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Evidence from a Randomized Controlled Trial on HIV Prevention

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Abstract

Financial incentives are a promising HIV prevention strategy. This paper assesses the effect on HIV incidence of a lottery program in Lesotho with low expected payments but a chance to win a high prize conditional on negative test results for sexually transmitted infections. The intervention resulted in a 21.4 percent reduction in HIV incidence over two years. Lottery incentives appear to be particularly effective for individuals willing to take risks. This paper estimates a model linking sexual behavior to HIV incidence and finds that risk-loving individuals reduce the number of unprotected sexual acts by 0.3/month for every $1 increase in the expected prize.

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Using Lotteries to Incentivize Safer Sexual Behavior: Evidence from a Randomized Controlled Trial on HIV Prevention*

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1 Introduction

In Africa alone, an estimated 1.6 million new HIV infections occurred in 2013, adding to the nearly 25 million people living with HIV on the continent (UNAIDS, 2013). Despite recent progress in antiretroviral treatment coverage, innovative solutions for HIV prevention remain a priority. Traditional behavior change interventions based on information and education campaigns aimed at promoting safer sexual practices have proven less effective than anticipated at stemming the tide of the HIV/AIDS epidemic (Bertrand et al., 2009; Napierala et al., 2010). No randomized controlled trial assessing a behavioral intervention has shown a significant effect on HIV incidence (Padian, et al., 2010). A few recent randomized field trials have explored the use of financial incentives, or conditional cash transfer (CCT) schemes, to incentivize safe sexual behavior by making payments contingent on, for example, testing for HIV, sexually transmitted infection (STI) status, or school enrollment. However, no CCT program has documented reductions in HIV incidence.

In this paper, we examine a financial incentive program – a lottery – with relatively low expected payments but with high prizes conditional on negative STI test results. While the use of lotteries as part of a public health intervention is not unprecedented, including in the area of HIV prevention, this is to our knowledge the first large scale randomized controlled trial to assess its impact as a prevention tool.[1]

Introducing a gamble into an otherwise standard financial incentive program has at least two potential advantages. First, with lotteries the program becomes relatively more attractive to individuals that are willing to take monetary risks. As risky sexual behavior, which is responsible for the vast majority of new HIV infections, also involves a risky gamble, lottery programs may better target those at higher risk of getting infected by HIV. Second, there is growing evidence from psychology and behavioral economics that people tend to overestimate small percentages, and therefore prefer a small chance at a large reward to a small reward for sure (Kahneman and Tversky, 1979, Kahneman, 2011, Barberis, 2013). If so, the perceived return from participating in a gamble (lottery) is higher than the return from an incentive program that pays the expected return with certainty, or likewise lotteries may provide stronger incentives for behavioral change compared to

[1]The HIV screening lottery in the Western Cape province in South Africa is probably the most notable example. The lottery, developed by ideas 42 – a Harvard-affiliated organization set up to develop psychology- and economics-based strategies for social policy – aims at encouraging people to get tested for HIV (Keating, 2013). Another well-known example of the use of lotteries in public health campaigns is the 1957 anti-Tuberculosis campaign in Glasgow. Geffen (2011) reports that intense media coverage and a weekly prize draw resulted in a number of screenings almost three times higher than the initial aim of reaching 250,000 people.

a traditional CCT holding the budget constant.

In the study, 3,029 young adults in rural Lesotho were randomly assigned to a control arm or to either one of two intervention arms eligible to receive a lottery ticket every four months with a chance to win either $50 or $100 conditionally on testing negative on two treatable STIs. The intervention resulted in a 21.4% reduction in HIV incidence, or 3.4 percentage points lower HIV prevalence rate, in the intervention compared to the control group after two years. The reduction came about although the expected per-round value of the lottery was low compared to other conditional cash transfer programs for HIV prevention ($4.9 per lottery round in the pooled intervention group). We also document a large reduction in STI prevalence and show that the significant differences between assignment arms in HIV and STI outcomes remained one year after the lottery program ended.

Using data from the control group, we further show that individuals with preference for risk, based on the perceived value of a risky gamble, were significantly more likely to become infected with HIV over the trial period. Moreover, these risk-loving individuals responded more forcefully to the lottery intervention. In fact we cannot rule out that the observed decrease in HIV incidence in the intervention compared to the control groups was driven solely by the changed behavior of the risk-loving individuals in the intervention groups. Over the two year trial period, we find that HIV negative individuals with preferences for risk ex-ante were as likely as risk-averse individuals to become infected with HIV in the intervention groups, while risk-loving individuals were more than twice as likely as risk-averse individuals to become infected with HIV in the control group.

Furthermore, we estimate a parsimonious model linking sexual behavior to the observed change in HIV incidence. We find that for the group of risk-loving individuals, the intervention reduced the number of unprotected sexual acts with HIV positive partners by as much as 62%, and estimate that risk-loving individuals reduced the number of unprotected sexual acts over a four month period by 1.2 for every $1 increase in the expected prize.

Our paper is related to a growing literature exploring the use of financial incentives to incentivize safer sexual behavior. Thornton (2008) assessed an experiment in Malawi that offered a single cash reward after one year to individuals who remained HIV negative. The intervention had no measurable effect on HIV status. de Walque et al (2012) evaluated a conditional cash grant program in Tanzania where the cash awards ($10 or $20 dollars every 4 months, so about three times higher than the expected payment per testing round in the Lesotho trial) were conditional on negative test results for a set of curable STIs. After one year, the group eligible to the $20 cash transfers showed a sig-

nificant reduction in STI prevalence, while no measurable effect was found in the group eligible for the $10 cash transfer. The study was not powered to measure impact on HIV incidence. Baird et al (2012) evaluated an intervention targeting human capital formation as an alternative HIV prevention strategy in Malawi. They found that a cash transfer of on average $10 per household and month ($40 every 4 months) conditional on school attendance for adolescent girls led to a significant reduction in HIV and herpes (HSV-2) prevalence after 18 months. As HIV status was measured at follow-up and not at baseline, changes in HIV incidence could not be assessed. Duflo, Dupas and Kremer (2014), on the other hand, found no impact (even in the longer run) on HSV-2 infection rate from an education subsidy program in Kenya. An education subsidy combined with HIV prevention education focusing on abstinence until marriage, however, resulted in a significant reduction in HSV-2 infection rate in the intervention compared to the control group.

The remainder of the paper is organized as follows. Details on the study setting, the research design, and the intervention are presented in section 2. Section 3 reports the main results. Section 4 concludes and discusses the implications of our findings. Additional results are reported in appendix.

2 Experimental design and data

2.1 Study setting

Lesotho is a small lower-middle-income country with an estimated population of 2.1 million. Poverty is widespread with 43 percent of the population (in 2003) living on less than $1.25 a day (World Bank, 2014). Lesotho has one of the highest HIV adult prevalence rate in the world (23.3%), with the HIV prevalence rate peaking (40.5%) among individuals aged 30-34 (Ministry of Health and Social Welfare and ICF Macro, 2010). Largely due to the HIV/AIDS epidemic, life expectancy at birth is low even by African standards (48 years).

2.2 Conceptual framework

We designed a financial incentive program – a lottery – with relatively low expected payments but with high prizes conditional on negative STI test results. As sexually transmitted infections (STIs) can be viewed as markers for risky sexual behaviors (Crosby et al, 2003; Fishbein and Pequegnat, 2000), the intervention aimed at modifying the trade-off between the benefit and costs of unprotected sex. If individuals' decisions on sexual be-

havior ignore the health externality of risky sexual behavior, such a transfer program can be justified by the negative externalities generated by a higher number of HIV positive individuals within a society. That is, the (expected) transfer can be viewed as a Pigouvian subsidy aimed at correcting the externality.

The use of lotteries and thus an uncertain return contingent on behavioral change makes lottery incentives different from traditional CCT programs. The expected utility of a lottery with cash prizes depends on individuals' attitude towards monetary risk. If individuals exhibiting risk-loving preferences in monetary gambles are also more risk-loving in other domains, including sexual behavior, lottery incentives may be particularly effective in targeting individuals with the highest risk of HIV/AIDS. Moreover, if people tend to overestimate small percentages, as growing evidence from prospect theory suggests (Kahneman, 2011; Barberis, 2013), the perceived return from participating in a lottery may also be higher than the return from an incentive program that pays the expected return with certainty, or likewise lotteries may provide stronger incentives for behavioral change compared to a traditional CCT holding the budget constant.[2]

2.3 Trial design

The study was a parallel group randomized trial. It had three separate arms – a control arm with an allocation ratio of 40% and two intervention arms (low-value lottery and high-value lottery) with an allocation ratio of 30% each. In the low-value lottery arm individuals were eligible to win lottery prizes worth 500 malotis or approximately $50 every four months. In the high-value lottery arm individuals were eligible to win lottery prizes of twice that amount. Lotteries were organized every fourth month and an individual in the intervention arms was awarded a lottery ticket if he/she tested negative for two curable STIs (syphilis and *trichonomiasis vaginalis*) in the week before the lottery draw. In expected terms, and conditional on being STI negative, the lottery paid $3.3 every four months in the low-value lottery group, $6.6 in the high-value lottery group and $4.9 in the pooled intervention group. In the pooled intervention group, and over the two year trial period, participants were thus eligible to receive approximately $30 in expectation.

