HOW BELIEFS ABOUT HIV STATUS AFFECT RISKY BEHAVIORS: EVIDENCE FROM MALAWI*

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This paper examines how beliefs about own HIV status affect sexual behavior. Risky behavior is measured as the propensity to engage in extramarital affairs or not use condoms. The empirical analysis is based on 2004 and 2006 data from the Malawi Diffusion and Ideational Change Project. Controlling for endogeneity between beliefs and risk-taking, we find that downward revisions in the belief of being HIV positive lead to a lower propensity to engage in extramarital affairs but have no effect on condom use. We show that the estimates provide a lower bound when there is measurement error in reported extra-marital affairs.

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1 Introduction

The AIDS epidemic has significantly curtailed the average lifespan in many developing countries. Although there has been progress over the last decade in combatting the spread of HIV in more advanced and middle income countries, the disease continues to impose a large toll on poorer populations, particularly in Africa. In 2005, out of forty million infected worldwide, twenty-six million resided in Sub-Saharan Africa. The disease prevalence there was as high as 7.2% among 15 to 49 year-olds (see Canning [2006]).

One of the challenges in combatting the spread of HIV in Africa is that there are large populations living in rural areas with relatively high HIV prevalence but with few opportunities for testing and treatment. In recent years, a variety of government and nongovernmental organizations increased access to testing and treatment services as well as take-up of these services though advertising campaigns and establishment of more and better equipped health clinics. HIV prevention efforts have focused on educational campaigns and condom distribution programs. It is hoped that informing individuals about their own HIV status and about methods of avoiding transmission will lead them to take less risky behaviors, although the quantitative evidence on behavioral responses is limited.

The goal of this paper is to study behavioral responses to changes in beliefs about HIV using a unique panel survey called the Malawi Diffusion and Ideational Change Project (MDICP) dataset. The MDICP sample covers rural populations from three different regions in Malawi, where the HIV prevalence rate is approximately 7%. Individuals in the MDICP sample had very limited opportunities to get tested for HIV prior to 2004 when the MDICP project team visited their villages and offered testing services. When given the opportunity, some individuals got tested and others did not. In HIV testing settings, it is common that a significant proportion of individuals who get tested never pick up their results. For this reason, the MDICP project also carried out an experiment that provided randomized incentives for the individuals who got tested to pick up their results. The incentive amounts varied across individuals, ranging from no incentives to incentives of 300 Kwachas, which is roughly equivalent to a few days' wage that a laborer would earn. The data generated by the randomized experiment were previously analyzed by Thornton (2008) who showed that the incentives were a powerful inducement to pick up results.

The notion that individuals change their behavior in response to changes in the prevalence and/or risk of infection posed by communicable diseases is generally well accepted and there is a theoretical literature in economics that explores the general equilibrium implications of this type of behavioral response. An early example is Kremer (1996), who presents a model where behavior is allowed to vary with prevalence.[1] In the model, the probability of infection is a function of the number of partners, the transmission rate and the disease prevalence. Kremer shows that those with relatively few partners respond to higher prevalence levels by reducing their sexual activity, because higher prevalence makes the marginal partner more "expensive." Interestingly, Kremer's model leads to a fatalistic behavior for those with a sufficiently high initial number of partners.[2] Philipson (2000) surveys other theoretical frameworks of how behavior responds to disease prevalence. These include models of assortative matching (HIV-positives matching with HIV-positives and HIV-negatives with HIV negatives), which are shown to have a dampening effect on the spread of the disease (Dow and Philipson [1996]); models that relate prevalence rates and the demand for vaccination; models for the optimal timing of public health interventions in the presence of elastic behavior; and, of particular interest to the present study, modeling frameworks for studying the implications of information acquisition (testing) for asymptomatic diseases such as HIV (more on this in section two). Mechoulan (2004) is another recent theoretical study that examines how testing could lead to increased sexual behavior of selfish individuals that turn out to be HIV-positive. He shows

[1] Classic models of disease spread typically do not allow prevalence to affect behavior, which is encoded by a contact parameter.

[2] For those individuals, an increase in prevalence may reduce the probability of infection from the marginal partner (even though the risk of contagion from the first few partners increases), leading to an increase in the optimal number of partners.

that without a sufficient fraction of altruistic individuals, testing can increase disease incidence.[3] In section three of this paper, we develop a two-period model of choices about risky behavior where testing can conceivably lead to more risk-taking; however, our empirical work finds this channel to be quantitatively less important.

Despite the growing theoretical literature, it has proven difficult to empirically establish a relationship between sexual behavior and disease prevalence. For example, Oster (2007) finds little evidence that sexual behavior responds to HIV prevalence in Africa, in line with earlier reported findings in Philipson and Posner (1995) for the United States. However, Oster does find some evidence that behavior responds to disease prevalence among the subgroups of richer individuals and those with higher life expectancies. A recent paper by Lakdawalla, Sood and Goldman (2007) studies the effect of the introduction of Highly Active Anti-Retroviral Treatment (HAART) drugs on the propensity of individuals to engage in risky behavior. They show that the HIV treatment could either increase or decrease risky behavior by uninfected individuals, because it decreases the costs of infection but also increases the risk of exposure by increasing the number of infected survivors. The authors find a net positive effect of HAART drugs on transmissive behavior.[4] Another branch of the empirical literature that is more related in scope to the current paper examines how HIV testing changes beliefs about infection and modifies risk-taking behavior. Section two discusses that branch of the literature in greater detail.

This paper studies the relationship between individual's beliefs about their own (and their spouse's) HIV status and risk-taking behaviors in an environment where beliefs are changing significantly over time, in part because of newly available HIV testing services. Specifically, we study how changes in beliefs about own HIV status affect the propensity to engage in extra-marital affairs or to use condoms for a sample

[3]This phenomenon is sometimes referred in this literature as the Philipson-Posner conjecture (see Philipson and Posner [1993]).

[4]The penetration of HAART drugs in Malawi was very small until 2003 at least, when only an estimated 4000 people were taking antiretroviral drugs (out of 170,000 in need) and increased to about 30,000 by 2005 but still much below what was needed according to WHO and UNAIDS estimates (see Harries *et al.* [2004] and `http://www.who.int/hiv/HIVCP_MWI.pdf`).

of married males in Malawi.[5] For some of our specifications we also include changes in beliefs about a spouse's status as an individual's behavior may also be affected by those. Those beliefs tend to correlate strongly with one's perception about own HIV status. In our sample, concurrent sexual partnerships are fairly common and about 15% of the men are polygamous. Our analysis combines the 2004 and 2006 MDICP panel surveys along with data gathered during the randomized experiment (described previously) that provided incentives to pick up HIV test results. The 2004 MDICP panel was collected before the testing was made available and the 2006 panel was collected two years after. Individuals in both the 2004 and 2006 rounds of the survey were asked about their beliefs about their own (and their spouse's) HIV status. Most individuals who participated in the testing and picked up their results learned that they were HIV negative.

An interesting aspect of the data is that beliefs do not always correlate with test results. Some individuals who receive a positive test result in 2004 report in 2006 that they are highly unlikely to be positive, which suggests that they may not believe the test result. HIV positive individuals are typically asymptomatic for many years and therefore may not believe that they carry the disease (especially those in more traditional societies). There is also anecdotal evidence for some skepticism about the quality of the tests at the time, which may have been exacerbated by the delay in the results availability (one or more months).[6] As shown in Table I, the majority of individuals who are tested positive in 2004 attach a zero probability of being HIV positive two years later. There are also some individuals who test negatively in 2004 but assign a high probability to being positive in 2006. This may be due to disbelief in the test results or may reflect risky behavior in the interim between survey rounds. HIV testing programs can only be effective in modifying behavior insofar as they

[5] A very small fraction of females report extra-marital affairs. Our estimates for females display no statistically significant relation between beliefs and transmissive behavior. Rare events are nevertheless known to generate biases in small samples and this may explain those results. Because of this we restrict our sample to males only.

