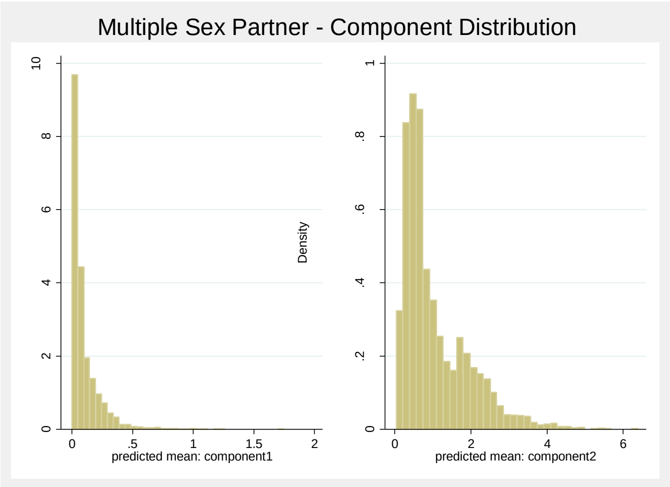
Figure 1a



Summary Statistics: Condom use last sex

Variable	Obs	Mean	Std. Dev.
Condom used	4670	0.772	0.295
Component 1	4110	0.675	0.261
Component 2	560	1.488	0.665

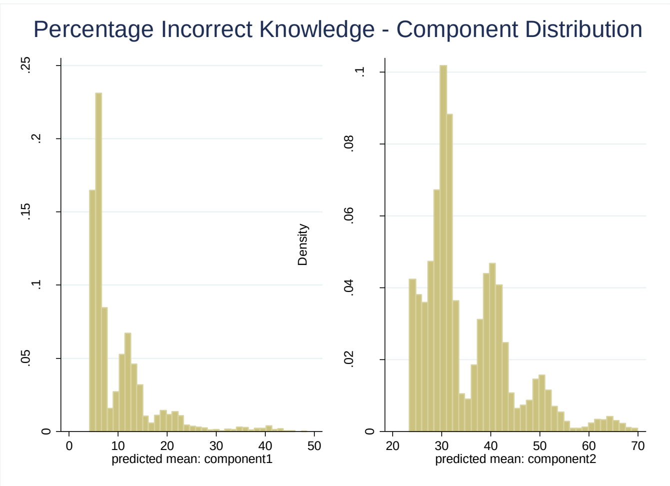
Figure 1b



Summary statistics: Multiple sex partners

Variable	Obs	Mean	Std. Dev.
Number Sex partners (more than one)	4676	0.192	0.186
Component 1	4213	0.097	0.128
Component 2	463	1.054	0.862

Figure 1c



Summary statistics: Incorrect Knowledge

Variable	Obs	Mean	Std. Dev.
Incorrect Knowledge	5752	23.378	7.858
Component 1	2707	10.018	6.854
Component 2	3045	35.254	8.913