Both lottery prizes represent a meaningful proportion of household income in a country where GDP per capita was $2,433 in 2012. The study population were primarily shepherds and self-employed and data from the Lesotho Labor Force Survey (2008) show that monthly earnings in the informal sector were 235 maloti (approximately $23.5) for men

[2]Furthermore, a large, albeit uncertain, payment may be preferable to a lower but certain payment flow if consumers face saving constraints and cannot purchase an indivisible good out of current income.

and 135 maloti (approximately $13.5) for women.

The choice to condition the incentives on syphilis and trichonomiasis status was based on the relatively high prevalence of these two STIs in Lesotho and the fact that they are curable and rapid test technologies are available, practical and affordable. Both STIs have high co-infection rates with HIV (Johnson and Lewis, 2008; Kalichman, Pellowski and Turner, 2011). Conditioning incentives on curable STIs also allowed individuals testing positive at one round to be eligible to win in the following rounds. It also allowed inclusion of HIV positive individuals in the trial, which was deemed important for both ethical and epidemiological reasons. Risk reduction among HIV positive individuals may have higher impact on HIV transmission in the community than that of HIV negative individuals.

The short time interval between lottery rounds was chosen in order to bring the benefits of safe sex closer to the present, which may be important if many individuals have high discount rates or a limited horizon (Oster, 2012).

The primary study outcome was HIV incidence.[3] The trial is registered at ClinicalTrials.gov (NCT01589965). The study protocol was approved by the Ethic Committee of the IRCCS Foundation (June, 2009) and by the Ministry of Health and Social Welfare, Lesotho (August 2009).

2.4 Participation and trial implementation

Inclusion criteria consisted of males and females, aged 18-32 years, residing in 29 rural and peri-urban villages across 5 districts in Lesotho. Both HIV-positive and HIV-negative individuals were eligible to enroll. Participation was voluntary but a variety of channels were used to maximize the interest in the project and boost participation. First, a community liaison officer from the implementing NGO visited each participating community before the beginning of the project to garner support from village leaders. Second, media channels were utilized in the form of radio announcements through the most popular local radio stations. Third, posters advertising the project were put up in visible places to inform about the project. Approximately 40% of the age-eligible population in the targeted villages agreed to participate in the study. In total the various procedures yielded a baseline study sample of 3,427 individuals, of which 3,029 (88.4%) completed baseline interview and tests for syphilis, trichonomiasis and HIV.

[3]HIV incidence is considered to be a more accurate measure than HIV prevalence of the state of the epidemic and of current sexual behaviors (Fishbein and Pequegnat, 1999; and Pettifor et al., 2012). HIV prevalence measures the stock of seropositive individuals and is affected both by HIV incidence – the flow of individuals who become HIV infected – and the mortality rate.

Randomization took place at the study mobile clinics in each village separately after baseline interview and testing, with participants selecting one of 10 colored marbles from an opaque bag containing 4 marbles assigning to the control arm, 3 marbles assigning to the low lottery prize arm and 3 marbles assigning to the high lottery prize arm. This highly transparent procedure was considered necessary for acceptability of randomization in the study population.

Village level lotteries were organized every four months and 4 lottery winners (one male and one female per lottery arm) per village were drawn. Individuals in the intervention arms testing positive for any of the two STIs did not receive a lottery ticket. They could, however, continue as study participants and thus become eligible in subsequent rounds. Individuals in the control arm were not eligible for lottery tickets, but all other study procedures were identical between the control and intervention arms. Anyone testing positive for a STI (regardless of arm) was offered counseling and free STI treatment and individuals testing positive for HIV were referred to public health clinics offering AIDS treatment for appropriate follow-up. Individual pre-test and post-test counseling following Lesotho national guidelines was provided to study enrollees at each testing interval.

Each participant received a small in-kind incentive (candles, matches, and washing powder), worth approximately $3, as a reward for their participation.

2.5 Data and measurement

All participants were tested for HIV, following the Lesotho national testing guidelines, at baseline and months 16, 20 and 24.[4] Participants were tested for syphilis and trichonomiasis at baseline and before each lottery draw.[5]

A baseline and end of trial survey were administered to all participants. The surveys were conducted in private with an enumerator of the same gender as the respondent to mitigate potential reporting biases. The surveys included modules on socioeco-

[4]First line testing was completed using the Determine™ HIV-1/2 rapid test. If the result was negative, the participant was considered HIV negative. If the participant tested positive, he or she was given a second rapid test using the DoubleCheckGold™ HIV 1&2 test. Once the participant received a second, confirmatory test, he or she was considered HIV positive. If, however, the second test was negative after an initial positive result, a third test was done to determine HIV status. The third test used is the Uni-Gold™ Recombigen® HIV. If the third test was positive (negative), the respondent was considered HIV positive (negative).

[5]For syphilis, both male and female participants were tested using the SD BIOLINE Syphilis 3.0 Rapid Blood Test. Male participants were tested for trichonomiasis with the InPouch™ TV manufactured by Biomed Diagnostics. The test provides a system for microscopic identification from urine or genital discharge. Female participants were tested for Trichomonas using the OSOM® Trichomonas Rapid Test, an immunochromatographic assay that detects pathogen antigens directly from vaginal swabs.

nomic characteristics, sexual attitudes and behaviors, and knowledge about HIV/AIDS and other sexually transmitted infections.

To measure preference for risk, we implemented a standard hypothetical risk aversion question in the baseline questionnaire. The question was based on Holt and Laury (2002) and consisted of a set of sub-questions where the respondent could choose between receiving a fixed amount of money for certain or participate in a lottery with 50% chance of winning 500 maloti. Using these data we construct an indicator variable "Risk loving" which takes the value 0 for respondents who preferred a fixed amount of money below the expected value (of 250 maloti) instead of a lottery with 50% chance of winning 500 maloti, and 1 for respondents who needed to be compensated with an amount equal or above (250 maloti) instead of a lottery with 50% chance of winning 500 maloti.

2.6 Power calculations

Power calculations were based on a comparison of HIV incidence between two, equal-sized study arms assuming a two-sided alternative hypothesis. No prior data were available on HIV incidence in the study communities. HIV prevalence data by age group from the 2009 DHS, however, suggested a high incidence rate in the study population (Ministry of Health and Social Welfare and ICF Macro, 2010). According to the 2009 DHS data, HIV prevalence among women was 4.1% in the 15-19 age group and 24.1% in the 20-24 age group, which is consistent with an annual HIV incidence rate of 4.6 percent over five years. HIV prevalence among women in the 25-29 age group was 35.4%, which is consistent with an annual HIV incidence rate of 3.9 percent over 10 years. HIV prevalence among men in the 15-19 age group and the 25-29 age group were 2.9% and 18.4%, respectively. With the assumption of a 4% annual incidence rate in the study population (which is consistent with a 4.6% annual HIV incidence rate for women and a 50% lower rate for men, and a study population with 75% women), a total sample size of 2,500 HIV negative individuals would be sufficient to provide at least 80% power to detect a 26% intervention-related reduction in annual HIV incidence (significant at the 5% level) over two years in each intervention arm.

2.7 Timing

Recruitment and baseline data collection started in February, 2010. The lottery trial was stopped after two years, following the protocol. A follow-up study was implemented one year after the intervention ended (February-May, 2013).

3 Results

Baseline characteristics

Baseline HIV and STI prevalence rates are reported in table 1. At baseline, 16.7% of the study participants tested positive for HIV and 13.5% tested positive for any of the two STIs (syphilis and trichonomiasis).[6] Consistent with data from the most recent DHS survey in Lesotho, the HIV prevalence rate was significantly higher for females (20.4%) than males (8.7%) participants and significantly higher for the older compared to the younger age cohorts.

Baseline characteristics, by assignment group, are presented in table 2.[7] Prevalence rates for HIV, and the two curable STIs, were similar across groups (panel A). The three assignment groups also had similar demographic and socioeconomic characteristics (panel B). Self-reported sexual behavior outcomes (panel C) were also similar on all but two outcomes – self-reported use of a condom during last intercourse (significantly higher at the 10%-level in the pooled intervention vs. control group) and self-reported likelihood that the last partner was HIV infected (significantly higher at the 10%-level in the pooled intervention vs. control group).

The last row in panel C reports average standardized pre-treatment effects of the four sexual behavior measures; i.e., we estimate a seemingly unrelated regression system,

$$Y = [I_K \otimes T]\,\beta + v\,, \tag{1}$$

where Y is a vector of K related sexual behavior outcomes, I_K is a K by K identity matrix, T is a vector of assignment to intervention group(s) indicators, and derive an average standardized pre-treatment effect, $\tilde{\beta} = \frac{1}{K}\sum_{k=1}^{K}\frac{\hat{\beta}_k}{\hat{\sigma}_k}$, where $\hat{\beta}_k$ is the point estimate on the treatment indicator in the k^{th} outcome regression and $\hat{\sigma}_k$ is the standard deviation of the control group for outcome k (see Kling et al., 2004; Duflo et al., 2008). We find no significant difference between assignment groups in this aggregate measure of self-reported sexual behavior ("practice safe sex"). As shown in panel D, among HIV negative individuals at baseline – the main sample for the HIV incidence analysis – all four self-reported

[6] 3.8% of the respondents were tested positive for syphilis while the prevalence of trichomoniasis was 10.4%. To increase precision, we consider the joint measure of syphilis and trichomoniasis prevalence as the main STI outcome.

