HIV/AIDS Prevalence and the Demand for Safe Sexual Behavior: Evidence from West Africa*

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Abstract

Increasing attention is being given to the HIV/AIDS crisis in Africa, with much of the effort focusing on East and Southern Africa, where the epidemic has been most pronounced. While it is justified to address the areas with highest prevalence, it is also necessary to concentrate efforts at preventing the spread of the disease and understanding what factors drive risky sexual behaviors in areas of the continent where incidence rates remain relatively low. This paper examines the determinants of the adoption of low risk sexual behavior in West Africa. The results show that individuals avoid risky sexual behavior if they perceive HIV/AIDS incidence in their community to be high. More educated people are more likely to adopt safer sexual behavior. In rural areas, wealth level is still a significant determinant of condom use, suggesting that price represent a substantial barrier to the adoption of condom.

1 Introduction and objectives

Increasing attention is being given to the HIV/AIDS crisis in Africa. Much of the effort, however, has been focused on East and Southern Africa, where the infection incidence is the greatest. While it is justified to address the areas that are most affected, it is also important to concentrate efforts preventing the spread of the disease in areas of the continent where incidence rates remain relatively low. Furthermore, it is necessary to understand what motivates low risk behaviors that maintain low HIV/AIDS prevalence. Epidemiological models have shown that infection of a small group of highly sexually active individuals may be enough to increase the number of new infections or maintain a persistent low prevalence of the disease in communities (Anderson, 1992; Anderson and May, 1991; Kremer, 1996). Therefore, identifying factors which cause people to reduce high risk sexual behavior is key to designing effective HIV/AIDS reduction strategies.

The aim of this paper is to use a set of surveys from West Africa, to explore the socioeconomic and behavioral correlates of HIV/AIDS infection in order to help develop effective HIV/AIDS control strategies. I focus on understanding the determinants of men' perceptions of their risk of becoming infected with HIV/AIDS and how this influences adoption of safe sexual behavior. In particular, I estimate the determinants of the adoption of protective sexual behavior, defined as the use of condom and the limitation of sexual partners. Understanding the incentives and constraints for adopting protective sexual behavior is central to formulating public interventions that limit HIV/AIDS transmission. The focus on men stems from two observations. First, information on women's sexual behavior is less detailed in some of the surveys. Second, when available, data on women's sexual behavior is more questionable than those of men (for a discussion, see Gersovitz, Jacoby, Dedi, and Tape, 1998). However, in a setting where men dominate sexual transactions in general, the cost for omitting the women sample may be minimal.

West Africa offers an interesting setting for testing the presence of behavioral response to HIV/AIDS. The widespread cross-country migration in West Africa in order to sustain livelihoods may increase the vulnerability of the region to the spread of HIV. For example, Ivory Coast has a high incidence of HIV/AIDS and is the main destination for international migrants from the Sahel countries. This may increase the spread of the virus in the region since migrants may contract

the disease and carry the virus back to their homelands[1]. On the other hand these population movements may also contribute to faster diffusion of knowledge about AIDS.

HIV/AIDS organizations have suggested that the relationship between poverty and HIV/AIDS prevalence can be explained by the fact that individuals in poor countries have limited access to condoms and are less-well informed about modes of infection and methods to reduce infection. Thus, increased use of condoms and lower HIV/AIDS prevalence could be achieved by improving the availability of condoms and by educating individuals in poorer countries about HIV/AIDS. There is, however, growing evidence suggesting that many individuals are in fact aware of HIV/AIDS, the means by which it is transmitted and possible methods to reduce infection and yet condom use remains relatively low and there is no evidence of change of sexual behavior[2]. This observation raises the question of what influences individual sexual behavior response to the spread of HIV/AIDS.

This paper tests the extent to which HIV/AIDS prevalence influences the demand for safe sexual behavior, defined as the use of condoms and the limitation of sexual partners. Other variables which are hypothesized to be important in behavioral change are wealth and education levels. Conceivably, individuals with higher income and education are able to support many commercial and casual sex partners, thereby having more sex partners in any given time. At the same time, these individuals might have better access to and understanding of AIDS related information and can also afford the cost of the condoms. Thus education and income may be positively correlated with both the number of sexual partners and the use of condoms. Neglecting the use of condoms as barriers against other STD's and conception, the need to use of condoms depends on the risk for contracting HIV/AIDS among potential partners (e.g. Philipson, 1999; Philipson and Posner, 1993). This suggests that aggregate adoption of safe sexual behavior may be low, while individuals who face higher risk of infection adopt safer sexual conduct. Therefore a positive relation between the adoption of protective

[1]In particular, the recent political crisis in the Ivory Coast which had led to increased movements of refugees and former migrants returning to their home countries may be fueling the spread of HIV/AIDS in the Sahel. For instance, earlier work shows that 75 percent of Ghanaian female migrants living in Abidjan are sex workers(Anarfi, 1992). If these women stayed in contact with their native communities, traveling back and forth, they may have contributed to the spread of HIV/AIDS.

[2]In a survey of a number of Sub-Saharan African nations by Population Services International, lack of availability was found not to be a significant obstacle to condom use (Agha, Kusanthan, Longfield, Klein, and J.Berman, 2002). Surveys conducted in Burkina (1998) revealed that over 87 percent of female respondents were aware of HIV/AIDS. Of those, over 81 percent knew various ways of avoiding HIV/AIDS. However, this knowledge of HIV/AIDS and safe sex was not translated into behavioral change: only 3.4 percent of the women surveyed claimed to have started to use condom to avoid contracting HIV/AIDS.

behavior and the perceived prevalence of AIDS in the residential community arises.