[6] In 2004, the MDICP team used oral cotton swab tests. In 2006, rapid blood tests were adopted, which eliminated the time delay between the time of testing and receiving results.

affect beliefs about infection. This paper considers how HIV testing affects beliefs and how beliefs affect behavior.

The paper is organized as follows. Section two describes the existing empirical literature on the relationship between beliefs about HIV, testing, and risky behaviors. Section three presents a simple two period model for exploring the determinants of risky behavior. The model illustrates that the net effect of changing beliefs on the risk-taking is theoretically ambiguous, so whether beliefs affect behavior and to what extent is an empirical question. Section four presents our empirical framework for estimating the causal effect of beliefs about own HIV status on risk-taking behaviors in a way that takes into account the potential for endogeneity of beliefs. Section five describes the empirical findings, which indicate that beliefs about own HIV status affect the propensity to engage in extra-marital affairs but have no causal effect on condom usage. Individuals in the survey were also asked directly about whether they changed their behaviors in response to the testing program and their responses are consistent with the results obtained from the estimation. That is, a large fraction respond that they changed their behavior to only have sex with their spouse but only a very small proportion reporting changing their use of condoms. Section five also considers the problem of measurement error in reported extra-marital affairs, where the measurement error is potentially nonclassical and non-mean-zero (e.g. underreporting of affairs). In that case, the estimates obtained previously provide a lower bound. Section six concludes and discusses directions for future research.

2 Related Literature

The empirical literature on how HIV testing effects on risk-taking in developing countries is fairly nascent, in part because the data needed to address this question have only recently become available. Employing a subset of the MDICP data, Thornton (2008) investigates the impact of learning HIV test results on condom purchases and on the number of sexual partners, which she measures through a special survey administered two months after the testing took place. Her analysis focuses on individuals who expressed interest in HIV testing and makes use of exogenous variation introduced by the randomized incentives to pick up test results. She reports that individuals who were informed of a positive HIV test result increased condom purchases with no change observed for individuals receiving a negative test results. She finds no impact of testing on sexual behavior. Additionally, Thornton finds that individuals who tested negative generally revised their subjective beliefs about being positive downward and that those who tested positive did not significantly revise their beliefs.

Our study uses a larger data sample from the same MDICP database that includes the sample that participated in the randomized incentives experiment as well as nonparticipants. We make use of an additional survey round gathered two years after the testing took place, in 2006. We find that individuals who revise their beliefs on own positive status downward between the survey years reduce their sexual activity but do not modify their usage of condoms. Our findings on sexual activity differ from those of Thorton (2008). The difference is likely attributable to the longer time between surveys, as more changes in sexual behavior would likely be observed over a two-year time period after the testing than over a two month time period. Our results are in line with findings reported in Coates *et al.* (2000), who document significant reductions in sexual activity among those who tested negative for HIV using randomized trials in Kenya, Tanzania and Trinidad. Coates and co-authors also find reductions in sexual activity among HIV-positive individuals, though their subsample of seropositive individuals is small[7] (see also Kamega *et al.* [1991] reporting increased caution after testing).

Another paper examining the relationship between beliefs about HIV status, testing and risky behavior is Boozer and Philipson (2000), which analyzes data from

[7]As noted by Thornton (2008), the individuals in the Coates et al. (2000) study were a self-selected group participating in HIV testing.

the San Francisco Home Health Study. Our identification strategy for estimating the effects of changes in beliefs on behavior is similar to Boozer and Philipson's in that we make use of belief information gathered in two different time periods, before and after HIV testing. In the SFHHS survey all individuals who were unaware of their status (around 70%) were tested immediately after the first wave of interviews and learned their status. Boozer and Philipson use those who already knew their status, the remaining 30%, as a control group. They find that belief revisions towards a lower probability of a positive status increase sexual activity; that is, individuals who considered themselves highly likely to be infected and discover they are not increase the number of partners and those who believe themselves to be relatively unlikely to be infected and discover otherwise reduce their number of partners.[8] In contrast, we observe that a downward revision in the subjective probability of being positive decreases risk-taking. The population we study consists of married couples in Subsaharan African, for which behavioral responses are potentially much different from those in the predominantly homosexual San Francisco population that Boozer and Philipson analyze. Furthermore, we instrument for belief change whereas Boozer and Philipson rely on a differences-in-differences strategy without instrumenting.

Other papers in the epidemiology literature using American data find little or mixed evidence of behavioral response to HIV testing (See, for example, Higgins *et al.* [1991], Ickovics *et al.* [1994], Wenger *et al.* [1991] and Wenger *et al.* [1992].) An exception is Weinhardt *et al.* (1999), who note that "the heterogeneity of effect sizes . . . suggest[*s*] that participants' responses to HIV-CT are multiply determined and complex. However, with only a few exceptions, HIV-CT studies have not been informed by theories of behavior change", p.1402). In a recent paper, Wilson (2008) estimates the effects of antiretroviral therapy in a model where behavior and beliefs interact using data from Zambia.

Delavande and Kohler (2007) use the MDICP dataset to study the accuracy

[8]The authors caution that the latter result nevertheless relies on the behavior of only five individuals in their sample.

of individuals' reported expectations of being HIV positive. They provide detailed documentation of the method used to elicit the probabilistic expectations in the survey that we use in some of our empirical analysis. They find that the probability assessments on HIV infection gathered in the 2006 round of the survey are remarkably well calibrated to prevalence rates in the local communities.[9] Anglewicz and Kohler (2005) point out that individuals in the 2004 wave seem to over-estimate the risk of being infected. 10% of husbands and 18% of wives estimate a medium or high likelihood of current infection while actual prevalence in 2004 was much lower: 6% of men and 9% of women were HIV positive. In reconciling the evidence with the well-calibrated probabilistic assessments in the later wave, Delavande and Kohler note problems of interpersonal comparability of the coarse belief categories and that, even if anchoring techniques are used (such as vignettes), complications would still remain in translating the coarse categories into more precise assessments. In this paper, we make use of both the coarse belief categories and the finer measurements, as described below in section four.

3 A Model of Risky Behavior Choices

As noted in the introduction, theoretical models are ambiguous as to the effect of changes in beliefs about one's own HIV status on risk-taking behaviors. On the one hand, learning a negative result should increase the expected length of life and thereby increase the benefits from risk avoidance. On the other hand, the testing might also be informative about the technology for HIV transmission. In our sample, individuals tend to overestimate the probability of becoming infected by HIV from one sexual encounter with an infected person and learning that they are negative despite a past

[9] For the 2004 wave of the MDICP data, the likelihood of own infection is reported only in broader categories (whether an individual thinks it highly likely, likely, unlikely or not at all possible that he or she is HIV positive).

life of risky behavior could increase their willingness to take risks.[10] Altruism also plays an important role in HIV transmission, as people who are altruistic towards others would be expected to curtail risky behaviors after learning a positive test result. Conversely, a negative test result may increase risk taking.