[7] In expectations, 30% of the sample should have been assigned to the high and low lottery arm, respectively. While the share assigned to the high [low] group is higher [lower] than 0.3, we cannot reject the null hypotheses that the sample comes from a distribution with means 0.3 for each group (results available upon request).

sexual behavior outcomes were also similar across assignment groups.

The attrition rate was low (table 3), with 95.4% (2888 out if 3029) of the participants surveyed and tested in the last round and 94.6% (2,865 out of 3,029) of the participants surveyed and tested in the one-year follow-up round. The attrition rate (5-6%) was similar across the three assignment groups and not predicted by any of the baseline socio-demographic characteristics listed in table 2, panel B, or STI status, except that HIV positive individuals at baseline were more likely to be lost to follow-up (41 of 507 or 8% of HIV positive individuals at baseline were lost to follow up).

STIs as markers for risky sexual behavior

The main objective of the intervention was to incentivize safer sexual behavior as a route to reducing the spread of HIV. The lottery incentives, however, were tied to STI status. Table A1 in appendix reports correlations between STI status and HIV status and self-reported sexual behavior using baseline data. STI-positive individuals were approximately 2.5 times more likely than STI-negative individuals to be HIV positive at baseline (column 1); i.e., there is a strong positive correlation between STI and HIV status. Columns (2)-(6) show that STI-positive individuals were also more likely to be involved in (self-reported) risky sexual behavior. The average standardized effect (Practice safe sex) is significantly negative and precisely estimated, providing evidence in favor of the assumption that prevalence of the two STIs can be viewed as a marker for risky sexual behavior.

Average treatment effects: HIV and STI

To assess the impact of the lottery intervention, we compare mean outcomes after accounting for stratification. That is, we estimate

$$y_{ij} = \alpha + \beta^L T_{ij}^L + \beta^H T_{ij}^H + \eta_j + \varepsilon_{ij} \,, \tag{2}$$

where y_{ij} is a binary variable that for HIV incidence takes the value 1 if the individual i living in village j became HIV infected over the trial period and 0 otherwise and for HIV [STI] prevalence takes the value 1 if the individual was HIV [STI] positive at the end of the trial, and 0 otherwise. T^L and T^H are indicator variables for assignment to the two intervention groups (low and high lottery group, respectively), η_j are village fixed effects, and ε_{ij} is an error term. Standard errors are clustered at the village level. We estimate the effects for the high- and low-value lottery arm and the pooled treatment effect using both OLS and a Probit model. In appendix, we also report odds-ratios and relative risk ratios.

Table 4 describes the impact of the lottery program on HIV incidence - the primary study outcome. Over the two-year trial period, the HIV incidence rate was reduced by

2.5 percentage points, or 21.4% (column 1), leading to a 3.4 percentage points lower HIV prevalence rate at the end of the trial (column 5), in the pooled intervention compared to the control group.[8,9]

Columns (3), (4), and (6) report the effects by intervention group. Relative to the control arm, the HIV incidence rate fell by 3.3 percentage points, or 28%, in the high prize lottery arm, and by half that size, 1.6 percentage points or 14%, in the low prize lottery arm. The point estimates thus suggest that the treatment effects were of the same relative magnitude as the relative values of the prizes in the two lotteries. The HIV incidence rates did not differ significantly between the two intervention arms. However, the difference in HIV incidence between the high price lottery arm and the control group was statistically significant while the difference in HIV incidence between the low price lottery arm and the control group was not.

In appendix, table A4, we report treatment effects by gender. The point estimates for the pooled intervention group and the high value lottery arm were significant in the sample of female participants but insignificant in the sample of male participants. We can reject the equality of treatment effects for female and male participants for the pooled intervention group (F-stat=3.79, p-value=0.06) for HIV incidence, but cannot reject the equality of treatment effects for males and females (F-stat=0.25, p-value=0.62) for HIV prevalence. Overall the differences between male and female participants should be interpreted with caution because the study was not designed to pick up gender specific treatment effects and ex post power calculations show that the study was not powered to detect effects on HIV incidence for men only. Moreover, the female and the male participants differed in other observables, for example in earnings. The difference in earnings by gender might explain the differential result on HIV incidence since lottery prizes are a higher fraction of earnings for women.

Table 5 reports the STI prevalence results. Two results stand out. First, STI prevalence rates have fallen in all three assignment groups. At baseline, 13.5% of the participants were infected by at least one of the two STIs (see table 1). After two years, STI prevalence in the control group is 3.8%.[10] Second, in the intervention groups STI prevalence was essentially zero in both lottery arms (0.2% in the high lottery arm and 0.5% the low lottery arm), implying effect sizes of 89% and 82%, respectively.[11]

[8] Adjusted odds-ratios and relative risk ratios are reported in table A2 in appendix.

[9] To examine potential bias due to non-random attrition, table A3 in appendix reports Lee bounds estimates. The significant effects for the pooled lottery and the high lottery arms remain intact.

[10] This large reduction in STI prevalence in the control group should be viewed through the lens of the trial protocol. Regular screening and free treatment of the two STIs were provided across all three study groups throughout the trial.

[11] Table A5 in the appendix breaks down the STI results by gender. We document large effects for both

Our core sample consists of HIV negative individuals at baseline. However, participation in the project was not conditional on HIV status. Columns (7)-(8) show that the lottery program also affected STI outcomes for the subsample of HIV-positive participants (as measured at baseline). STI prevalence rate among HIV-positive participants in the control group was 11.2% (22/196), while no HIV-positive participant in the intervention arms was tested positive for the two STIs at the end of the trial

Sexual behavior

We document large reductions in HIV incidence and HIV and STI prevalence in the intervention relative to the control groups. What do these results imply for sexual behavior change?

To answer this question, we estimate a parsimonious model linking sexual behavior to the observed change in HIV incidence. We focus on two outcomes: the number of risky sexual acts over the trial period, defined as the number of unprotected acts with a HIV positive partner, and the number of unprotected sexual acts.

Backing out sexual behavior change from a model of HIV incidence has two advantages. First, as HIV incidence is measured using biomarkers, the results are not affected by recall and social desirability biases. Social desirability biases in self-reported data on sexual behavior are a general concern, but especially so when the data are collected within the context of a project involving counseling and testing, as is the case here (Strauss and Thomas, 1998; Powers et al., 2008; and Boily et al., 2009). Second, it may be difficult for respondents to recall information on some outcomes, like number of unprotected sexual encounters with HIV positive partners, simply because the respondents may not know, or at least not perfectly, the status of their sexual partners.

A model linking sexual behavior and HIV incidence

Let k denote the number of risky sexual acts. We assume that k is Poisson distributed in the sample with mean μ and a probability mass function[12]

$$f(k) = \frac{e^{-\mu}\mu^k}{k!}. \tag{3}$$

We further assume that the mean is conditional assignment status; i.e., $\mu = \alpha_0 + \alpha_1 T_1 + \alpha_2 T_2$, where T_j is a binary indicator for intervention group j. Individuals can affect the number of risky sexual acts in several ways, including reducing the number of partners/sexual acts, changing the type of partner, and increasing the use of condoms.

the group of male (significant at the 10%-level) and female participants (significant at the 1%-level).

[12]For a review of the characteristics of the Poisson model for assessing the impact of sexual behavior, see Hu et al. (2011).

Heterosexual transmission is responsible for the vast majority of new HIV infections, particularly in Sub-Saharan Africa. Thus, the probability of not being infected by HIV conditional on k_i risky sexual encounters is $(1-\pi)^{k_i}$, where π is the HIV positive-to-susceptible-partner per-risky act transmission probability. The unconditional probability of not being infected by HIV is therefore

$$p = \sum_{k=0}^{\infty} (1-\pi)^k \frac{e^{-\mu}\mu^k}{k!} \tag{4}$$

Letting $\lambda = (1-\pi)\mu$, we can rewrite equation (4) as

$$p = e^{-\mu+\lambda} \sum_{k=0}^{\infty} e^{-\lambda} \frac{\lambda^k}{k!} = e^{-\mu\pi} \tag{5}$$

where the second equality follows since $\sum_{k=0}^{\infty} e^{-\lambda}\lambda^k/k! = 1$. Using the HIV incidence data and an estimate of π, we can use maximum likelihood to estimate the unknown parameter vector μ in equation (5).[13]

Individuals may not observe, or at least not perfectly, whether their sexual partner is HIV positive or not. One of the strengths with the estimation procedure laid out above is that we can estimate the unobserved average number of risky sexual acts. With an additional assumption on the link between the number of unprotected sexual acts and the risk of becoming infected with HIV, we can also use the model to estimate the reduction in the number of unprotected sexual acts. Specifically, under the assumptions that individuals randomly choose their partners for unprotected sex from the village in which they reside and that HIV status is unobservable, we can use baseline HIV prevalence by village as a proxy measure for the unconditional probability that the partner is HIV positive. That is, the HIV positive-to-susceptible partner per-unprotected sex act transmission probability is $\theta\pi$, where θ is the unconditional probability that a randomly chosen partner is HIV positive and π is as before the HIV positive-to-susceptible partner per-risky act transmission probability.