To test these hypotheses I use national surveys from six countries in West Africa (Benin, Burkina, Guinea, Mali, Niger and Togo) to examine the influence of education, wealth and perceived HIV/AIDS prevalence on the occurrence of casual sexual intercourse and the use of condoms. Prevalence of HIV/AIDS at the community level is proxied by the fraction of individuals who know someone who has HIV/AIDS. Estimation results demonstrate that sexual behavior changes in response to perceived HIV/AIDS prevalence in the community. Relatively higher prevalence rate (as measured by the proxy) in the community is associated with relatively lower probability of engaging in risky sexual behavior. Wealth and education exert a positive effect on the adoption of safe behavior. Although there are some discrepancies across countries and between rural and urban areas, behavioral patterns are detectable. The remainder of the papers is organized as follows: the second section presents the theoretical and empirical settings, the third section presents the data and describes the variables used for the estimations, the fourth section discusses the main estimation results, the fifth section concludes and discusses possible extensions for future research.

2 Theoretical and empirical setting

From an economic perspective, estimable demand for protective behavior is derived from the expected utility defined over the benefits of unsafe sex and the cost of being infected. I draw from the "susceptible-infected" (SI) epidemiological model as set forth by Anderson and May (1991), to formalize the probability of getting infected. According to this model, the probability of infection (P) depends on the number of partners (r), the probability of getting infected during a contact with an already infected partner (B), and the average level of infection in the pools of potential partners (Y). The model is written as follows:

$$P = rBY \tag{1}$$

This relation can be used to motivate a simple behavioral model of sexual partner choice and condom use. In the model individuals derive utility from their sexual activity, which is discounted by the cost of being infected with HIV/AIDS. I start from the premise that there is a disutility

from using a condom (Rao, Gupta, Lokshin, and Jana, 2003; Philipson and Posner, 1993), which is denoted s. As a result, some individuals willingly tradeoff future utility for the current utility gain from unsafe sex.

Assuming that individuals prefer higher r and dislike condom use (Rao, Gupta, Lokshin, and Jana, 2003; Philipson and Posner, 1993), defining prices w_1 for r and w_2 for s, and a lifetime costs of being infected with HIV/AIDS (C)[3], the epidemiological model can be used to motivate a utility function of sexual behavior as follows[4].

$$v = u(s, r) - B(s)rYC \tag{2a}$$

$$w_1 s + w_2 r \leq E \tag{2b}$$

Where v is a value function and u is a utility function, with $\frac{\partial u}{\partial s} < 0$, $\frac{\partial u}{\partial r} > 0$, and $\frac{\partial B}{\partial s} < 0$

The main insight conveyed by this model is that conditional on their characteristics (age, education, income etc), local prices for condom and sexual services, and perceived HIV/AIDS incidence, people may choose different combinations of sexual behavior and number of partners to maximize their utility[5]. By allowing the transmission rate to depend on s, it is recognized that individuals can alter the transmission rate by the use of condom. While in the epidemiological literature s and r are treated as parameters, economists stress the fact that these reflect behavioral responses to opportunities resulting from rational choices (e.g. Gersovitz, 2000; Philipson and Posner, 1993). The maximization of the utility function generates estimable demand functions for the use of condom (s) and the number of partners (r) conditional on the prevalence (Y), income (E) and the prices w_1 and w_2.

$$s = \alpha_1 X + \alpha_2 W + \alpha_3 Y_c + \varepsilon_s \tag{3}$$

[3]The costs (C) inclusive of the pain resulting from being ill, the disutility of being stigmatized and the loss of future income stream and reduced life expectancy.

[4]I assume that sexual behavior is separable from the preferences of other commodities, so that I restrict the analysis to sexual behavior.

[5]It is conceivable that individuals may alter Y (the pool of potential partners), as a result of perceived differential prevalence rates among different segments of the population. For the moment, I will maintain that Y is exogenously given as prostitutes and casual friends for a male.

$$r = \beta_1 X + \beta_2 W + \beta_3 Y_c + \varepsilon_r \tag{4}$$

Where X is a set of variables which include individual characteristics such as age, sex, ethnicity, W represents wealth and education levels and Y_c is the average prevalence rate measured at the community level (the perceived prevalence rate). Local prices of condoms and sexual services will be captured by dummy variables. Two testable hypotheses are obvious from the theoretical model. First, individuals react to perceived high HIV/AIDS in their community by using more condoms and by reducing the number of their sexual partners, i.e. $\alpha_3 > 0$ and $\beta_3 < 0$. Second, wealthier and more educated men use condom more frequently and also have more sexual partners, i.e. $\alpha_2 > 0$ and $\beta_2 > 0$. As the theoretical derivation suggests, I estimate (3) and (4) by the mean of full information maximum likelihood, allowing for non-zero correlation between ε_s and ε_r.

In principle, regressions 3 and 4 could be estimated directly. However, since Y_c is an average (calculated at the community level), estimating directly 3 and 4 may yield biased estimates. In the terminology of the "social interactions" literature, the average prevalence Y_c can be characterized as a contextual variable, i.e. a variable which exerts similar influence on people living in the same community (Manski, 1993, 2000). To characterize the bias and how the coefficients may be interpreted, consider the following specification which is a common approach for accounting for social interactions.

$$s_i = \alpha_1 + \alpha_2 X_i + \alpha_3 X_c + \alpha_4 Y_c + \alpha_5 s_c + \mu_{is} \tag{5}$$

$$r_i = \beta_1 + \beta_2 X_i + \beta_3 X_c + \beta_4 Y_c + \beta_5 r_c + \mu_{ir} \tag{6}$$

Where X_c collects the average of individual characteristics at the relevant community level, s_{ic} is average outcome in and all other variables are as defined before. X_c captures the fact that individual outcomes may vary with the exogenous characteristics of the group. s_{ic} captures the fact that holding everything else constant, individual use of condom may be affected by the average use of condom in their community[6]. Identification issues associated with (5) and (6) have been discussed by Manski

[6]The same variable definitions apply for the demand of partners, i.e. equation (6).