We next present a simple two-period model to explore the relationship between beliefs on own HIV status and sexual behavior. In the model, individuals choose their level of risky behavior in the first period and update their beliefs on own HIV status in a Bayesian way. Let $Y_0 \in \mathbb{R}$ denote an individual's chosen level of risky sexual behavior (risky behavior represents activities such as having unprotected sex or engaging in extramarital affairs). The probability of infection is an increasing function of risky behavior and we denote it by $g(Y_0) \in [0, 1]$.[11] To be sure, other factors such as the prevalence rate in the community modulate the link between sexual behavior and the likelihood of infection and could be incorporated into the function $g(\cdot)$. We abstracts from such influences here for ease of presentation, but the empirical analysis includes conditioning variables intended to hold constant local prevalence rates. Let B_0 denote the individual's prior belief about his own HIV status. Individuals potentially obtain satisfaction from risky sexual behaviors in the first period. We also allow one's perception on HIV status to directly affect utility: $U(Y_0, B_0)$. How beliefs affect the marginal utility of risky behavior can be regarded as a measure of altruism. In the second period, individuals receive a "lump-sum "utility flow equal to $\overline{U}$, but this is reduced by $\lambda\overline{U}$ if an individual contracts HIV in the first period. λ can be interpreted as the mortality rate for an HIV-positive individual. The discount factor is β. Beliefs are updated in a Bayesian way. The belief of being HIV positive in the second period (B_1) depend on previous period beliefs (B_0) plus

[10] The probability is thought to be about 0.1% (see Gray *et al* [2001]).This channel is not in the model we present here. Individuals in the survey to not seem to revise their beliefs about the probability of infection from one sexual encounter substantially from 2004 to 2006. This channel is nevertheless allowed to operate in our empirical analysis.

[11] The probability of infection may be the perceived probability of infection. In a multiperiod context, this belief may also be updated through time but we take it as predetermined when the risky behavior decision is taken.

the probability of having contracted the disease last period:

$$B_1 = B_0 + (1 - B_0)g(Y_0). \tag{1}$$

The individual's problem is then

$$\max_{Y_0} \quad \{U(Y_0, B_0) + \beta(1 - \lambda B_1)\overline{U}\}.$$

or, equivalently,

$$\max_{Y_0} \quad \{U(Y_0, B_0) + \beta(1 - \lambda B_0 - \lambda(1 - B_0)g(Y_0))\overline{U}\}.$$

The first order condition yields:

$$U_1(Y_0, B_0) - \beta\lambda(1 - B_0)g'(Y_0)\overline{U} = 0 \tag{2}$$

where $U_1(\cdot, \cdot)$ denotes the derivative of $U(\cdot, \cdot)$ with respect to its first argument. This condition implicitly defines Y_0 as a function of the belief variable B_0. Furthermore,

$$\frac{dY_0}{dB_0} = -\frac{U_{12}(Y_0, B_0) + \beta\lambda g''(Y_0)\overline{U}}{U_{11}(Y_0, B_0)}$$

which, given a concave (in Y_0) utility function, is positive if

$$U_{12} + \beta\lambda g''(Y_0)\overline{U} > 0.$$

Assume that $g''(Y_0) > 0$, which is reasonable if the probability of infection $g(Y_0)$ is low (take for instance $g(\cdot)$ to be a logistic or normal cdf and consider the low rates of transmission per sexual act). If an individual's marginal utility from (risky) sexual behavior is insensitive to his or her perception on HIV status (that is, not altruistic), the inequality is trivially satisfied. As long as one's marginal utility does not decrease much (relative to $\beta\lambda\overline{U}$), higher prior beliefs are associated with riskier behaviors. A person who is not altruistic would be expected to increase risky behavior upon learning a positive HIV test result and to decrease risky behavior upon learning a negative test result.

In a multi-period context, beliefs affect current behavior and also respond to past behavior through updating. This implies that our prior belief B_0 is based at least in part on previous choices regarding Y_0. As described in the next section, dependence of beliefs on previous behavior poses challenges in estimation, because it leads to a potential endogeneity problem. Another potential source of endogeneity arises from any unobservable traits that affect both beliefs B_0 and behavior Y_0.

4 Empirical Framework

As noted in the introduction, our primary goal is to assess how beliefs about own HIV status affect risk-taking behaviors. Such an understanding is required to assess the efficacy of policy interventions aimed at changing beliefs. Let Y_{it} denote the measure of risk taking behavior of individual i in period t, which in our data is an indicator for whether the individual engaged in extra marital affairs over the previous 12 months or alternatively for whether the individual reported using condoms. Let B_{it} denote an individuals' beliefs at time t about their own HIV status, measured on a 0 to 1 scale, with 0 being no likelihood of being positive and 1 being positive with certainty.

Below, we describe an IV fixed effects estimation strategy to control for endogeneity of beliefs and for unobservable heterogeneity.[12] The model developed in the previous section implies a decision rule for risky behavior that depends on beliefs about own HIV status (see equation (2)). In the empirical specification, we introduce

[12] The lack of strict exogeneity precludes us from using nonlinear panel data methods.

additional covariates to allow for other determinants of risky behavior, such as age, education, and religion. One other potentially important motivation for not using condoms or for having extramarital affairs is the desire to have additional children, so we also include the current number of children as a conditioning variable (it would be a state variable in the dynamic decision problem). Our analysis assumes that the fixed effects control for local prevalence rates and for other unobserved costs of risky sexual behavior that may differ across people or across geographic regions. Prevalence rates (at the national level at least) change very little over 2004-2006, so we assume these variables to be approximately constant over the two-year time period. As described below in section 5.2, our sample covers three geographic regions that have cultural and economic differences, including differences in religiosity, polygamous practices and wealth. These differences will be taken into account in that our analysis is based on within rather than between region variation.

With the assumptions of linearity and a fixed effect error structure, the empirical specification for the risky behavior decision rule can be written as:

$$Y_{it} = \alpha + \beta B_{it} + \gamma X_{it} + f_i + v_{it}. \tag{3}$$

where we assume weak exogeneity ($\mathbb{E}[v_{it}|B_{it}, X_{it}, f_i] = 0$). This specification is a linear approximation to the implicit decision rule implied by equation (2).[13] We observe the panel at two time periods, in 2004 (period $t-1$), before any testing took place, and in 2006 (period t), two years after the testing. In the previously described model, current beliefs about HIV status depend on prior beliefs and last period behaviors through updating (equation (1)):

$$B_{it} - B_{it-1} = (1 - B_{it-1})g(Y_{it-1})$$

[13]Though, note that linearity of U_1 and $f(\cdot)$ would imply the linear specification above.

where Y_{it-1} is a function of f_i and v_{it-1} (equation (3). This updating implies a potential correlation between B_{it} and v_{it-1} and f_i. We use differencing to eliminate the fixed effect:

$$Y_{it} - Y_{it-1} = \beta(B_{it} - B_{it-1}) + \gamma(X_{it} - X_{it-1}) + v_{it} - v_{it-1}.$$

In addition, to control for potential endogeneity between B_{it} and v_{it-1}, we instrument for the change in beliefs. Our instruments include the initial belief level B_{it-1} and the geographic distance to HIV result centers. For the subsample that participated in the testing, the randomized incentive amounts also provide a source of instruments.[14] Below, we report estimates for different sets of instruments.