The estimate of the number of unprotected sexual acts should be viewed with caution. First, the baseline HIV prevalence rate provides a lower bound of θ, even if the individuals choose their partners randomly in the village, since the HIV prevalence rate is increasing over time in our study population. Not taking this into account will lead to

[13] The log-likelihood function is

$$\ln L(\mu) = \sum_{\text{no HIV}} (-\mu\pi) + \sum_{\text{HIV}} \ln(1-\mu\pi)\,.$$

an over-estimation of the number of unprotected sexual acts. Second, while HIV status is not perfectly observable, it might be partly so, and if individuals choose not to have unprotected sex with individuals they know with certainty are HIV-positive then our assumption that individuals randomly choose their partners will lead us to under-estimate the number of unprotected sexual acts. Finally, the assumption that individuals choose partners only from their own village may not be a good approximation. The direction of the bias this will create is, however, unclear.

Estimated sexual behavior change

Table 6 reports the results with π set to $\pi = 0.0128$.[14] The effect of the intervention on the estimated number of risky sexual acts is presented in columns (1)-(2). On average we observed a reduction of two risky sexual acts in the pooled intervention group over the 2 year study period, or a 20% reduction relative to the control group, and 2.7 fewer risky sexual acts in the high lottery arm. The mean number of risky sexual acts in the control group was 9.75 over the trial period.

Columns (4)-(5) report the results for the number of unprotected sexual acts. For the pooled intervention group we estimate a reduction of approximately 11 unprotected sexual acts during the two year study period, with a mean of 59 unprotected sexual acts in the control group. The treatment effect was larger for the high-lottery arm (15.5 fewer unprotected sexual acts as compared to the control group) than for the low-lottery arm (5.4 fewer unprotected sexual acts as compared to the control group), although we cannot reject the equality of these effects (χ^2-stat=1.39, p-value=0.24).

Columns (3) and (6) in table 6 exploit the random variation in prizes; i.e. we estimate

[14]Our preferred estimate of π ($\pi = 0.0128$) is taken from Baeten et al. (2005). Their sample population (from Mombasa, Kenya) looks similar on a number of observable characteristics to our sample from Lesotho (similar age ranges of the participants, low condom use, most study participants are uncircumcised, and similar rate of baseline HIV prevalence rates among prospective partners). Our estimate of the per-act transmission probability π is consistent with the review and meta-analysis in Powers et al. (2008) and Boily et al. (2009). Powers et al. (2008) conclude that in a low-income context where the partner has STI or is uncircumcised, heterosexual infectivity probably exceeds 1%. Boily et al. (2009) estimate lower pooled female-to-male and male-to-female per-act transmission probabilities in a low income setting (0.38% and 0.30%, respectively). These estimates, however, are drawn from studies primarily implemented within the context of interventions involving an important counseling component (use of condoms) and thus do not provide an accurate estimate of the per-risky act transmission probability. Inconsistent use of condoms is positively correlated with infectivity. Hira et al (1997), for example, estimate a 4.7 times higher infection rate among couples who report using condoms less consistently compared to couples who reported using condoms at every intercourse. Adjusting Boily's et al. (2009) pooled number for sex without condoms, would imply an upper-bound per-risky act transmission rates of $\pi = 0.0179$ and $\pi = 0.0141$ (it is an upper-bound because the estimates in Boily et al. (2009) are weighted averages of condom and non-condom based per-act transmission probabilities). Moreover, risk factors that increase the per-act infectivity, and that likely play an important role in Lesotho, such as the presence or history of genital ulcer, usually caused by a sexually transmitted infection, and the low rate of male circumcision, are not properly accounted for in the pooled per-act estimates in Boily et al. (2009).

equation (5) with $\mu = \alpha_0 + \alpha_1 E[prize]$ and where the expected prize is expressed per lottery round. The number of risky sexual acts fell by 0.4 for every $1 increase in the expected prize, while the number of unprotected sexual acts was reduced by approximately 2.4 for every $1 increase in the expected prize per round over the trial period.

As a comparison, table A6 reports treatment effects on self-reported sexual behavior (panel A) and reproductive health outcomes (panel B). The overall effect of treatment (practice safe sex, column 5, panel A) was significantly positive. Quantitatively, the effects were relatively small for two out of the four individual indicators (1.8% reduction in number of partners, 4.3% increase in condom use, 15.9% reduction in sex with partner with high likelihood of HIV, and 29.1% reduction in extramarital sex).

Panel B, table A6, reports the impact of the lottery intervention on pregnancy and births. Women in the pooled intervention group were 22.3% less likely to have given birth in the last four months or be currently pregnant. As pregnancies and births are a result of unprotected sex, the findings are consistent with the results reported in table 6. Columns (7)-(8) disaggregate the sample by whether or not the women live in a long-term relationship (here labeled as married vs. unmarried). Pregnancies among single women are more likely to be unwanted and due to unprotected sex with a non-regular partner. Despite the smaller samples, the results suggest that the effect in the full sample was mainly driven by the sample of single women (a 31% reduction in recent births and pregnancies among single women).

Heterogeneous effects: Preferences for risk

The expected utility of a lottery with cash prizes depends on individuals' attitude towards monetary risk. In this section, we explore whether individuals with preference for risk, based on the perceived value of a risky gamble, are more likely than risk-averse individuals to respond to a prevention scheme with a high but uncertain return conditional on behavioral change.[15] Better understanding of how to strategically target social behavioral programs to groups at higher risk of infection is often raised as a priority by policy makers.[16]

Participants' preferences for risk were measured using a hypothetical risk aversion question in the baseline questionnaire. Summary statistics are provided in table 2. Sixty-two percent of the participants report they would prefer a fixed amount of money below the expected value of a lottery instead of taking part in the lottery (risk-averse), while

[15]Lammers and van Wijnbergen (2007) show, using experimental data from students in South Africa, and the same risk aversion measure as employed in the Lesotho trial, that less risk-averse individuals have higher (self-reported) risk of contracting HIV.

[16]Apart from specific groups (commercial sex workers for example), however, little is known about how to identify and target those at high risk, in particularly in a population at large (UNAIDS, 2013).

38% (risk-loving) report they would need to be compensated with an amount equal to or above the expected value to not choose the gamble.[17]

As individuals that exhibit risk-loving preferences in a monetary gamble may not be risk-loving in other domains, especially when it comes to sexual behavior, we start by investigating whether our measure of risk has bearing on risky sexual behavior. Table A8 in appendix compares risk-loving and risk-averse individuals on observable characteristics at baseline. Risk-averse and risk-loving individuals had similar demographic and socioeconomic characteristics (panel B), but risk-loving participants were less likely to report that they practice safe sex (panel C) and more likely to be HIV positive. The STI prevalence rate was also higher in the group of risk-loving individuals, albeit not significantly so (p-value=0.129).

Table 7 reports on the correlations between risk aversion and risky sexual behavior (HIV incidence and STI prevalence) over the trial period, using data from the control group. Risk-lovers were more than twice as likely to become infected with HIV over the trial period (column 1) and the results continue to hold (column 2) when controlling for the full set of baseline demographic and socioeconomic characteristics (listed in table 2, panel B) and STI status. The risk-loving individuals account for about one-third of the sample. However, they account for almost two-thirds of the new HIV infections in the control group over the two year study period.

Columns (3)-(4) compare STI prevalence rates in the control group between risk-loving and risk-averse respondents. Consistent with the HIV results reported in columns (1)-(2), risk-lovers were significantly more likely than risk-averse individuals to be STI positive in the control group at the end of the trial period.

Do risk-loving individuals respond differently than risk-averse individuals to the lottery program? Table 8 suggests they do.

Table 8, columns (1)-(3), use the full sample and interact the pooled intervention group and risk-lover indicators.[18] Columns (4)-(5) use data for risk-loving individuals only. HIV incidence was 12.3 percentage points higher for risk-loving compared to risk-averse individuals in the control group but essentially the same for risk-loving and risk-averse individuals in the pooled intervention group (column 1). The magnitude of this effect is substantial and corresponds to an effect size of 58-59% in the sub-group of risk-loving individuals (columns 1 and 4). As the treatment effect for risk-averse participants was

[17] 60% of the repondents successfully completed the hypothetical risk aversion question in the baseline questionnaire. Table A7 in appendix reports mean characteristics for the sub-groups successfully completing and not completing the risk aversion question. The means across essentially all baseline characteristics are similar for the two groups.

[18] Table A9 reports the effects by intervention group.

insignificant and the point estimate close to zero, we cannot rule out that the observed decrease in HIV incidence in the pooled intervention compared to the control group was driven solely by the changed behavior of risk-loving individuals. That is, the results suggests that the lottery program lowered HIV incidence in the intervention group by making risk-loving individuals behave similarly to risk-averse individuals.

As risk preferences are not randomly assigned, a concern with the results reported in columns (1) and (4) is that the treatment effects for risk-loving individuals reflect differences in demographic and socioeconomic characteristics across participants, rather than truly stronger response to the lottery incentives for this sub-group. To partly address this concern we added the full set of baseline demographic and socioeconomic characteristics (listed in table 2, panel B) and STI status at baseline in column 2. The point estimate for the interaction effect remains basically unchanged. Column (3) in addition adds interactions between assignment to intervention and all additional covariates. Again the results remain unchanged, suggesting that differences in demographic and socioeconomic characteristics and STI status at baseline did not drive the results reported in column (1).[19]

Similarly, table 9 reports heterogeneous treatment effects on STI prevalence. In both the group of risk-averse and the group of risk-loving individuals we observe large reductions in the prevalence of any of the two STIs in the intervention as compared to the control group. All 645 risk-averse individuals and 383 out of 386 risk-loving individuals (99.2%) in the pooled intervention group were tested STI negative at the end of the project period. In the control group 5.1% (13 out of 256) of the risk-loving individuals and 2.2% (9 out of 406) of the risk-averse individuals were tested STI positive at the end of the trial. For the group of risk-loving individuals this corresponds to a reduction in STI prevalance of 70.6% (table 9, column 4).