(2000, 1993), and by Durlauf (2002). To illustrate the identification issue associated with (6) and (5), consider the equilibrium outcome.

$$s_c = \frac{\alpha_1}{1-\alpha_5} + \frac{\alpha_2+\alpha_3}{1-\alpha_5}X_c + \frac{\alpha_4}{1-\alpha_5}Y_c \tag{7}$$

After substituting for s_c using the equilibrium outcome, (5) can be written as:

$$s_{ic} = \frac{\alpha_1}{1-\alpha_5} + \alpha_2 X_{ic} + \frac{\alpha_3+\alpha_2\alpha_5}{1-\alpha_5}X_c + \frac{\alpha_4}{1-\alpha_5}Y_c + \mu_{ic} \tag{8}$$

Using these regressions, the error term in (3) can be expressed as follows:

$$\varepsilon_s = \nu + \frac{\alpha_3+\alpha_2\alpha_5}{1-\alpha_5}X_c \tag{9}$$

Where ν is a pure noise, and the other variables and parameters have been defined before. It is apparent that the estimates in 3 are consistent only if $\alpha_3 = \alpha_5 = 0$ in 5. Note, however, that if one is not directly interested in α_5, then 8 can be used to recover a consistent estimate of the compounded effect $\tilde{\alpha}_4$ where $\tilde{\alpha}_4 = \alpha_4/(1-\alpha_5)$.

The extent to which individual use of condom is influenced by average condom use in one's community is far from ambiguous. In fact, if one believes that sexual behavior (use of condom or demand for multiple sexual partners) is essentially private, there is no reason to expect α_5 to be different from zero[7]. However, if some elements of X_c are correlated with Y_c (for example average wealth and education influence the perceived average prevalence level), the coefficient of Y_c is biased in 3 but is consistent in (8). A final source of concern is that some omitted community characteristics which are subsumed in the error term in (8) may correlated with Y_c. In attempt to control for this potential source of bias, I include other community characteristics.

[7]If individuals living in the same communities are, however, exposed to the same HIV/AIDS-condom related interventions, then a spurious positive correlation between s_i and s_c is likely.

3 Data and variables description

The data for this analysis are drawn from the latest round of the Demographic and Health Survey (DHS) from each of the six countries. The DHS is a general purpose survey which focuses mainly on maternal and child health, and fertility. HIV/AIDS awareness related questions have been included in recent rounds of the surveys. These questions relate to general knowledge on how to avoid HIV/AIDS, the number of and relationship with sexual partners and the use of condoms during sexual intercourse. For the purpose of this study, I focus on the relationship with the last sexual partner and whether a condom was used and the proportion of respondents who report knowing some one with HIV/AIDS (or who has died from HIV/AIDS) within the survey cluster. I use this variable as a proxy for HIV/AIDS prevalence within the community.

Table 1 summarizes the HIV/AIDS situation in the six countries in 2000, taken from UNAIDS and UNECA (2000). The first column reports the estimated average prevalence rate among the adult population and the third column shows the median prevalence rate among women attending antenatal clinics in different years. In 2000 and by West Africa's standards, there are two countries with high prevalence, i.e. estimated prevalence exceeding 5 percent (Burkina, 6.44 percent and Togo, 5.98 percent). Two countries with moderate prevalence or prevalence between 2 and 3 percent (Benin and Mali), and two countries with low prevalence, where the prevalence is below 2 percent (Guinea and Niger).

The variables used in the estimations are summarized in tables 2 to 7 for the six countries and in each country for the urban and the rural sample. The variable "prevalence"is the fraction of individuals in each community who know a person who has AIDS (or has died from AIDS). This variable is used as a proxy for the perceived prevalence rate in the population. The assumption is that people who live in communities where "actual" prevalence is high are more likely to come across someone infected with HIV/AIDS or who has died from the disease. Highest "prevalence" rates are found in Burkina (.54) and in Togo (.39), and this is reflective of the prevalence rates reported in table 1. Note however that to the extent that people may have imprecise knowledge of HIV/AIDS, the proxied prevalence may deviate from the that true prevalence. This should not be a source of substantial concern if we assume that individuals do not respond to the actual prevalence rate but

to what they believed is the prevalence rate, a measure which may be relatively well captured by the proxy variable used. A more serious source of concern is migration. In particular returning migrants are more likely to report cases of HIV/AIDS (actual or perceived) even if there is no case of HIV/AIDS in their communities[8].

The percentage of urban respondents reporting intercourse with a casual partner varies from 19 percent in Burkina to 42 percent in Mali. And the likelihood of having the last sexual intercourse with a casual sex partner is consistently higher in urban than in rural areas, reflecting the differences in opportunities for sexual encounters between the two settings. Condom use is more frequent in urban areas, an observation that could be explained either by the relatively larger fraction of urban men engaging in casual sex or simply by the fact that condoms are more accessible in urban areas, both in terms of supply and costs. Men report using condom more frequently in Burkina and in Togo (the two countries with the highest prevalence). However given that the environment may vary across countries and the lack of pattern in the other countries, it would not be prudent to draw implications between prevalence and condom use based at this observation alone. Wealth is calculated using the score index of a set of qualitative variables (see Filmer and Pritchett, 2001, for more discussion on the approach). Thus the wealth index could not be compared across countries, but the comparison within countries indicate that urban households are wealthier in each of the six countries.

4 Results and discussion

For empirical implementation, additional assumptions are made on the joint distribution on the error terms:

$$E[\mu_{is}] = E[\mu_{ir}] = 0 \tag{10}$$

$$var(\mu_{is}) = var(\mu_{ir}) = 1 \tag{11}$$

[8]This is an important issue, given frequent population movements between rural and urban areas and across countries within the region. Later versions of this paper will elaborate more on this concern

$$cov(\mu_{is}, \mu_{ir}) = \rho \tag{12}$$

I estimate 8 (use of condom during the last sexual intercourse and whether the last sex partner was a regular or casual partner) and 10-12 as a bivariate probit model. The model is estimated by maximum likelihood methods assuming that the errors in the regressions defining the demand for casual sex and the use of condom have a joint probability distribution that is bivariate normal. The estimation results are reported in tables 8 to 13 for the six countries. For each country, the first pair of columns shows the estimates of the demand for casual sex and the use of condom for the urban sample. The second pair of columns shows the corresponding estimates for the rural sample.