5 Data and Empirical Results

5.1 Background on the MDICP Dataset

The MDICP dataset was gathered by the Malawi Research Group.[15] The Malawian population is composed of more than 20 different ethnic groups with different customs, languages and religious practices. Malawi's three different administrative regions (North, Center and South) are significantly different in several aspects that

[14] The incentives were only given to those who elected to participate in the testing. Therefore, using the incentive amounts as instruments (for those individuals) requires an added assumption that the decision to participate in the testing is uncorrelated with v_{it-1}. The decision to participate may, however, be correlated with the unobserved fixed effect. Another potential regards the potential "income effects" of the monetary incentive. If the incentives directly affect the propensity to engage in transmissive behavior (as it allows one to engage in more extra-marital affairs for example) this variable would not be excluded from the regression of interest. This effect is nevertheless unlikely as incentives correspond to at most a few days of labor. Furthermore, even if they directly induce more promiscuous behavior in the period immediately following the experiment, our extra-marital affairs variable refers only to the 12 months preceding the survey in 2004 and 2006, thus excluding the few months following the experiment.

[15] The data collection was funded by the National Institute of Child Health and Human Development (NICHD), grants R01-HD37276, R01-HD044228-01, R01-HD050142, R01-HD/MH-41713-0. The MDICP has also been funded by the Rockefeller Foundation, grant RF-99009#199. Detailed information on this survey can be obtained at http://www.malawi.pop.upenn.edu/.

are relevant to our analysis. The MDICP gathers information from four rounds of a longitudinal survey (1998, 2001, 2004, 2006) that together contain extensive information on sexual behavior and socio-economic background on more than 2,500 men and women. We use the later two rounds of the survey that include information on beliefs about own HIV status along with information gathered during the incentive experiment on the incentive amounts and on the test results. Also, we only analyze data on men, who are more than twice as likely to report extramarital affairs than women. The MDICP survey contains information on sexual relations, risk assessments, marriage and partnership histories, household rosters and transfers as well as income and other measures of wealth. The data also include information on village-level variables as well as regional market prices and weather related variables. Recent studies on the quality of this dataset have validated it as a representative sample of rural Malawi (see, for instance, Anglewicz et al. [2006]). Appendix A provides further information about the dataset.

5.2 Descriptive Analysis

Table II shows the mean and standard deviations for the variables used in our analysis. The total sample size is 644 married men for whom data were collected in both the 2004 and 2006 rounds of the survey.[16] The average age of the sample is 43 in the 2006 round. The sample resides in three regions of Malawi: Balaka (South), Rumphi (North) and Mchinji (Center). Although the original sample was designed to include about equal numbers of respondents from each of the three districts, the share of men from Balaka drops in later waves both in the full MDICP data and our analysis subsample. In our subsample, 38% of the men are from Rumphi, about 33.5% from Mchinji, and about 28.5% from Balaka. The explanation for the higher attrition in Balaka is higher rates of migration typical to the area.

[16]Because our analysis relates to extramarital affairs, we restrict the sample to men who were married in both rounds. We include men who may have been married to different women in the two years.

The Northern region, where Rumphi is located, is primarily patrilineal with patrilocal residence. Almost all of its population is Christian, predominantly protestant. This region, which has the smallest population, is also the least densely populated and least developed in terms of roads and other infrastructure. However, it has the highest rates of literacy and educational attainment. The most commonly spoken language in the region is chiTumbuka, the language of the Tumbuka tribe, which is the biggest tribe in the area. The northern region has the highest rates of polygamy, but the lowest HIV prevalence for men age 15-19, estimated to be around 5.4%. The HIV prevalence for similar age women is higher than that of the central region (Department of Health Services). The Central region, where Mchinji is, is predominantly Christian as well, with a mix of Catholics and protestants. The largest group in the region is the Chewa tribe, which is the largest ethnic group in all of Malawi. Its language, chiChewa is the official language together with English, and is the most spoken in the region as well as in the whole country. The Chewa tribe historically used a matrilineal lineage system with matrilocal residence. Today, the lineage system is less rigid, with mixed matrilocal and patrilocal residence (Reniers 2003). The Central Region is home to Lilongwe, the capital city which in recent years has become the biggest city in the country. Finally, the Southern region, where Balaka is, predominantly uses matrilineal lineage systems with matrilocal residence. It has a large Muslim population, concentrated mainly in the north-east part of the region around the southern rim of Lake Malawi. The Southern Region has the largest population and is the most densely populated. It has the lowest rates of literacy and percentage of people ever attending school.

As displayed on Tables IIa and IIb, the different characteristics of the three administrative regions of Malawi are evident in our sample. Across the three regions, the predominant religion is Christianity (74.9%) with the remainder Muslim (18.9%) and a small percentage reporting other religions or no religion. Most of the overall sample has only some primary schooling (68.3%), with 13% never attending school and 18% having some secondary schooling. About 18% of the sample are polygamous;

the polygamy rate for 2004 in Rumphi is more than twice than that in Balaka and Mchinji, with about 26.5% in Rumphi and just above 11% in the two other sites. While Muslims represent about two thirds of the Balaka sub-sample, they are less than 2% in the other two sites. Balaka has the highest percentage of respondents who never attended school and the lowest percentage of respondent with some secondary schooling. Rumphi has the lowest rate for respondents without any schooling, and the highest rate of respondents with some secondary schooling. Owning a metal roof (as opposed to thatch, which is most commonly used), is an indicator of wealth in rural Malawi. Rumphi has the highest percentage of respondents residing in a dwelling with a metal roof, at 22%, while Balaka has the lowest, with 7.3%. In addition, individuals nationwide are mainly affiliated with three tribes and speak a variety of local languages. Finally, individuals in our sample have on average between four and five children and 38% report that they desire more children.

Table IIa also reports the average own beliefs about being HIV positive in 2004 and 2006 and the average reported beliefs about the spouse. In 2004, 67.7% report that they have close to zero chance of being HIV positive. In 2006, the percentage in this category increases to 78.7% , reflecting the fact that many individuals got tested, received a negative test result and updated their beliefs accordingly. In 2004, 10.4% of individuals believed that they had a medium or high chance of being HIV positive. This fraction decreases to 6.5% in 2006. Figure I depicts the change in the belief distribution over time, namely the move to a higher fraction reporting no likelihood of being positive and a lower spread in beliefs.

As seen in Table IIa, in 2004 77.5% assign a negligible probability to their spouse being HIV positive, in comparison to 86.3% in this category in 2006. Even though individuals were not informed about their spouse's test result for confidentiality reasons (if their spouse got tested), the survey indicates that about 96% of the spouses shared their test results with their husbands in our sample. Less than 2% believe that the probability that their wife is infected with HIV is high.

With regard to risky behaviors, 26.3% reported using condoms over the last 12 months in 2004 but this percentage increased to 36.6% in 2006. 12% reported having an extramarital affair in the last 12 months in 2004 in comparison with 8.4% in 2006. 83% of the sample was tested for HIV and 72.6% of those picked up the test result.

Table IIIa and Table IIIb examine the temporal pattern in extramarital affairs and in condom use. 82.1% of the sample does not report having an affair in either 2004 or 2006. 9.5% reports having an affair in 2004 but not in 2006, whereas 5.9% report having an affair in 2006 but not in 2004. About 2.5% report engaging in extramarital relations in both 2004 and 2006. Table IIIb shows that 54.2% of the sample did not use a condom in both 2004 and 2006. 7.3% used a condom in 2004 but not in 2006, and 16.9% used a condom in 2006 but not in 2004. 18.5% reported using in both years.

The MDICP dataset measured beliefs about own HIV status using two different measurement instruments. In both the 2004 and 2006 surveys, individuals were asked to choose one of four categories: no likelihood, low likelihood, medium likelihood and high likelihood. In the 2006 survey, the categorical measure was supplemented with a probability measure. One might be concerned that low education populations would have difficulty in reporting a probability measure. For this reason, the MDICP survey used a novel "bean counting" approach to elicit probabilities, which appeared to work well.[17] Delavande and Kohler (2007) study both the categorical and more continuous measure and demonstrate the continuous measure is well calibrated to regional HIV rates. In Table IV, we examine how the continuous belief measure (the bean measure) varies within the coarser subjective belief categories. People who report their infection probability as being "low" choose a number of beans corresponding to a 17% average probability. The bean average for the medium category corresponds to a 44.5% probability and the bean average for the high category to a 76.5% probability.