Sexual behavior change, based on the estimation of equation (5), is reported in table 10. Risk-lovers in the control group had an average of 18.5 risky sexual acts over the project period (column 1). Risk-loving individuals in the pooled intervention group had an estimated 11.5 fewer risky sexual acts; i.e., a reduction in the number of risky sexual acts of 62%.

The estimated number of unprotected sexual acts is reported in columns (4)-(5). The control group mean for risk-loving individuals was 100.7 unprotected sexual acts over the study period, while the mean in the pooled intervention group was approximately 40 unprotected sexual acts.

The estimate in column (6) implies that an increase in the expected prize by $1 per lot-

[19] All of the additional interaction effects are both individually and jointly insignificant. However, STI-positive status (+), age (+), female (+), and no education (-) are all significant correlates of HIV incidence.

tery round would reduce the number of unprotected sexual acts by 1.2 over a four month period, or by 9.4 unprotected sexual acts over a two year period. Put differently, increasing the expected prize by $1, starting from the control group outcome with $E[prize] = 0$, would reduce the risk of becoming infected with HIV over the trial period by 1.8 percentage points.

Longer run effects

The results reported so far were limited to a 24 months program with recurrent village level lotteries every fourth months, and cannot address the sustainability of the decline of HIV incidence over a longer period, particularly after the lottery program has been discontinued. Nor can the results address the possibility of adverse consequences to the extent that extrinsic incentives may reduce long-term intrinsic motivation to engage in safe sexual behaviors after incentives have been withdrawn. On the other hand, much work on behavior change in Sub-Saharan Africa, or lack thereof, focuses on cultural barriers to changing behavior (e.g., fatalism, low levels of female bargaining power), and it is possible that the financial scheme considered here helps overcome these adverse cultural constraints.

To assess the longer run effects, a follow-up study was implemented one year after the intervention ended. The survey was not announced in advance. In the follow-up study we re-interviewed and re-tested the participants that were screened at the end of the intervention. The main findings are reported in table 11. The significant differences in HIV incidence (column 1), HIV prevalence (column 2), and STI prevalence (column 3) between the pooled intervention group and the control group remained. As the HIV incidence rates were similar across assignment groups in the year following the trial (5.3% in the pooled intervention group and 5.1 in the control group, not reported), and the STI prevalence rate increased by 2.7 percentage points in both assignment groups, there is no evidence of adverse reactions or consequences in the intervention relative the control group, at least based on data one year after the intervention ended.

Columns (4)-(6) show that the heterogeneous treatment effects also remained essentially unchanged, with the HIV prevalence rate for risk-loving individuals being 10.9 percentage points lower in the pooled intervention group relative to the control group, and with HIV prevalence among risk-loving (28.9%) and risk-averse (28.7%) individuals in the intervention group being almost identical.

4 Discussion

The extremely high social and economic cost of the HIV/AIDS epidemic motivates the continued search for innovative prevention approaches. This study is the first rigorous impact evaluation of an intervention aimed at sexual behavior change to show a significant decrease in HIV incidence, the ultimate objective of any HIV prevention intervention (Galárraga et al., 2009; Pettifor et al., 2012). The study shows that financial incentives, when implemented in the form of giving individuals a chance of a high reward conditional on negative results of periodic screenings for incident sexually transmitted infections – an objectively measured marker for risky sexual behavior – can be a powerful tool for HIV prevention.

We are not aware of any large scale randomized trial to assess the impact of these kinds of financial schemes. The use of lotteries as part of a public health intervention is not unprecedented, however, not even in the area of HIV prevention. In South Africa, for example, a growing number of programs for HIV screening use cash lottery prizes to encourage people to get tested, with the HIV screening lottery in the Western Cape Province being the most notable example.

Our study did not have an intervention arm where participants were given the expected value of lottery for certainty conditional on STI status. Thus, we cannot rule out that similar effects would have been achieved with a conditional financial cash transfers program that paid out the expected value instead of a lottery ticket with a chance to win. To the extent that we can learn from comparing similar experiments implemented in other contexts, however, the available evidence suggests that conditional financial incentive programs with certain cash transfers of the same (expected) magnitude do not lead to significant behavioral changes. The RESPECT study in Tanzania (de Walque et al., 2012, 2014) shared a number of similarities to the Lesotho trial, including financial incentives tied to periodic (every four month) screening of STIs, a low and a high financial transfer arm, free STI treatment of all trial participants, and similar inclusion criteria (males and females, aged 18-30 years). The prevalence rates for any of syphilis and trichomonas at baseline were also similar in the two trials (13.8% and 13.5%, respectively).[20] However, the transfers were higher in the Tanzania project – participants were eligible for $10 or $20 per testing round, or $30 or $60 for the trial period, compared to $3.3 or $6.6 in expected terms per testing round, or $20 or $40 for the trial period in the Lesotho project – and participants received the full cash reward for certainty conditional on being STI negative

[20] We are grateful to the RESPECT study team for providing us with summary statistics on baseline and end of trial prevalence of syphilis and trichomonas.

rather than a lottery ticket with a chance to win.[21]

By comparing outcomes across the two trials, we found that the prevalence of any of the two STIs followed the same pattern in the control group over the study periods: the prevalence of any of the two STIs was reduced from 13.8% to 3.6% and 13.5% to 3.8% in the Tanzania and Lesotho trial, respectively. de Walque et al. (2012) further document a significant (27%) reduction in STI prevalence in the Tanzania trial in the group eligible to the high ($20) conditional cash transfer – a transfer over the full trial period twice as large as the expected conditional transfer in the pooled intervention group in the Lesotho trial.[22,23] In the group eligible to the low ($10) conditional cash transfer – a transfer over the full trial period of $30, so essentially the same as the expected conditional transfer in the pooled intervention group in the Lesotho trial – and in the pooled intervention group with a 50% higher expected conditional transfer relative the pooled intervention group in the Lesotho trial – no measurable effects were found in the Tanzania study. As a comparison, and as reported in table 5, STI prevalence was reduced by 84% and 81% in the pooled intervention group and low lottery arm, respectively, in the Lesotho trial, with the largest reduction occuring in the group of risk-loving individuals (see table 9).[24]

The two trials differed also in other dimensions (see footnote 21), and context does matter. The comparison should therefore at best be viewed as suggestive. Taken together, however, the results suggest that the introduction of stochastic rewards do increase the effectiveness of financial incentives as a HIV prevention strategy.

The use of lotteries could plausibly affect the costs and potential scalability of financial

[21]The design of the Lesotho trial was inspired by the RESPECT study. The two trials differed in more dimensions than payment amount and the use of lotteries. In the RESPECT study the financial incentives were tied to test results for chlamydia, gonorrhoea, and trichomonas, while in the Lesotho trial the incentives were tied to test results for syphilis and trichomonas. Study participants in the Tanzania trial were also screened for chlamydia, mycoplasma genitalium, HIV, herpes (HSV-2), and syphilis. All participants in the RESPECT study were invited to participate in a monthly group counseling session, while counseling was provided as part of testing every fourth month in the Lesotho trial. The HIV prevalence rate at baseline was much lower in the Tanzania trial compared to the Lesotho trial (3.5% as compared to 16.7%) and the Tanzania trial was not powered to detect impact on HIV incidence. The Tanzania trial evaluated impact after 12 months rather than 24 months as was done in the Lesotho trial.

[22]As noted in footnote 21, STI prevalence in the RESPECT study was measured as the combined prevalence of any of four STIs. The reduction in the prevalence of syphilis and/or trichomoniasis only, however, broadly mirrors the reduction in the four STIs combined, with an adjusted 28% reduction in the high conditional cash transfer arm relative to the control arm, and no significant reductions in the low conditional cash transfer and combined intervention arms.

[23]PPP adjusted GDP per capita in 2012 was $1,685 in Tanzania and $2,433 in Lesotho, so expressed in GDP per capita terms, the conditional payment in the high intervention group was 116% and 73% higher in the Tanzania trial (0.036) than in the combined lottery arm (0.016) and high prize lottery arm (.206) in the Lesotho trial.

[24]STI prevalence among risk-loving individuals was 0.8% in the pooled intervention group and 5.1% in the control group at the end of the trial as compared to 0% in the pooled intervention group and 2.2% the control group for the sub-sample of risk-averse individuals (see table 9 for details).

incentives programs. For example, the administrative costs of a lottery program are potentially lower compared to a traditional CCT program as only winners need to be paid. While the research and ethical protocol for the study required that all project participants were offered testing, the incentive for behavioral change will, under certain conditions, remain the same if only lottery winners are tested or if STI screening also is subject to a lottery, thus further reducing costs.

Our study has some limitations. The recruitment was based on voluntary enrollment after providing information about the study and the lottery program at the village level. However, by comparing baseline HIV prevalence rates in our sample with HIV prevalence rates from the most recent DHS for Lesotho (Ministry of Health and Social Welfare and ICF Macro, 2010), we found that our sample was not too different from the general population of Lesotho and that, if anything, HIV prevalence was slightly lower at baseline in our study sample than overall in Lesotho, probably because our sample did not include large urban centers such as Maseru, the capital city.[25]

The lottery intervention may have influenced outcomes through non-pecuniary channels. For example, a public lottery event every four months could have highlighted the role of prevention in the community. This channel, though, presumably influenced all study participants, independent of assignment arm. Participation in a lottery may also have yielded direct non-pecuniary rewards, for example by offering participants an element of entertainment or fun. We view this as an additional benefit of using lotteries to incentivize safer sexual behavior.