To facilitate the interpretation, the marginal effects implied by the regressions are reported in tables 14 and 15. As a brief summary of the main regression results, one can note that prevalence rate has a negative influence on the demand of casual sex (except in rural Guinea, rural Mali and urban Niger), and a positive influence on the demand of condom (except in urban Guinea and urban Niger). Wealth is associated with both more demand for casual sex and use of condom in rural Benin, in urban in Guinea, in rural Mali, and in rural Togo, though the coefficients are not significant in most of the cases. A clear pattern that emerges is that more education is always associated with higher demand for condoms in both urban and rural areas, and the coefficients are generally significant. The estimated ρ which reflects the extent to which unobserved variables are influencing the two equations is reported in the third row (starting from the bottom) in each table. Except in the case of Guinea, it can be inferred that unobserved variables that increase the likelihood for casual sex also increase the likelihood that a condom is used, suggesting that individuals who engage into casual sex are also more likely to use condoms.

Tables 14 and 15 report the marginal effects of key variables (prevalence, wealth and education) on the unconditional probabilities for observing each behavior. For each country, the odd-numbered column shows the marginal effects on the odds that the last sexual partner is a casual encounter. The even-numbered column shows the marginal effects on the odds that a condom is used during this sexual encounter. It can be seen that for the urban sample the perceived prevalence has a consistent negative effect on the probability of casual sexual intercourse across the six countries, although

the estimates are not significant (at the 10 percent level) in three countries (Burkina, Niger and Togo). The point estimates are comparable in magnitude (about .2 decrease in probability) in Benin, Burkina, Guinea, and Togo. The smallest marginal effects are observed in Mali and Niger, where official reported HIV/AIDS infection prevalence rates are among the lowest of the region. Wealth has a positive effect on condom use as expected, except in Niger. Prevalence has a positive and significant effect on condom use only in Benin. Condom use is positively associated with education, and the result is consistent across all countries.

Turning to rural households, prevalence has a dissuasive effect on the odds of casual sexual partner only in Benin. Prevalence has, however, the expected positive effect on condom use in Niger (statistically significant but very small: .0001) and Togo where the estimate is statistically significant and relatively large (.075). In rural areas, higher wealth is associated with higher probability of condom use in Benin, Burkina, Mali, and Togo, suggesting that in these areas costs may still constitute a barrier to widespread adoption of condoms. More educated individuals are more likely to use condoms as reflected by the positive coefficients associated with "read easily" (significant at the 10 percent in Guinea, Niger and Togo).

With the bivariate probit estimates, it is possible to reconstruct other outcomes of interest. In particular, one can derive the conditional probabilities and examine how they respond to changes in the variables of interest. For the purpose of this study, three outcomes are considered. The "riskiest behavior", which leads of course to a greater exposure of infection risks is the probability of not using a condom conditional on having a sexual intercourse with a casual partner. The "safest behavior" is the probability of using a condom conditional on that the sexual intercourse is with one's regular partner[9]. The "safe behavior",which may lead to a reduced exposure to infection risks consists of using condom with casual sexual partners. The results are reported in table 16 for the urban samples and in table 17 for the urban samples. In each table the marginal effects associated with the riskiest behavior are reported in columns 1, 4, 7, 10, 13 and 16. The marginal effects associated with the safest behavior are reported in columns 2, 5, 8, 11, 14 and 17. And the marginal effects associated with the safe behavior are reported in columns 3, 6, 9, 12, 15 and 18..

From table 16, an increase in the perceived HIV/AIDS prevalence has a consistent negative effect

[9]For this category the use of condom may be motivated for other such fertility control than attempt to avoid HIV/AIDS infection, but I abstract from these distinctions.

on the riskiest behavior, except in Niger where the positive response is significant. In addition, the coefficients are significant at the five percent level in Benin, Guinea, and Togo. Except in Mali and Togo where its effect is negative and statistically significant, wealth has no discernable effect on the riskiest behavior in the remaining countries in the sense that the coefficients are in general relatively small and statistically nonsignificant. Across all countries, individuals with higher education engage in less riskiest behavior as compared to those with no education at all, and the coefficients are significant at the five percent level in Benin, Burkina and Guinea.

5 Conclusions and possible extensions

This paper has used data from six counties in West Africa to estimate the determinants of the demand for casual sex and for condom. The aim was to seek the extent to which empirical regularities in the data could be interpreted as evidence of change in sexual behavior.

The evidence uncovered suggests that perceived prevalence, measured as the fraction of the population in a community who knows someone who has HIV/AIDS (or has died from HIV/AIDS) has a negative influence on the demand for casual sex and a positive influence the use of condom, suggesting that individuals change their sexual behavior in response to the spread of the disease. There is also evidence that wealth has a strong positive effect on the use of condom in rural areas, indicating that in poor rural areas costs may be a barrier to a condom use. In general more education is associated with more use of condom, which could be due to a simple wealth effects (more educated people are richer) or better access to and understanding of HIV/AIDS related information.

This analysis focused on men, and hence could be extended to consider women as well. Indeed, a number of studies document the imbalance of power between men and women created by a differential access to productive resources in the Western African context. To the extent that this imbalance in power translates into an unequal balance of power in sexual interactions, the partner with more power may have greater control over the couple sexual's behavior. Thus an understanding of the outcome of the sexual interaction may necessitate an understanding of gender and sexuality as driven by the interplay of economic forces that determine the distribution of power. The central premise is that since women are, in general, economically more vulnerable than men, they are less able to

negotiate the use of a condom or fidelity with a monogamous male partner. Thus, women are less likely to leave a relationship that they perceive to be risky because they evaluate the short-term costs of leaving the relationship to be higher than the potential long-term health costs. If for example, it is shown that women ability to negotiate for safer sex is determined by their education, then programs targeting female education, and improving women's income generating ability may help to reduce the spread of HIV/AIDS.