Table V examines revisions in beliefs between the 2004 and 2006 surveys.

[17] Individuals were first given examples of how to represent the likelihood of common events using 0-10 beans, such as the chance of having rain the next day, and then asked to report the likelihood of being HIV positive using the bean measure.

There were substantial revisions, with about three fourths of people who thought they had a low, medium or high likelihood of having HIV in 2006 revising their belief downward to zero likelihood. About 3.2% of people reporting a zero or low likelihood of having HIV in 2004 believe their likelihood is high in 2006, and about 8.8% of those who thought they had a high likelihood in 2004 remain in the high category. The transition in beliefs is also illustrated in Figure II.

In Tables VI and VII, we explore the potential determinants of decisions about extramarital affairs and about condom use using cross-sectional analysis. A probit regression of an indicator for extra-marital affairs on beliefs and other covariates shows that beliefs are a statistically significant predictor of affairs. People who assign a higher probability of themselves being HIV positive are more likely to report engaging in extramarital affairs. Schooling level is also a significant predictor of affairs, with people in the no schooling and the secondary schooling categories reporting the highest likelihood of infection (the omitted category is University education). In the cross-section, the reported probability of being HIV positive decreases with age. A similar analysis for condom usage, reported in Table VII, shows that only education and region of residence significantly predict condom usage. Individuals with less than university education are more likely to use condoms, with the highest rates of condom usage reported for those in the no schooling and secondary schooling categories. Individuals who reside in the northern Rumphi region are also more likely to use condoms.

Finally, Figure III displays the distribution of monetary incentives. About 27.4% of the subjects received zero incentives, 7.3% got 50 Kwachas, 6% got 300 Kwachas and the remainder received between 100 and 200 Kwachas.

5.3 Estimated Causal Effects

Table VIII presents estimates of the causal effect of beliefs on risky behavior, based on the fixed effect IV estimation strategy outlined previously. For purposes of comparison, the first two columns of the table report fixed effect estimates without instrumenting. These estimates would be valid if the error terms followed a fixed effect error structure and the correlation between beliefs and the residual arose only from a correlation with the unobserved fixed effect. This assumption is unlikely to hold, given that we expect individuals to update beliefs based on previous behaviors, generating a correlation between current beliefs and lagged residuals. The differenced specification reported in Table VIII only includes age squared and not a linear term, because the linear term is collinear with the constant term after differencing (the effects of other covariates that are constant over time, such as education, religion, region of residence, are also eliminated as they are included in the fixed effect).

In the estimating equation, we aggregate the categories medium and high likelihood, because such a small fraction report being in these categories, making it difficult to estimate separate effects precisely. Finally, we include the number of children in some specifications, because prior fertility may affect risky behavior choices for reasons described in the previous section. This variable may itself be endogenous, because the birth of a child in the last period may depend on past risky behavior and therefore on lagged residuals. Hence, for those specifications where the number of children is included, we instrument for the change in the number of children using the lagged number of children.

The estimates indicate that people reporting a medium or high likelihood of being HIV positive are significantly more likely to engage in extramarital affairs. Those that attach a low likelihood to being HIV positive also seem to be more likely to engage in extramarital affairs (around 5 percentage points more so) though this coefficient estimate is not significant. Beliefs about the spouse are not a statistically significant determinant of risky behavior. The coefficient on own beliefs is not much affected by whether beliefs about the spouse is included in the specification. Columns three through six report the IV estimates for varying specifications and sets of instruments. The instrument set (a) includes the lagged (2004) coarse belief categories (low and medium/high), the randomized incentive amount (for those that received an incentive), and the distance to the nearest testing clinic (measured in 2006). Instrument set (b) adds an indicator for the randomized incentive amount equaling zero. Instrument set (c) includes lagged belief coarse categories (low, medium, and high), lagged spouse belief categories (low and medium/high), randomized incentive amount, and distance to the testing clinic. The estimated coefficient on own belief being medium or high is relatively robust to the inclusion of different sets of covariates. As seen in Table V, the majority of individuals who revised their beliefs in between 2004 and 2006 revised them downward. According to the estimates in Table VIII, a downward revision in beliefs leads to a 15-16 percentage point lower likelihood of engaging in extramarital affairs. The estimates would also imply that informing HIV positive individuals of their positive status and revising their beliefs upward increases their risk-taking. However, only a small fraction of individuals in our sample revised their beliefs upward and such an interpretation may be unwarranted given the source of identification is mainly individuals who revised their beliefs downward.

Table IX shows the estimates from the first stage IV regressions. The F-statistics for all of the specifications greatly exceed 10, which is a rough metric sometimes used to test for weak instruments (Stock and Staiger 1997). The coefficient estimates show that lagged beliefs significantly predict changes in beliefs, as the model of section two would imply. The distance to VCT clinic is also a significant correlate of whether individuals believe themselves to have a low likelihood of being HIV positive. The coefficients indicate that individuals who live further from the testing center are generally less likely to revise their beliefs. The randomized incentive amounts are not statistically significant predictors of changes in beliefs though they appear with the expected signs.

Table X shows results that are analogous to Table VIII, except that the dependent variable is whether the individual reported using a condom in the last 12 months. As seen in Table III, condom use in this population is fairly low – under 30% – and according to Table X beliefs about own HIV status appear to have no effect on the propensity to use a condom. Recall that in the cross-sectional regression (for which results were reported in Table VII), beliefs about own status were not a predictor of condom use. The explanations for the low use of condoms in Malawi range from moral to political reasons. According to qualitative research conducted in the country, many view condoms as promoting promiscuous behavior or as opposing "God's will". Others feel that they detract from the enjoyment of sexual intercourse or do not trust their efficacy. The negative attitudes towards condoms are exacerbated by rumors and perceptions that they serve as a measure of population control by the government and international organizations (Kaler 2004; Chimbiri 2007).

It is interesting that a separate set of questions in the MDICP survey asked individuals who were tested whether they changed their behavior after the test. Around 50% of the individuals tested claimed to have changed their behavior. For those, roughly three-quarters report now having sex only with the spouse. Only 7% reported using condoms. The responses to these survey questions provide additional evidence that behavioral changes were typically channeled through changes in the number of partners rather than modification in the use of condoms. It is also telling that the use of condom seems to depend largely on the type of relationship with one's sexual partner. In 2004, out of the men in our sample who reported having sex with their spouses in the previous 12 months, 22.5% report ever using condom with their spouses. Out of the 77 who reported extramarital affairs that year, 58.4% report ever using condom with their partners. One explanation for this disparity is that people are more likely to use condoms when they suspect their partner might be infected with HIV/AIDS. Moreover, there seems to be an increase in the predisposition to use condoms with a partner who is suspected to have HIV. The number of individuals who think it is acceptable to use condoms with the spouse if she is suspected to be HIV positive increases between 2004 and 2006.[18] Another explanation is that to many

[18]We repeated the regressions in Table X using as a dependent variable the indicator response to the attitudinal question ("Is it acceptable to use a condom with a spouse if one suspects or knows that the other has HIV/AIDS?"). We find a positive coefficient on the belief of being positive with high or medium likelihood. The number of individuals who say it is acceptable to use condoms with the spouse (with no qualification about the spouse's status) is nevertheless roughly unchanged between rounds.

individuals condom use inside marriage "blurs the distinction between a girlfriend or prostitute and a wife " (Bracher et al. 2004).