Identifying ways to increase demand for prevention remains a priority. Our results provide evidence of one complementary tool – lotteries – that may be successfully implemented in various other prevention programs to enhance the demand for safer sexual behavior. The evidence we have presented further suggests that lotteries are particularly able to influence the behavior of individuals with a relatively high ex ante risk of getting infected by HIV.

[25]HIV prevalence according to DHS by age group was: age 15-19: 4.1% for women (2.9% for men); age 20-24: 24.1% (5.9%); age 25-29: 35.4% (18.4%). HIV prevalence at baseline in our sample was: age 18-19: 5.4% for women (1.2% for men); age 20-24: 17.6% (4.2%); age 25-29: 29.1% (15.2%).

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Table 1. Biomarkers: Summary statistics

	HIV positive	STI positive
All	16.7% (507/3029)	13.5% (409/3029)
Female	20.4% (424/2077)	17.1% (356/2077)
Male	8.7% (83/952)	5.6% (53/952)
Age 18-22	8.4% (115/1372)	12.0% (165/1372)
Age 23-27	18.3% (197/1076)	13.9% (150/1076)
Age 28-32	33.6% (195/581)	16.2% (94/581)

Note: Data are n/N (%). Sample of individuals age 18-32 at baseline with complete individual characteristics and biomarker data. HIV positive (HIV prevalence) is equal to 1 if the respondent tested positive for HIV at least twice and 0 otherwise; STI positive (STI prevalence) is equal to 1 if the respondents tested positive for any of the two STIs (syphilis and trichomoniasis).

Table 2. Baseline Characteristics

	Obs.	All	Control (C)	Any lottery (T)	High lottery (T_H)	Low lottery (T_L)	P-value (T=C)	P-value (T_H=C)	P-value (T_L=C)
Panel A: Biomarkers									
HIV positive	3029	0.167	0.176	0.161	0.162	0.160	0.452	0.494	0.467
STI positive	3029	0.135	0.133	0.136	0.137	0.136	0.853	0.837	0.897
Panel B: Household Characteristics									
Female	3029	0.686	0.698	0.678	0.684	0.671	0.395	0.513	0.343
Age	3029	23.45	23.50	23.41	23.33	23.50	0.539	0.339	0.996
Single	3029	0.491	0.481	0.498	0.510	0.484	0.363	0.184	0.896
No education	3029	0.012	0.014	0.010	0.010	0.011	0.416	0.383	0.526
Primary education	3029	0.456	0.456	0.456	0.436	0.478	0.985	0.358	0.298
Some secondary education	3029	0.399	0.383	0.410	0.422	0.396	0.203	0.096	0.610
Durable goods	3029	3 060	3.046	3.069	3.055	3.087	0.669	0.878	0.574
Risk loving	1778	0.379	0.381	0.377	0.379	0.375	0.885	0.964	0.834
Panel C: Sexual behavior									
Extramarital sex last intercourse	1326	0.131	0.143	0.123	0.112	0.134	0.362	0.264	0.706
Condom used last intercourse	1836	0.347	0.323	0.364	0.374	0.352	0.096	0.063	0.325
N. of partners in lifetime	2987	2.149	2.147	2.150	2.091	2.216	0.983	0.719	0.571
High likelihood HIV last partner	1832	0.141	0.120	0.156	0.146	0.167	0.088	0.282	0.064
Practice safe sex				0.008	0.036	-0.020	0.800	0.370	0.548
				(.033)	(.040)	(.033)			
Panel D: Sexual behavior (for HIV negative)									
Extramarital sex last intercourse	1067	0.111	0.126	0.100	0.091	0.111	0.262	0.186	0.545
Condom used last intercourse	1486	0.354	0.333	0.368	0.374	0.360	0.246	0.197	0.462
N. of partners in lifetime	2486	2.042	2.054	2.035	1.986	2.090	0.886	0.679	0.782
High likelihood HIV last partner	1484	0.096	0.079	0.108	0.101	0.116	0.100	0.261	0.074
Practice safe sex				0.013	0.035	-0.013	0.728	0.394	0.748
				(.030)	(.041)	(.040)			

Note: Mean outcomes. Sample of individuals age 18-32 at baseline with complete individual characteristics and biomarker data. Any lottery is high and low lottery combined. The P-values for the null hypothesis that the means are equal are calculated using village-clustered standard errors. "HIV positive" (HIV prevalence) is equal to 1 if the respondent tested positive for HIV at least twice and 0 otherwise; "STI positive" (STI prevalence) is equal to 1 if the respondents tested positive for any of the two STIs (syphilis and trichomoniasis). "Female" is an indicator variable for female participants; "Age" is the age of the participant; "Single" is a indicator variable for singles (incl. divorced and widows); "No education"/"Primary education"/"(At least) some secondary" are indicator variables for educational outcomes; "Durable goods" is an index (0-7) indicating whether the household owned the following items: car, electricity, mobile phone, lamp, radio, fridge, television. “Risk loving” is a binary variable taking the value 0 for respondents who preferred a fixed amount of money below 250 maloti instead of a lottery with 50% chance of winning 500 maloti and 1 for respondents who needed to be compensated with an amount equal or above the expected value (of 250 maloti) instead of a lottery with 50% chance of winning 500 maloti; "Condom used last intercourse" is a indicator variable equal to 1 if the respondent reported using a condom last intercourse, 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "N. of partners" is the number of sexual partners the respondent reported to have, capped at 10; "High likelihood HIV last partner" is a binary variable equal to 1 if the respondent answered "very likely" or "likely" to the question: "What do you think is the likelihood that your last partner was infected with HIV?", 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "Extramarital sex" is a binary variable equal to 1 if the respondent reported that the last sexual intercourse was not with spouse/cohabiting partner (restricted to married or cohabiting individuals reporting to have had sex during the last 4 months). "Practice safe sex" is the average standardized pre-treatment effect of "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime" and "High likelihood HIV last partner", with robust standard errors clustered at the village level in parentheses.

Table 3. Sample sizes

	Full sample		Any lottery		High lottery		Low lottery		Control	
	obs.	share	obs.	share	obs.	share	obs.	share	obs.	share
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Baseline	3029		1821		967		854		1208	
16 months	2829	0.93	1717	0.94	916	0.95	801	0.94	1112	0.92
24 months	2888	0.95	1746	0.96	930	0.96	816	0.96	1142	0.95
36 months	2865	0.95	1735	0.95	921	0.96	814	0.95	1130	0.94

Note: Sample sizes by survey round (baseline, 16 months, 24 months and 36 months). Sample of individuals aged 18-32 at baseline with complete individual characteristics and biomarker data. Any lottery is high and low lottery combined. Share is number of observations at follow-up rounds out of total number of observations at baseline.

Table 4. Effects of the lottery incentive intervention on HIV incidence and prevalence

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.025**	-0.026**			-0.034*	
	(0.010)	(0.010)			(0.018)	
High lottery			-0.033**	-0.035***		-0.041**
			(0.013)	(0.014)		(0.019)
Low lottery			-0.016	-0.016		-0.027
			(0.014)	(0.013)		(0.020)
Mean control group	0.117	0.117	0.117	0.117	0.269	0.269
P-value (T_H=T_L)			0.297	0.253		0.390
Observations	2422	2422	2422	2422	2888	2888

Note: HIV incidence: Sample of HIV negative individuals aged 18-32 at baseline with the dependent variable equal to one if the individual tested HIV positive at least twice after 24 months and zero otherwise. HIV prevalence: Sample of individuals aged 18-32 at baseline with the dependent variable equal to one if the individual tested HIV positive at baseline or least twice after 24 months, and zero otherwise. Any lottery is high and low lottery combined. Probit estimates are marginal effects calculated at the mean. P-value (T_H=T_L) is the p-value for the test that the treatment effects are equal in the high and low lottery arm. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 5. Effects of the lottery incentive intervention on STI prevalence

Sample	All						HIV+ baseline	
	OLS	OLS	Probit	OLS	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any lottery	-0.032***	-0.032***	-0.033***				-0.108***	
	(0.009)	(0.009)	(0.008)				(0.039)	
High lottery				-0.034***	-0.034***	-0.039***		-0.112***
				(0.010)	(0.010)	(0.013)		(0.039)
Low lottery				-0.031***	-0.031***	-0.029***		-0.102**
				(0.010)	(0.009)	(0.009)		(0.038)
Mean control group	0.038	0.038	0.038	0.038	0.038	0.038	0.112	0.112
Control STI status baseline	No	Yes	No	No	Yes	No	No	No
P-value (T_H=T_L)				0.44	0.41	0.49		0.13
Observations	2884	2884	2884	2884	2884	2884	466	466

Note: Sample of individuals aged 18-32 at baseline. The dependent variable (STI prevalence) is equal to one if the individual tested positive for any of the two STIs (syphilis and trichomoniasis) after 24 months and zero otherwise. Any lottery is high and low lottery combined. Probit estimates are marginal effects calculated at the mean. P-value (T_H=T_L) is the p-value for the test that the treatment effects are equal in the high and low lottery arm. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 6 Estimated sexual behavior

	Estimated number of risky sexual acts			Estimated number of unprotected sexual acts		
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-1.97**			-10.85*		
	(0.97)			(5.89)		
High lottery		-2.67**			-15.53**	
		(1.13)			(6.95)	
Low lottery		-1.15			-5.39	
		(1.24)			(7.65)	
Expected prize			-0.41**			-2.37**
			(0.17)			(1.07)
Constant	9.75***	9.75***	9.81***	59.03***	59.03***	59.73***
	(0.89)	(0.89)	(0.82)	(5.85)	(5.85)	(5.69)
Observations	2422	2422	2422	2422	2422	2422

Note: Sample of HIV negative individuals aged 18-32 at baseline. See main text for details. Any lottery is high and low lottery combined. The expected price for individuals in the control group (low lottery price group) [high lottery price group] is 0 ($3.3) [$6.6]. Maximum likelihood estimates, with robust standard errors clustered at the village level in parentheses. *** 1% , ** 5% , * 10% significance.