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Table 1: HIV/AIDS prevalence in selected countries

	(1)	(2)	(3)	(4)
Country	Estimated	Year	Measured	Year
Benin	2.45	2000	3.71	1998
Burkina	6.44	2000	7.44	1998
Guinea	1.54	2000	1.5	1996
Mali	2.03	2000	2.7	1997
Niger	1.35	2000	1.3	1993
Togo	5.98	2000	6.8	1997

Table 2: Summary statistics, Benin

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.261	0.439	0.000	1.000
Condom	0.175	0.380	0.000	1.000
Prevalence	0.299	0.190	0.000	0.889
Wealth index	0.932	1.244	-1.007	3.873
married	0.480	0.500	0.000	1.000
age	32.384	11.276	15.000	64.000
educ. Yrs	6.078	5.060	0.000	21.000
educ	3.049	1.440	1.000	7.000
Rural				
Casual sex partner	0.254	0.436	0.000	1.000
Condom	0.131	0.338	0.000	1.000
Prevalence	0.279	0.201	0.000	0.889
Wealth index	0.082	1.115	-1.007	3.873
married	0.575	0.494	0.000	1.000
age	33.326	11.752	15.000	64.000
educ. Yrs	2.476	3.563	0.000	19.000

Table 3: Summary statistics, Burkina

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.192	0.394	0.000	1.000
Condom	0.460	0.499	0.000	1.000
Prevalence	0.536	0.135	0.167	1.000
Wealth index	1.550	0.995	-0.932	3.864
married	0.471	0.500	0.000	1.000
age	31.871	10.806	15.000	59.000
educ. Yrs	5.954	5.539	0.000	18.000
Rural				
Casual sex partner	0.143	0.350	0.000	1.000
Condom	0.127	0.333	0.000	1.000
Prevalence	0.298	0.180	0.000	0.829
Wealth index	-0.482	0.374	-0.916	2.480
married	0.780	0.414	0.000	1.000
age	35.460	11.659	15.000	59.000
educ. Yrs	0.721	2.160	0.000	14.000

Table 4: Summary statistics, Guinea

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.261	0.439	0.000	1.000
Condom	0.247	0.432	0.000	1.000
Prevalence	0.311	0.212	0.000	1.000
Wealth index	1.234	1.117	-0.787	4.481
married	0.413	0.493	0.000	1.000
age	30.860	10.932	15.000	59.000
educ. Yrs	6.540	5.889	0.000	20.000
Rural				
Casual sex partner	0.198	0.399	0.000	1.000
Condom	0.057	0.232	0.000	1.000
Prevalence	0.231	0.224	0.000	1.000
Wealth index	-0.467	0.450	-0.996	2.681
married	0.747	0.435	0.000	1.000
age	35.661	11.848	15.000	59.000
educ. Yrs	2.239	4.060	0.000	19.000

Table 5: Summary statistics, Mali

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.424	0.494	0.000	1.000
Condom	0.225	0.418	0.000	1.000
Prevalence	0.312	0.605	0.000	9.000
Wealth index	1.754	1.588	-1.012	5.478
married	0.450	0.498	0.000	1.000
age	30.792	11.441	15.000	59.000
educ. Yrs	6.080	5.573	0.000	20.000
Rural				
Casual sex partner	0.306	0.461	0.000	1.000
Condom	0.046	0.209	0.000	1.000
Prevalence	0.226	0.251	0.000	1.333
Wealth index	-0.394	0.451	-1.124	3.160
married	0.691	0.462	0.000	1.000
age	34.137	12.475	15.000	59.000
educ. Yrs	1.086	2.604	0.000	17.000

Table 6: Summary statistics, Niger

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.345	0.476	0.000	1.000
Condom	0.217	0.413	0.000	1.000
Prevalence	0.269	0.160	0.000	1.000
Wealth index	1.563	1.235	-0.631	5.536
married	0.651	0.477	0.000	1.000
age	34.139	11.181	15.000	59.000
educ. Yrs	2.237	2.385	0.000	12.000
Rural				
Casual sex partner	0.107	0.310	0.000	1.000
Condom	0.029	0.167	0.000	1.000
Prevalence	0.299	0.213	0.000	1.000
Wealth index	-0.452	0.306	-0.802	1.768
married	0.895	0.307	0.000	1.000
age	35.815	11.090	15.000	59.000
educ. Yrs	0.669	1.697	0.000	7.000

Table 7: Summary statistics, Togo

	(1)	(2)	(3)	(4)
	Mean	St. dev	Minimum	Maximum
Urban				
Casual sex partner	0.263	0.441	0.000	1.000
Condom	0.285	0.452	0.000	1.000
Prevalence	0.391	0.120	0.133	0.778
Wealth index	1.075	0.999	-1.264	3.772
married	0.443	0.497	0.000	1.000
age	30.947	10.202	15.000	59.000
educ. Yrs	7.137	4.251	0.000	19.000
Rural				
Casual sex partner	0.209	0.407	0.000	1.000
Condom	0.126	0.332	0.000	1.000
Prevalence	0.341	0.184	0.000	1.000
Wealth index	-0.463	0.631	-1.410	2.212
married	0.633	0.482	0.000	1.000
age	33.460	11.095	15.000	59.000
educ. Yrs	3.803	3.869	0.000	18.000