5.4 Robustness

One possible concern with the previous analysis is that there may be misreporting of extramarital affairs. Another potential concern is that attrition between rounds may affect the results. In this subsection, we explore the robustness of the previous specification to allowing for measurement error in extra-marital affairs and beliefs and to controlling for nonrandom attrition between the two waves of the panel (2004 and 2006). We also check the robustness of the estimates to using a finer measure of beliefs that was available only in the 2006 survey round.

5.4.1 Extra-Marital Affairs

Because many of the surveyed topics concern sensitive topics, an obvious concern is the potential for misreporting. To further explore the problem, the MDICP team carried a small set of qualitative interviews with men that had reported not having extramarital affairs during the 1998 round of the survey when slightly over 9% of the interviews admitted to having had extra-marital affairs. These follow-up interviews were very casual (no questionnaire or clipboard, typically no tape recorder) and were later transcribed by the principal investigators in the field (the transcripts are available online at `http://www.malawi.pop.upenn.edu/Level%20 3/Malawi/level3_malawi_qualmobilemen.htm`). Many of those who had originally denied infidelity, admitted otherwise in these informal interviews. Even though the reference period was longer and the men may tend to exaggerate in these casual conversations, this provides evidence of some underreporting by the respondents during the more formal interviews.

There are different strategies to learn about misreporting. First of all, apart from the individual's own response, the survey also provides a spouse's report on an individual's infidelity. Using this additional information, we construct an infidelity measure that records infidelity if it is either self-reported or the spouse suspects infidelity. Under the assumption that males will tend to underreport their extra-marital activities and that wives' suspicions will typically be valid, this variable would provide a more accurate measure of infidelity. We reestimated the previous specification using this alternative measure, and the results corroborate our previous findings with the original marital affairs measure. The instrumented regression using coarse belief categories retains a positive and highly significant coefficient on the variable indicating medium or high likelihood of infection (coefficient of 0.2 with a t-statistic of 2.43) whereas the variable for low likelihood is positive though not significant (coefficient 0.03 with a t-statistic of 0.5). The estimates are basically unchanged if we introduce the number of children as an additional control. The results are less significant if we use a quadratic polynomial for the median of the finer belief measure (beans) for the coarse belief categories using the lagged imputed belief measures as instruments (as well as the testing incentives and the distance to VCTs) but remain significant if we use the coarse belief categories as instruments instead.

Another way of exploring the effect of measurement error is to apply the method of Hausman, Abrevaya and Scott-Morton (1998)'s for discrete choice models with misreporting of the dependent variable. For instance, let $\tilde{Y} \in \{0,1\}$ denote whether an individual actual had an extra-marital affair and let $Y \in \{0,1\}$ denote what is actually reported. Let F denote the cdf of the residual of the discrete choice model. Assume that the probability of misclassification may depend on $\tilde{Y}$ but is otherwise independent of covariates X and is given by:

$$\begin{aligned} \mathbb{P}(Y &= 1|\tilde{Y} = 0) = \alpha_0 \\ \mathbb{P}(Y &= 0|\tilde{Y} = 1) = \alpha_1. \end{aligned}$$

Then, assuming that

$$\mathbb{E}(\tilde{Y}|X) = F(X, \beta)$$

we obtain

$$\mathbb{E}(Y|X) = \alpha_0 + (1 - \alpha_0 - \alpha_1)F(X, \beta). \tag{4}$$

Notice that in our linear probability case, $F(X, \beta) = X'\beta$ and in particular:

$$\mathbb{E}(\Delta Y|\Delta X) = \Delta X'(1 - \alpha_0 - \alpha_1)\beta.$$

This result shows that measurement error will affect the overall scale of the parameters, shrinking them towards zero. However, the sign of the parameters will be the same with and without measurement error. Thus, the estimates we obtained for the effects of beliefs on behavior will be lower bounds when there is measurement error in the dependent variable.

Hausman, Abrevaya and Scott-Morton (1998) propose estimating α_0 and α_1 via nonlinear least squares for the case when F is nonlinear in a model without fixed effects (under the assumption that $\alpha_0 + \alpha_1 < 1$). The measurement error parameters are not identified in the linear probability model or in a nonlinear model with fixed effects. Nevertheless, just to get an idea of the potential magnitude for the measurement error, we performed the discrete choice estimation for 2004 and 2006 (pooled and separately) assuming simple logit and probit specifications for $F(\cdot)$ and with different sets of conditioning variables, as in Table VIII but including variables that would normally be eliminated by the fixed effect. Typically, α_0, the probability of reporting an affair when there was none, was estimated to be around 5% and α_1, the probability of reporting no affair when there was one, ranged from 50% to 70% (the coefficient on beliefs remained positive for most specifications). This indicates the potential for considerable underestimation of β as indicated above. Accounting for measurement error, the effects of beliefs on risky behavior may be stronger than estimated in the earlier analysis.

5.4.2 Beliefs

In addition to the coarse belief categories used in the earlier analysis, in 2006 the MDICP also collected finer belief measures on a 0-10 scale. Delavande and Kohler (2007) provide detailed documentation of the method used to elicit probabilistic expectations in the survey. The methodology basically asked individuals to represent their perceptions on (own) HIV-status in (zero to ten) beans. As highlighted by Delavande and Kohler the bean count methodology has the advantage of being visual, relatively intuitive and fairly engaging to the participants. The authors find that the probability assessments on HIV infection assessed in the 2006 round of the survey are remarkably well calibrated to prevalence rates in the local communities.

Unfortunately, the beans measure was not available in the 2004 wave of the survey, so we follow Delavande and Kohler (2007) and use the median number of beans in each of the coarse belief categories in 2006 as a proxy for the bean count in 2004. The estimates we obtain using the finer bean measure of beliefs are very similar to those obtained using the coarser belief categories. Across many of the specifications, we estimate that a ten percentage point increase in the belief of own infection (=one bean) is associated with a one to two percentage point increase in the probability of extra-marital affairs (see Table XI). With the finer belief measure, we are able to allow for a more flexible specification by including a squared term on beliefs, which is typically negative and statistically significant. This pattern suggests that the effect of beliefs on sexual behavior is initially positive and then negative past a certain level; at very high beliefs of being HIV positive, individuals might curtail their risky behavior. However, we have very few datapoints in this region, so we view the results as only suggestive. As in the earlier analysis, we find no effect of beliefs (measured using the finer measure) on condom use.

5.4.3 Marriage Dissolution

Another possible concern with the earlier analysis is that positive HIV test results may lead to marriage dissolution and conditioning the entire analysis on married men may be problematic. Divorce can be seen as a way for women to guard themselves against a higher risk of HIV infection from a spouse engaging in extra-conjugal affairs (see for instance Reniers [2003]). If certain individuals increase their beliefs about own infection and that leads to higher sexual activity but at the same time to higher divorce and to exclusion from our sample, then our estimates could be biased.

To address potential selectivity bias arising from divorce between sample rounds, we estimate a variety of selection-corrected versions of our model and report a representative specification in Table XIII. We basically use a censored selection model in which married individuals in 2004 are selected in or out of the 2006 married sample according to a selection mechanism based on the region of residence, whether they tested positive for HIV in 2004 and on their age in 2004. Individuals select out of the 2006 married sample if we observe them as single in 2006 or if they drop out of the survey. Attrition in the sample is typically a consequence of migration and, as pointed out for instance in Reniers (2008), migration is often associated with marriage dissolution. This would be the case especially in the South where residence is matrilocal and divorce would more likely dislodge the husband, which is why we focus on region as a potential explanatory variable for attrition. The estimated coefficients associated with the belief variables are generally robust to allowing for nonrandom attrition.