Table 7. Correlation between risk measure and risky sexual behavior

	HIV incidence		STI prevalence	
	(1)	(2)	(3)	(4)
Risk-loving	0.139***	0.119***	0.037***	0.034**
	(0.038)	(0.035)	(0.013)	(0.014)
Mean risk averse	0.095	0.095	0.022	0.022
Baseline controls	No	Yes	No	Yes
Observations	555	555	662	662

Note: Sample of control group individuals aged 18-32 at baseline who responded to the hypothetical risk aversion question. See notes to tables 4 and 5 for definitions of HIV incidence and STI prevalance. Risk-loving is an indicator variable taking the value 1 for respondents who, at baseline, prefered a fixed amount of money equal or above 250 maloti instead of a lottery with 50% chance of winning 500 maloti, and 0 for respondents who prefered a fixed amount of money below 250 maloti instead of a lottery with 50% chance of winning 500 maloti. The control variables are STI status at baseline and all household characteristics listed in panel B, table 2. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 8. Heterogeneous treatment effects - HIV incidence: Risk preferences

Sample	Panel A: All			Panel B: Risk-lovers	
	(1)	(2)	(3)	(4)	(5)
Any lottery×Risk-loving	-0.122***	-0.107**	-0.100**		
	(0.042)	(0.039)	(0.039)		
Risk-loving	0.123***	0.111***	0.104		
	(0.033)	(0.032)	(0.031)		
Any lottery	-0.003	-0.005	0.223	-0.124***	-0.114***
	(0.018)	(0.018)	(0.141)	(0.036)	(0.033)
Mean control group	0.139	0.139	0.139	0.211	0.211
Baseline controls	No	Yes	Yes	No	Yes
Full set of control×treatment covariates	No	No	Yes	-	-
Observations	1420	1420	1420	525	525

Note: Sample of individuals aged 18-32 at baseline who responded to the hypothetical risk aversion question. Panel A: Full sample. Panel B: Risk-loving individuals. See notes to table 4 for the definition HIV incidence. Risk-loving is an indicator variable taking the value 1 for respondents who, at baseline, prefered a fixed amount of money equal or above 250 maloti instead of a lottery with 50% chance of winning 500 maloti, and 0 for respondents who prefered a fixed amount of money below 250 maloti instead of a lottery with 50% chance of winning 500 maloti. Any lottery is high and low lottery combined. The control variables are STI status at baseline and all household characteristics listed in panel B, table 2. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 9. Heterogeneous treatment effects - STI prevalence: Risk preferences

	Panel A: All			Panel B: Risk-loving	
	(1)	(2)	(3)	(4)	(5)
Any lottery×Risk-loving	-0.021*	-0.019	-0.017		
	(0.012)	(0.012)	(0.013)		
Risk-loving	0.031	0.030**	0.028**		
	(0.011)	(0.012)	(0.012)		
Any lottery	-0.020*	-0.021**	0.005	-0.036***	-0.037***
	(0.010)	(0.010)	(0.053)	(0.012)	(0.013)
Mean control group	0.033	0.033	0.033	0.051	0.051
Baseline controls	No	Yes	Yes	No	Yes
Full set of control×treatment covariates	No	No	Yes	-	-
Observations	1693	1693	1693	642	642

Note: Sample of individuals aged 18-32 at baseline who responded to the hypothetical risk aversion question. Panel A: Full sample. Panel B: Risk-loving individuals. See notes to table 5 for the definition of the dependent variable. Risk-loving is an indicator variable taking the value 1 for respondents who, at baseline, prefered a fixed amount of money equal or above 250 maloti instead of a lottery with 50% chance of winning 500 maloti, and 0 for respondents who prefered a fixed amount of money below 250 maloti instead of a lottery with 50% chance of winning 500 maloti. Any lottery is high and low lottery combined. The control variables are STI status at baseline and all household characteristics listed in panel B, table 2. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 10. Heterogeneous treatment effects - sexual behavior: Risk lovers

	Estimated number of risky sexual acts			Estimated number of unprotected sexual acts		
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-11.49***			-60.63***		
	(3.43)			(19.85)		
High lottery		-12.29***			-66.32***	
		(3.84)			(21.91)	
Low lottery		-10.54***			-53.36***	
		(3.61)			(21.37)	
Expected prize			-1.69***			-9.35***
			(0.52)			(3.00)
Constant	18.47***	18.47***	16.70***	100.72***	100.72***	93.14***
	(2.77)	(2.77)	(2.24)	(17.24)	(17.24)	(14.09)
Observations	525	525	525	525	525	525

Note: Sample of risk-loving individuals aged 18-32 at baseline. See notes to table 6 for details. Maximum likelihood estimates, with robust standard errors clustered at the village level in parentheses (see section 5.4 for details). *** 1% , ** 5% , * 10% significance.

Table 11. Effects of the lottery incentive intervention one year after the intervention ended

Dep variable	HIV incidence	HIV prevalence	STI prevalence	HIV incidence	HIV prevalence	STI prevalence
Years	2011-2013	2011-2013	2011-2013	2011-2013	2011-2013	2011-2013
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.029**	-0.038**	-0.031**	0.006	0.003	-0.039**
	(0.012)	(0.019)	(0.012)	(0.021)	(0.027)	(0.016)
Any lottery×Risk-loving				-0.132***	-0.112**	-0.018
				(0.047)	(0.049)	(0.028)
Risk-loving				0.116	0.098	0.014
				(0.036)	(0.034)	(0.024)
Mean control group	0.171	0.320	0.065	0.187	0.187	0.070
Observations	2317	2783	2745	1364	1639	1618

Note: OLS regressions. Sample of individuals aged 18-32 at baseline and tested at 24 and 36 months. Columns (1) and (4): Dependent variable equal to one if the individual tested HIV positive at least twice after 36 months, and tested HIV negative at baseline, zero if the individual tested HIV negative at baseline and after 36 months. Columns (2) and (5): Dependent variable equal to one if the individual tested HIV positive at baseline or after 36 months, and zero otherwise. Columns (3) and (6): Dependent variable is equal to one if the individual tested positive for any of the two STIs (syphilis and trichomoniasis) after 36 months, and zero otherwise. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Appendix

Table A1. STI as marker for risky sexual behavior and HIV

	HIV prevalence	Extramarital sex last intercourse	Condom used last intercourse	N. of partners in lifetime	High likelihood HIV last partner	Practice safe sex
	(1)	(2)	(3)	(4)	(5)	(6)
STI positive at baseline	0.205***	0.038	- 0.063**	0.161	0.085***	-0.143***
	(0.029)	(0.030)	(0.030)	(0.137)	(0.024)	(0.033)
Mean: STI negative- at baseline	0.139	0.125	0.355	2.124	0.126	
Observations	3029	1326	1836	2987	1832	3021

Note: Baseline data. See table 2 for definitions of the variables. Point estimate and standard error in column (1) is from an OLS model. Point estimates and standard errors in columns (2)-(5) are derived from a seemingly unrelated regression system. "Practice safe sex" is the average standardized difference between STI+ and STI- individuals in "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime" and "High likelihood HIV last partner". Robust standard errors clustered at the village level in parentheses. *** 1% , ** 5% , * 10% significance.

Table A2. Effects of the lottery incentive intervention on HIV incidence: Adjusted OR and RR

	Intervention group	Control group	Adjusted OR (95% CI)	Adjusted relative risk (95% CI)
Combined intervention group				
HIV incidence	140/1476 (9.5%)	111/946 (11.7%)	0.76 (0.61-0.95)	0.79 (0.65-0.96)
High lottery arm				
HIV incidence	68/785 (8.7%)	111/946 (11.7%)	0.69 (0.51-0.93)	0.72 (0.55-0.94)
Low lottery arm				
HIV incidence	72/691 (10.4%)	111/946 (11.7%)	0.87 (0.66-1.15)	0.89 (0.70-1.13)

Note: Data are n/N (%) at 24 months. Confidence intervals are constructed using robust standard errors clustered at the village level. Adjusted odds ratios (OR) calculated with a logistic regression model of individual data with independent variables that include treatment status and indicators for geographical area (villages). Adjusted relative risks (RR) is estimated using the marginal standardization technique with the 95% CIs estimated with the delta method (Norton et al, 2013).