Table 8: Bivariate probit regression, Benin

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	-0.601	0.766	-0.941	0.206
	[2.12]**	[2.70]***	[3.97]***	[0.75]
wealth index	-0.054	0.153	0.023	0.261
	[0.69]	[1.60]	[0.20]	[1.73]*
married	-0.544	-0.492	-0.681	-0.250
	[3.76]***	[2.66]***	[6.95]***	[1.97]**
age	-0.079	-0.058	-0.057	0.017
	[2.28]**	[1.83]*	[2.82]***	[0.49]
age squared	0.001	0.000	0.001	-0.001
	[2.04]**	[1.00]	[2.38]**	[1.58]
some ed.	-0.063	0.050		
	[0.38]	[0.23]		
primary	0.127	-0.694		
	[0.49]	[1.64]		
second.	-0.156	0.424		
	[0.84]	[1.85]*		
higher	-0.457	0.443		
	[1.53]	[1.38]		
read with dif.			0.186	-0.055
			[1.44]	[0.30]
read easily			0.041	0.176
			[0.36]	[1.38]
Constant	3.777	1.101	1.992	-3.306
	[2.68]***	[0.76]	[1.72]*	[2.27]**
ρ	0.202		0.045	
$\chi^2(1)$	[7.63]***		[.50]	
Observations	936	936	1475	1475

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 9: Bivariate probit regression, Burkina Faso

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	-0.856	0.017	-0.263	0.479
	[1.58]	[0.03]	[0.56]	[1.38]
wealth index	0.150	0.108	-0.079	0.380
	[1.68]*	[1.29]	[0.45]	[2.53]**
married	-1.294	-1.087	-1.709	-0.694
	[5.83]***	[6.20]***	[10.26]***	[4.30]***
age	0.046	0.023	0.001	0.041
	[0.93]	[0.51]	[0.02]	[0.99]
age squared	-0.001	-0.001	0.000	-0.001
	[1.17]	[1.29]	[0.90]	[2.05]**
some ed.	-0.012	0.131		
	[0.05]	[0.64]		
primary	0.085	-0.079		
	[0.37]	[0.38]		
second.	0.132	0.283		
	[0.67]	[1.56]		
higher	-0.402	0.211		
	[1.55]	[0.96]		
read with dif.			0.004	0.175
			[0.02]	[0.90]
read easily			-0.137	0.275
			[0.57]	[1.42]
Constant	2.925	-0.821	1.436	-4.599
	[1.35]	[0.43]	[0.78]	[2.59]***
ρ		0.099		0.265
$\chi^2(1)$		[1.23]		[10.00]***
Observations	635	635	1412	1412

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 10: Bivariate probit regression, Guinea

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	-0.710	-0.121	0.001	0.430
	[2.13]**	[0.32]	[0.00]	[0.99]
wealth index	0.026	0.160	0.502	0.132
	[0.32]	[1.73]*	[2.65]***	[0.83]
married	-0.891	-1.081	-0.906	-0.808
	[3.86]***	[5.83]***	[5.06]***	[3.53]***
age	0.017	-0.002	-0.002	0.191
	[0.45]	[0.06]	[0.04]	[2.94]***
age squared	0.000	0.000	0.000	-0.003
	[0.71]	[0.55]	[0.89]	[3.41]***
some ed.	0.259	0.055		
	[1.55]	[0.26]		
primary	-0.243	0.583		
	[0.94]	[2.51]**		
second.	-0.069	0.259		
	[0.42]	[1.45]		
higher	-0.387	0.273		
	[1.74]*	[1.19]		
read with dif.			-0.471	0.376
			[1.57]	[1.35]
read easily			0.007	0.566
			[0.05]	[2.78]***
Constant			0.117	0.073
			[0.65]	[0.34]
Constant	-1.349	-4.241	0.827	-5.965
	[0.93]	[2.30]**	[0.64]	[3.45]***
ρ	-0.012		-0.134	
$\chi^2(1)$	[0.013]		2.49	
Observations	664	664	1005	1005

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 11: Bivariate probit regression, Mali

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	-0.210	-0.119	0.104	0.190
	[1.63]	[1.02]	[0.48]	[0.44]
wealth index	-0.215	0.220	0.267	0.250
	[3.18]***	[3.24]***	[1.90]*	[1.21]
married	-0.587	-0.733	-1.301	-1.099
	[3.27]***	[3.49]***	[7.93]***	[6.04]***
age	-0.100	0.130	0.046	0.036
	[2.97]***	[3.35]***	[1.67]*	[0.73]
age squared	0.001	-0.002	-0.001	-0.001
	[1.89]*	[3.30]***	[2.26]**	[1.38]
some ed.	0.241	0.589		
	[1.40]	[2.48]**		
primary	0.486	0.772		
	[1.92]*	[2.46]**		
second.	0.156	0.570		
	[1.06]	[3.90]***		
higher	0.295	1.045		
	[1.33]	[5.58]***		
read with dif.			-0.026	0.472
			[0.16]	[2.10]**
read easily			-0.056	0.691
			[0.33]	[3.33]***
Constant	1.617	-5.801	0.508	-4.282
	[1.20]	[4.04]***	[0.37]	[1.49]
ρ	0.189		0.433	
$\chi^2(1)$	[5.93]***		[22.90]***	
Observations	1154	1154	2528	2528

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 12: Bivariate probit regression, Niger

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	0.000	-0.002	-0.001	0.005
	[0.30]	[2.07]**	[0.70]	[2.18]**
wealth index from factor scores	-0.263	-0.139	0.210	-0.326
	[3.03]***	[1.87]*	[1.00]	[1.39]
married	-3.551	-1.564	-2.607	-1.364
	[12.77]***	[8.12]***	[12.94]***	[5.54]***
current age - respondent	-0.217	0.010	-0.152	0.036
	[4.30]***	[0.23]	[4.40]***	[0.79]
age2	0.002	0.000	0.002	-0.001
	[3.71]***	[0.37]	[3.62]***	[0.94]
mv149==1	1.421	0.447		
	[4.62]***	[1.49]		
mv149==2	0.508	0.651		
	[1.35]	[2.71]***		
mv149==3	0.292	0.875		
	[1.11]	[4.17]***		
mv149==4	0.790	0.850		
	[2.63]***	[3.40]***		
read==2			0.313	0.000
			[1.24]	[0.00]
read==3			0.327	0.666
			[1.42]	[3.03]***
mv131==4			0.908	0.634
			[2.80]***	[2.31]**
Constant	-4.342	2.742	5.778	-3.021
	[1.13]	[1.99]**	[1.23]	[0.76]
ρ	0.551		0.644	
$\chi^2(1)$	[12.81]***		[19.53]***	
Observations	828	828	1611	1611