6 Conclusions

This paper examined the relationship between beliefs about own and spousal HIV status and risky sexual behavior in the form of extra-marital affairs or not using condoms. We use a unique panel dataset from Malawi that includes longitudinal measures of subjective beliefs and behaviors. The individuals in our sample were given the opportunity to get tested for HIV in 2004, which led to substantial revisions in their beliefs over the time period covered by the data collection. Most individuals who participated in the MDICP testing program learned that they were HIV negative and revised their beliefs of being HIV positive downward.

Simple cross-sectional correlations suggest that individuals who believe they have a higher likelihood of being HIV positive engage in riskier behaviors. These correlations do not have a causal interpretation, though, because behavior is likely to be correlated over time and beliefs would be updated to reflect additional risk posed by lagged behaviors. To control for the potential endogeneity of the belief variable as well as for individual unobserved heterogeneity, we use a fixed effect IV approach that relates changes in behavior over time to changes in beliefs. Our estimates indicate that downward revisions in beliefs lead to a lower propensity to engage in extramarital affairs but have no effect on condom use. Our consideration of measurement error showed that our estimates provide a lower bound in the case of possibly asymmetric measurement error in reported extramarital affairs.

The results we obtained from the estimated model are generally supported by separate survey questions (not used in the estimation) that directly elicited from respondents how participating in the testing altered their behavior. Individuals who changed their behavior in response to testing often reported reducing their number of extra-marital sex partners but only a small fraction reported changing their usage of condoms.

In general, our findings suggest that HIV testing programs can be effective in reducing risk-taking in the form of extramarital sexual relationships by informing people of their HIV negative status. Learning that one is HIV negative increases the marginal benefit from staying negative and, through this mechanism, can reduce risky behavior. Consequently, the value of testing is not only to identify HIV positive individuals, so that they can gain access to treatment and avoid infecting others, but also to inform HIV negative individuals of their status so that they take greater precautionary measures. The effectiveness of testing in the subsaharan setting, though, is somewhat mitigated by the fact that some individuals seem not to be skeptical about the validity of the test results. Also, the lack of response of condom use patterns to changes in beliefs and the reported attitudes towards condom use indicate that there are still strong cultural barriers to using condoms, particularly within marital relationships.

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Appendix

Malawi. Malawi is a landlocked country in Southern Africa with a population of about 13.5 million. In the UNDP's 2007 Human Development Index, combining data collected in 2005 on health, education and standards of living, Malawi was ranked 164 out of 177 countries, with a rank of 1 being the most developed. Malawi's GDP per capita was ranked 174, at US$667, making Malawi a poor country even by Sub-Saharan standards. Malawi is one of the countries worst hit by the HIV/AIDS epidemic with an estimated prevalence rate of 12% in the overall population and 10.8% in the rural areas (Demographic Health Survey, 2004).

MDICP sampling. The MDICP collected data from three out of Malawi's 28 districts, one in each of the three administrative regions. The districts are Rumphi in the north, Mchinji in the center, and Balaka in the south. The original sample, drawn in 1998, consisted of 1,541 ever married women aged 15-49 and 1,065 of their husbands. The consequent waves targeted the same respondents and added any new spouses. In 2004, 769 adolescents and young adults, aged 14-28 were added to the sample, out of which 411 were never married. The original sample wasn't designed to be representative of rural Malawi, but is similar in many socioeconomic characteristics to the rural samples in the Malawi Demographic and Health Surveys, which are representative (Watkins et al. 2003; Anglewicz et al. 2006).

Testing description. In 2004, in addition to the survey, all the respondents were offered tests for HIV and three other STIs (chlamydia and gonorrhea for both males and females and trichomonas for females). The tests were conducted in the respondents' residences several days after the respondents were interviewed. The results were typically available for respondent about five to seven weeks after testing. For distributing the results, temporary VCT sites were set up such that most respondents' homes were within five kilometers distance from at least one site. Before the results were made available, households were grouped into zones according to geo-spatial coordinates and a location within each zone was randomly selected to place a tent. The average distance to a center was 2.0 km and over 95 percent of those tested lived within five kilometers. The testing component in 2004 was linked to a random experiment studying the incentives for VCT uptake. After the collection of specimen, the respondents randomly drew a monetary compensation written on a bottle cap, ranging in value from 0 to 300 Malawian Kwacha. This compensation was given to respondents upon receiving their STI and HIV results. In two of the three sites, Balaka and Mchinji, two separate incentives were given for collection of the HIV and the STI results. In Rumphi, one incentive amount was paid for picking up either of the results (there was no significant difference in the pattern of picking up the results). Participation of respondents in testing was high at about 90% in all three sites for a total of 1275 men tested for HIV. A bit more than two thirds of the tested respondents returned for their HIV results. The overall HIV prevalence rate for men in the sample is 5.7% ranging from 3.4% in Rumphi to 7.2% in Balaka.

Definition of risky behavior variables. Both measurements for risky behavior were taken from the "Sexual Behaviors" section of the survey. In the section, the respondents were asked to name up to three of their partners in the prior 12 months, including spouses, and a series of questions about the partnerships were asked. We consider a man to have had an extramarital affair if he reported any relationship with a woman who is not his wife. For the rare cases in which a man has three or more wives, the variable equals one if the number of reported sexual partners in the prior 12 months exceeds the number of wives. The condom variable equals one, if the respondent reports using a condom at least once with any of his partners, spouses or not.

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Table I

HIV Test Results (2004) and Beliefs (2006)

	Negative	Positive
Believe that HIV probability is zero in 2006	401	8
Believe that probability is low in 2006	77	6
Believe that probability is medium in 2006	12	2
Believe that probability is high in 2006	15	4

Table IIa
Descriptive Statistics for males
in 2004 and 2006 MDICP samples

Variable	Mean	Std. Deviation
Age (in 2006)	43.005	11.925
Muslim	0.199	0.400
Christian	0.749	0.434
No school	0.132	0.339
Primary education only	0.683	0.466
Secondary education	0.179	0.383
Reside in Balaka	0.284	0.451
Reside in Rumphi	0.380	0.486
Percent polygamous (2004)	0.171	0.377
Percent polygamous (2006)	0.180	0.385
Number of children (2004)	4.682	3.107
Number of children (in 2006)	4.955	3.108
Number of children not reported (in 2004)	0.014	0.117
Number of children not reported (in 2006)	0.056	0.230
Desire more children (in 2006)	0.375	0.485
Metal roof	0.160	0.367
Believe that own prob of HIV is zero in 2004	0.677	0.468
Believe that own prob of HIV is low in 2004	0.219	0.414
Believe that own prob of HIV is medium in 2004	0.051	0.221
Believe that own prob of HIV is high in 2004	0.053	0.224
Believe that own prob of HIV is zero in 2006	0.787	0.410
Believe that own prob of HIV is low in 2006	0.148	0.355
Believe that own prob of HIV is medium in 2006	0.033	0.178
Believe that own prob of HIV is high in 2006	0.033	0.178
Believe that spouse prob of HIV is low in 2004	0.166	0.373
Believe that spouse prob of HIV is medium in 2004	0.037	0.189
Believe that spouse prob of HIV is high in 2004	0.023	0.149
Believe that spouse prob of HIV is low in 2006	0.101	0.302
Believe that spouse prob of HIV is medium in 2006	0.024	0.153
Believe that spouse prob of HIV is high in 2006	0.013	0.113
Subjective probability assigned to being HIV positive (number of beans) (in 2006)	0.788	1.795
Use condom in last 12 months in 2004	0.263	0.441
Use condom in last 12 months in 2006	0.314	0.464
Report extramarital affair in last 12 months in 2004	0.120	0.325
Report extramarital affair in last 12 months in 2006	0.084	0.277
Incentive amount (Kwachas)	99.677	93.587
Distance to testing results center	1.941	1.224
Took HIV test in 2004	0.828	0.378
Took test and picked up test result	0.600	0.490
Number of observations	644	--