Table A3. Lee bounds: HIV incidence

	(1)	(2)
Any lottery l. bound	-0.038***	
	(0.013)	
Any lottery h. bound	-0.021*	
	(0.013)	
High lottery l. bound		-0.048***
		(0.017)
High lottery h. bound		-0.029**
		(0.015)
Low lottery l. bound		-0.025
		(0.018)
Low lottery h. bound		-0.012
		(0.016)

Note: Sample of HIV negative individuals aged 18-32 at baseline with the dependent variable equal to one if the individual tested HIV positive at least twice after 24 months and zero otherwise. Any lottery is high and low lottery combined. Lee bounds (upper and lower) are bounds on the coefficients in table 4 using the procedure proposed by Lee (2009). Standard errors in parentheses are bootstrapped and account for village level clustering. *** 1% , ** 5% , * 10% significance.

Table A4. Effects of the lottery incentive intervention on HIV incidence and prevalence by gender

Panel A: Women

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.037***	-0.038***			-0.038**	
	(0.013)	(0.013)			(0.017)	
High lottery			-0.045***	-0.048***		-0.041*
			(0.016)	(0.017)		(0.022)
Low lottery			-0.027	-0.027		-0.034
			(0.020)	(0.019)		(0.021)
Mean control group	0.153	0.153	0.153	0.153	0.326	0.326
P-value (T_H=T_L)			0.437	0.396		0.785
Observations	1592	1592	1592	1592	1985	1985

Panel B: Men

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.003	-0.003			-0.031	
	(0.014)	0.018			(0.030)	
High lottery			-0.009	-0.013		-0.045
			(0.015)	(0.021)		(0.034)
Low lottery			0.003	0.007		-0.015
			(0.019)	(0.023)		(0.032)
Mean control group	0.045	0.045	0.045	0.045	0.137	0.137
P-value (T_H=T_L)			0.516	0.455		0.262
Observations	830	635	830	635	903	903

Note: See note to table 4. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table A5. Effects of the lottery incentive intervention on STI prevalence

Panel A: Women				
	(1)	(2)	(4)	(5)
Any lottery	-0.040***	-0.039***		
	(0.013)	(0.013)		
High lottery			-0.043***	-0.042***
			(0.013)	(0.013)
Low lottery			-0.036***	-0.036***
			(0.013)	(0.013)
Mean control group	0.046	0.046	0.046	0.046
Control STI status baseline	No	Yes	No	Yes
P-value (T_H=T_L)			0.18	0.18
Observations	1982	1982	1982	1982
Panel B: Men				
	(1)	(2)	(4)	(5)
Any lottery	-0.013*	-0.014*		
	(0.007)	(0.007)		
High lottery			-0.011	-0.012
			(0.008)	(0.008)
Low lottery			-0.016**	-0.016**
			(0.007)	(0.007)
Mean control group	0.017	0.017	0.017	0.017
Control STI status baseline	No	Yes	No	Yes
P-value (T_H=T_L)			0.20	0.30
Observations	902	902	902	902

Note: See note to table 5. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table A6. Self-reported sexual behavior and reproductive health outcomes

Panel A: Sexual behavior

	Number of partners last 4 months	Condom used last intercourse	High likelihood HIV last partner	Extramarital sex last intercourse	Practice safe sex
	(1)	(2)	(3)	(4)	(5)
Any lottery	-0.020	0.021	-0.014	-0.030	0.051**
	(0.031)	(0.025)	(0.015)	(0.021)	(0.021)
Mean control group	1.115	0.485	0.088	0.103	
Observations	2707	1667	1775	1300	2920

Panel B: Reproductive health

	Birth or current pregnancy		
Sample	All	Unmarried	Married
	(6)	(7)	(8)
Any lottery	0.056**	0.069**	-0.047
	(0.022)	(0.035)	(0.030)
Mean control group	0.251	0.220	0.272
Observations	1652	644	1008

Note: Sample of individuals aged 18-32 at baseline. Panel A: Point estimates, standard errors, and average standardized effect are derived from a seemingly unrelated regression system of the variables in columns 1-4. "Number of partners last 4 months" is the number of sexual partners the respondent reported to have during the last 4 months; "Condom used last intercourse" is a indicator variable equal to 1 if the respondent reported using a condom last intercourse, 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "High Likelihood last partner HIV+" is a indicator variable equal to 1 if the respondent answered "very likely" or "likely" to the question: "What do you think is the likelihood that your last partner was infected with HIV?", 0 otherwise (restricted to those that reported to have had sex during the last 4 months) ; "Extramarital sex" is a binary variable equal to 1 if the respondent reported that the last sexual intercourse was not with spouse/cohabiting partner (restricted to married or cohabiting individuals reporting to have had sex during the last four months). "Practice safe sex" is the average standardized effect of the four estimates in panel A, reversing the sign of "Number of partners last 4 months", "High likelihood last partner HIV+", and "Extramarital sex". Panel B: OLS regressions. "Births or current pregnancy" is an indicator variable for whether the women had given birth in the last 4 months or was currently pregnant. Any lottery is high and low lottery combined. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table A7. Baseline characteristics for respondents and non-respondents to hypothetical risk aversion question

	Respondents to the question on risk	Non-respondents to the question on risk	Difference	P-value
Panel A: Treatment assignment				
Any lottery	0.607	0.593	0.014	0.414
High lottery	0.322	0.316	0.006	0.756
Low lottery	0.285	0.277	0.008	0.603
Panel B: Biomarkers				
HIV positive	0.168	0.167	0.001	0.967
STI positive	0.149	0.115	0.034	0.016
Panel C: Household Characteristics				
Female	0.680	0.694	-0.014	0.490
Age	23.41	23.50	-0.090	0.549
Single	0.487	0.497	-0.010	0.617
No education	0.012	0.012	0.000	0.966
Primary education	0.460	0.451	0.009	0.585
Some secondary education	0.400	0.398	0.002	0.908
Durable goods	3.024	3.112	-0.088	0.220
Panel D: Sexual behavior				
Extramarital sex last intercourse	0.136	0.124	0.012	0.556
Condom used last intercourse	0.367	0.320	0.047	0.075
N. of partners in lifetime	2.145	2.154	-0.009	0.923
High likelihood HIV last partner	0.153	0.125	0.028	0.208
Practice safe sex (difference)			-0.004	0.826
			(0.031)	

Note: Mean outcomes at baseline for the respondents and the non-respondents to the hypothetical risk aversion question. The P-values for the null hypothesis that the means are equal are calculated using village-clustered standard errors. *** 1%, ** 5% , * 10% significance. See table 2 for variables' definition. "Practice safe sex" is the average standardized difference between respondents and non-respondents in "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime", and "High likelihood HIV last partner".

Table A8. Baseline characteristics of the risk loving vs risk-averse participants

	Risk lover	Risk averse	Difference	P-value
Panel A: Biomarkers				
HIV positive	0.190	0.154	0.036	0.058
STI positive	0.168	0.138	0.030	0.129
Panel B: Household Characteristics				
Female	0.695	0.671	0.024	0.372
Age	23.63	23.28	0.350	0.038
Single	0.484	0.488	-0.004	0.918
No education	0.013	0.011	0.002	0.654
Primary education	0.443	0.470	-0.027	0.249
Some secondary education	0.398	0.401	-0.003	0.933
Durable goods	3.114	2.969	0.145	0.015
Panel C: Sexual behavior				
Extramarital sex last intercourse	0.154	0.125	0.029	0.444
Condom used last intercourse	0.407	0.342	0.065	0.017
N. of partners in lifetime	2.449	1.958	0.491	0.000
High likelihood HIV last partner	0.172	0.141	0.031	0.311
Practice safe sex (difference)			-0.077	0.032
			(0.041)	

Note: Sample of individuals aged 18-32 at baseline who responded to the hypothetical risk aversion question. Mean outcomes for the sample of risk loving and risk-averse individuals. An individual is labelled risk-loving if the respondents, at baseline, preferred a fixed amount of money equal or above 250 maloti instead of a lottery with 50% chance of winning 500 maloti. An individual is labelled risk-averse if the respondents, at baseline, preferred a fixed amount of money less than 250 maloti instead of a lottery with 50% chance of winning 500 maloti. The P-values for the null hypothesis that the means are equal are calculated using village-clustered standard errors. *** 1%, ** 5% , * 10% significance. See table 2 for variables' definition. "Practice safe sex" is the average standardized difference between risk-loving and risk-averse individuals in "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime", and "High likelihood HIV last partner".

Table A9: Heterogeneous treatment effects by assignment group

	HIV incidence		STI prevalence	
	(1)	(2)	(3)	(4)
High lottery×Risk-loving	-0.117**	-0.105**	-0.023*	-0.022
	(0.047)	(0.045)	(0.013)	(0.013)
Low lottery×Risk-loving	-0.127**	-0.108**	-0.018	-0.016
	(0.047)	(0.044)	(0.013)	(0.013)
Risk-loving	0.123***	0.111***	0.031**	0.030**
	(0.033)	(0.032)	(0.011)	(0.012)
High lottery	-0.015	-0.015	-0.020*	-0.020**
	(0.022)	(0.023)	(0.010)	(0.010)
Low lottery	0.011	0.007	-0.020*	-0.020**
	(0.025)	(0.024)	(0.010)	(0.010)
Mean control group	0.013	0.013	0.046	0.046
Baseline controls	No	Yes	No	Yes
Observations	1420	1420	1693	1693

Note: See notes to tables 8 and 9. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.