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 13: Bivariate probit regression, Togo

	(1)	(2)	(3)	(4)
	urban		rural	
	casual	condom	casual	condom
prevalence	-0.818	0.539	-0.320	0.525
	[1.92]*	[1.38]	[1.45]	[2.01]**
wealth index	-0.113	0.052	0.070	0.099
	[1.51]	[0.70]	[0.80]	[1.04]
married	-0.447	-0.673	-1.006	-0.801
	[2.95]***	[5.07]***	[10.40]***	[7.08]***
age	-0.114	0.040	-0.068	0.039
	[3.69]***	[1.07]	[3.35]***	[1.35]
age squared	0.001	-0.001	0.001	-0.001
	[2.97]***	[1.82]*	[2.02]**	[2.50]**
some ed.	0.300	-0.028		
	[1.45]	[0.12]		
primary	0.300	-0.126		
	[1.39]	[0.42]		
second.	0.282	0.306		
	[1.48]	[1.36]		
higher	0.046	0.256		
	[0.24]	[1.13]		
read with dif.			0.111	0.015
			[1.13]	[0.09]
read easily			0.031	0.478
			[0.31]	[3.41]***
Constant	1.031	0.906	-0.190	3.198
	[0.83]	[0.77]	[0.15]	[2.25]**
ρ	0.141		0.118	
$\chi^2(1)$	[5.24]		[3.78]*	
Observations	996	996	1961	1961

Robust z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1

Table 14: Behavioral responses in urban areas, unconditional probabilities

	Benin		Burkina		Guinea		Mali		Niger		Togo	
	casual	condom	casual	condom	casual	condom	casual	condom	casual	condom	casual	condom
Prevalence	-0.180	0.108	-0.180	0.007	-0.209	-0.031	-0.081	-0.025	-0.0001	-0.0003	-0.196	0.159
	[2.090]	[2.770]	[1.580]	[0.030]	[2.140]	[0.310]	[1.620]	[1.010]	[0.300]	[2.110]	[1.550]	[1.320]
wealth	-0.016	0.022	0.032	0.042	0.008	0.041	-0.083	0.046	-0.065	-0.026	-0.032	0.028
	[0.680]	[1.570]	[1.680]	[1.290]	[0.320]	[1.700]	[3.200]	[3.120]	[3.030]	[1.850]	[1.850]	[1.540]
some ed	-0.019	0.007	-0.002	0.052	0.081	0.014	0.095	0.155	0.491	0.103	0.108	-0.003
	[0.380]	[0.220]	[0.050]	[0.630]	[1.480]	[0.260]	[1.380]	[2.110]	[4.660]	[1.280]	[1.510]	[0.040]
primary	0.039	-0.062	0.019	-0.031	-0.066	0.182	0.192	0.225	0.149	0.160	0.111	-0.031
	[0.470]	[2.920]	[0.350]	[0.380]	[1.030]	[2.210]	[1.960]	[1.990]	[1.190]	[2.300]	[1.460]	[0.360]
second	-0.046	0.066	0.029	0.111	-0.020	0.070	0.061	0.131	0.077	0.203	0.101	0.109
	[0.860]	[1.710]	[0.640]	[1.560]	[0.420]	[1.410]	[1.060]	[3.710]	[1.070]	[3.690]	[1.690]	[1.540]
higher	-0.116	0.080	-0.072	0.083	-0.103	0.076	0.116	0.307	0.247	0.221	0.030	0.099
	[1.880]	[1.110]	[1.850]	[0.950]	[1.930]	[1.120]	[1.320]	[4.690]	[2.450]	[2.810]	[0.500]	[1.320]

Absolute value of z statistics in brackets
some ed: primary education incomplete, primary: primary completed, some sec: secondary education incomplete, higher: completed secondary and higher education, no education is excluded category

Marginal probabilities from bivariate probit
Dependent variables: Partner during last sexual intercourse: casual partner=1, 0 otherwise; Use of condom: 1=yes, 0 otherwise

Table 15: Behavioral responses in rural areas, unconditional probabilities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Benin		Burkina		Guinea		Mali		Niger		Togo	
	casual	condom	casual	condom	casual	condom	casual	condom	casual	condom	casual	condom
Prevalence	-0.278	0.023	-0.023	0.046	0.000	0.015	0.019323	0.000	-0.0001	0.0001	-0.070	0.075
	[3.960]	[0.760]	[0.560]	[1.350]	[0.000]	[0.960]	[0.480]	[0.430]	[0.700]	[2.280]	[1.380]	[2.570]
wealth	0.007	0.029	-0.007	0.036	0.112	0.005	0.04958	0.000	0.014	-0.007	-0.001	0.021
	[0.200]	[1.730]	[0.450]	[2.390]	[2.670]	[0.860]	[1.920]	[1.070]	[0.930]	[1.240]	[0.080]	[2.280]
read w. diff.	0.058	-0.006	0.000	0.019	-0.083	0.019	-0.00479	0.000	0.029	0.000	0.028	0.001
	[1.370]	[0.310]	[0.020]	[0.810]	[2.110]	[0.970]	[0.160]	[0.930]	[0.980]	[0.000]	[1.130]	[0.070]
read easily	0.012	0.021	-0.011	0.032	0.002	0.030	-0.01016	0.000	0.030	0.029	0.008	0.062
	[0.360]	[1.240]	[0.640]	[1.180]	[0.050]	[1.710]	[0.340]	[1.290]	[1.150]	[1.680]	[0.320]	[3.250]

Absolute value of z statistics in brackets

Absolute value of z statistics in brackets
read w diff: read with difficulty; cannot read is excluded category

Marginal probabilities from bivariate probit
Dependent variables: Partner during last sexual intercourse: casual partner=1, 0 otherwise; Use of condom: 1=yes, 0 otherwise

Table 16: Behavioral responses in urban areas, conditional probabilities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	Benin			Burkina			Guinea			Mali			Niger			Togo		
	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe
Prevalence	-0.165	0.103	0.029	-0.093	0.129	-0.063	-0.197	0.041	-0.035	-0.064	0.000	-0.023	0.117	-0.046	0.026	-0.183	0.172	-0.013
	[1.93]	[3.37]	[1.84]	[1.44]	[0.79]	[1.07]	[1.95]	[0.46]	[1.67]	[1.52]	[0.00]	[1.54]	[2.06]	[0.73]	[1.39]	[2.00]	[1.93]	[0.24]
wealth	-0.011	0.008	0.002	0.011	0.026	0.021	0.017	0.005	0.006	-0.062	0.026	0.012	-0.001	-0.002	-0.001	-0.030	0.029	-0.001
	[0.64]	[1.02]	[0.61]	[1.15]	[1.08]	[2.48]	[1.03]	[0.33]	[1.22]	[3.74]	[4.00]	[2.42]	[0.18]	[0.19]	[0.35]	[2.33]	[2.15]	[0.21]
some ed	-0.024	0.015	0.004	-0.017	0.052	-0.004	0.068	0.013	0.023	-0.009	0.058	0.092	0.015	0.086	0.029	0.080	-0.032	0.028
	[0.51]	[0.64]	[0.33]	[0.72]	[0.71]	[0.16]	[1.41]	[0.27]	[1.46]	[0.15]	[1.58]	[2.08]	[0.46]	[1.28]	[1.13]	[1.37]	[0.59]	[0.89]
primary	0.056	-0.040	-0.018	0.017	-0.026	0.010	-0.086	0.210	0.026	0.031	0.052	0.164	-0.028	0.143	0.014	0.092	-0.050	0.019
	[0.72]	[2.51]	[1.67]	[0.54]	[0.37]	[0.36]	[2.05]	[3.20]	[0.92]	[0.34]	[1.03]	[2.10]	[1.37]	[2.31]	[0.98]	[1.40]	[0.87]	[0.53]
second	-0.084	0.073	0.020	-0.010	0.107	0.028	-0.033	0.097	0.019	-0.026	0.058	0.068	-0.041	0.182	0.016	0.041	0.050	0.059
	[1.86]	[2.55]	[1.42]	[0.45]	[1.76]	[1.14]	[0.86]	[2.30]	[1.53]	[0.57]	[2.73]	[3.18]	[2.15]	[3.68]	[0.02]	[0.96]	[0.97]	[1.99]
higher	-0.141	0.113	0.006	-0.048	0.147	-0.020	-0.100	0.148	0.007	-0.073	0.125	0.175	-0.036	0.207	1.380	-0.006	0.063	0.035
	[3.48]	[1.82]	[0.28]	[2.54]	[1.96]	[0.91]	[2.61]	[2.40]	[0.43]	[1.21]	[2.81]	[3.65]	[1.46]	[2.85]	[0.93]	[0.13]	[1.08]	[1.27]

Absolute value of z statistics in brackets
some ed: primary education incomplete, primary: primary completed, some sec: secondary education incomplete, higher: completed secondary and higher education, no education is excluded category

Marginal probabilities from bivariate probit
Dependent variables: Partner during last sexual intercourse: casual partner=1, 0 otherwise; Use of condom: 1=yes, 0 otherwise

Riskiest behavior: casual partner and no condom
Safest behavior: regular partner with condom
Safe behavior: casual partner with condom

Table 17: Behavioral responses in rural areas, conditional probabilities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	Benin			Burkina			Guinea			Mali			Niger			Togo		
	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe	Riskiest	safest	safe
Prevalence	-0.280	0.041	-0.010	-0.012	0.077	0.009	-0.032	0.012	0.001	0.029	0.000	0.000	-0.021	0.015	0.001	-0.080	0.065	0.010
	[4.34]	[1.83]	[1.01]	[0.34]	[2.67]	[1.11]	[0.50]	[0.90]	[0.63]	[0.71]	[0.15]	[0.34]	[0.86]	[1.53]	[0.49]	[1.73]	[2.84]	[1.27]
wealth	-0.005	0.016	0.005	-0.021	0.026	0.000	0.094	0.005	0.002	0.028	0.000	0.000	0.008	0.001	0.001	-0.005	0.017	0.004
	[0.22]	[1.67]	[1.60]	[1.68]	[1.96]	[0.15]	[3.87]	[1.34]	[1.70]	[1.31]	[0.07]	[0.34]	[0.72]	[0.13]	[0.72]	[0.33]	[2.26]	[1.65]
Read w. diff.	0.052	-0.005	0.003	0.007	0.037	0.007	-0.081	0.021	0.000	-0.009	0.000	0.000	0.005	0.005	0.001	0.026	-0.001	0.002
	[1.40]	[0.35]	[0.37]	[0.39]	[1.44]	[1.13]	[2.14]	[1.13]	[0.20]	[0.32]	[0.85]	[0.77]	[0.26]	[0.50]	[0.52]	[1.11]	[0.07]	[0.48]
Read easily	0.000	0.025	0.009	-0.014	0.068	0.004	0.006	0.031	0.005	-0.014	0.000	0.000	0.008	0.039	0.007	-0.005	0.049	0.013
	[0.00]	[1.89]	[1.60]	[0.99]	[2.14]	[0.84]	[0.21]	[1.99]	[1.49]	[0.49]	[1.23]	[1.27]	[0.64]	[2.07]	[1.44]	[0.23]	[3.08]	[2.95]

Absolute value of z statistics in brackets

Absolute value of z statistics in brackets
read w diff: read with difficulty; cannot read is excluded category

Marginal probabilities from bivariate probit
Dependent variables: Partner during last sexual intercourse: casual partner=1, 0 otherwise; Use of condom: 1=yes, 0 otherwise

Riskiest behavior: casual partner and no condom
Safest behavior: regular partner with condom
Safe behavior: casual partner with condom