Table IIb
Descriptive Statistics by region for males
in 2004 and 2006 MDICP samples

Variable	BALAKA		MCHINJI		RUMPHI	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age (in 2006)	44.098	12.748	41.023	11.256	43.935	11.689
Moslem	0.661	0.475	0.019	0.135	0.012	0.110
Christian	0.333	0.473	0.944	0.230	0.890	0.314
No school	0.273	0.447	0.148	0.356	0.012	0.110
Primary education only	0.683	0.467	0.750	0.434	0.624	0.485
Secondary education	0.038	0.192	0.102	0.303	0.351	0.478
Percent Polygamous (in 2004)	0.115	0.312	0.111	0.315	0.265	0.442
Percent Polygamous (in 2006)	0.142	0.350	0.106	0.309	0.273	0.447
Number of children (2004)	4.355	2.689	4.194	2.767	5.355	3.544
Number of children (in 2006)	4.760	2.822	4.338	2.626	5.645	3.550
Num. children not reported (in 2004)	0.000	0.000	0.042	0.200	0.000	0.000
Num. children not reported (in 2006)	0.038	0.192	0.088	0.284	0.041	0.198
Desire more children (in 2006)	0.373	0.485	0.338	0.474	0.409	0.493
Metal roof	0.073	0.260	0.104	0.306	0.221	0.416
Believe that own prob of HIV is zero in 2004	0.721	0.450	0.681	0.467	0.641	0.481
Believe in low own prob of HIV in 2004	0.224	0.418	0.148	0.356	0.278	0.449
Believe in medium own prob of HIV in 2004	0.011	0.104	0.116	0.320	0.024	0.155
Believe in high own prob of HIV in 2004	0.044	0.205	0.056	0.230	0.057	0.233
Believe that own prob of HIV is zero in 2006	0.814	0.390	0.782	0.414	0.771	0.421
Believe in low own prob of HIV in 2006	0.142	0.3500	0.130	0.337	0.167	0.374
Believe in medium own prob of HIV in 2006	0.038	0.192	0.051	0.220	0.012	0.110
Believe in high own prob of HIV in 2006	0.005	0.074	0.037	0.189	0.049	0.216
Believe in low spouse prob of HIV in 2004	0.133	0.340	0.128	0.335	0.222	0.417
Believe in med spouse prob of HIV in 2004	0.005	0.074	0.041	0.199	0.058	0.233
Believe in high spouse prob of HIV in 2004	0.022	0.147	0.015	0.123	0.029	0.168
Believe in low spouse prob of HIV in 2006	0.095	0.294	0.101	0.302	0.105	0.308
Believe in med spouse prob of HIV in 2006	0.017	0.129	0.043	0.204	0.013	0.112
Believe in high spouse prob of HIV in 2006	0.006	0.075	0.005	0.069	0.025	0.157
Subjective probability of being HIV positive (number of beans) (in 2006)	0.601	1.245	0.995	1.989	0.747	1.946
Use condom in last 12 months in 2004	0.176	0.382	0.274	0.447	0.318	0.467
Use condom in last 12 months in 2006	0.289	0.455	0.323	0.464	0.476	0.501
Report extramarital affair in last 12 months in 2004	0.153	0.360	0.139	0.347	0.078	0.268
Report extramarital affair in last 12 months in 2006	0.120	0.326	0.079	0.270	0.061	0.240
Incentive amount	121.44	96.888	88.750	85.764	103.10	94.043
Distance to testing results center	2.313	1.499	1.571	0.948	1.990	1.118
Took HIV test in 2004	0.874	0.332	0.704	0.458	0.869	0.338
Took test and picked up result	0.694	0.462	0.551	0.499	0.571	0.496
Number of observations	183	--	216	--	245	--

Table IIIa
Cell frequency of indicator for engaged in extramarital affair
In 2004 and 2006

	No extramarital affair in last 12 months in 2006	Extramarital affair in last 12 months in 2006
No extramarital affair in last 12 months in 2004	529	38
Extramarital affair in last 12 months in 2004	61	16

Table IIIb
Cell frequency of condom use measures in 2004 and 2006

	Did not use condom in last 12 months in 2006	Used condom in last 12 months in 2006
Did not use condom in last 12 months in 2004	367	89
Used condom in last 12 months in 2004	59	105

Table IV
Average subjective belief of being HIV positive, reported by
Bean measure, within coarse belief categories

	Average belief measure (number of beans)
Believe that HIV probability is zero in 2006	0.18
Believe that HIV probability is low in 2006	1.72
Believe that probability is medium in 2006	4.48
Believe that probability is high in 2006	7.67

Table V
Changes in beliefs between 2004 and 2006
(rows sum to 100)

	Believe that HIV probability is zero in 2006	Believe that HIV probability is low in 2006	Believe that HIV probability is medium in 2006	Believe that HIV probability is high in 2006
Believe that HIV probability is zero in 2004	80.73%	12.61%	3.44%	3.21%
Believe that HIV probability is low in 2004	75.18%	19.15%	2.84%	2.84%
Believe that HIV probability is medium in 2004	69.70%	24.24%	6.06%	0.00%
Believe that HIV probability is high in 2004	76.47%	14.71%	0.00%	8.82%

Table VI
Probit estimation exploring correlates of extramarital affairs in 2006
(Std error in parentheses)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bean count measure of subjective belief	0.022*** (0.004)		0.018*** (0.004)		0.018*** (0.004)		0.019*** (0.004)	
Believe HIV prob is low†		0.124*** (0.042)		0.101*** (0.039)		0.103*** (0.039)		0.102** (0.040)
Believe HIV prob is medium or high†		0.230*** (0.073)		0.207*** (0.072)		0.215*** (0.073)		0.229*** (0.080)
Age in 2006			-0.006 (0.005)	-0.005 (0.005)	-0.004 (0.005)	-0.004 (0.005)	-0.005 (0.006)	-0.005 (0.005)
Age squared in 2006			0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Moslem			-0.039 (0.038)	-0.039 (0.037)	-0.047 (0.034)	-0.048 (0.033)	-0.024 (0.053)	-0.027 (0.050)
Christian			0.013 (0.044)	0.012 (0.044)	0.005 (0.045)	0.003 (0.045)	0.035 (0.044)	0.033 (0.045)
No school†			0.975*** (0.031)	0.970*** (0.044)	0.975*** (0.030)	0.969*** (0.042)	0.974*** (0.032)	0.975*** (0.034)
Primary school†			0.460*** (0.139)	0.443*** (0.143)	0.471*** (0.137)	0.455*** (0.139)	0.441*** (0.143)	0.448*** (0.146)
Secondary school†			0.982*** (0.027)	0.981*** (0.031)	0.982*** (0.026)	0.981*** (0.029)	0.977*** (0.037)	0.981*** (0.031)
Resides in Balaka †			0.108** (0.043)	0.097** (0.041)	0.108** (0.043)	0.097** (0.041)	0.118*** (0.045)	0.111** (0.044)
Resides in Rumphi†			-0.007 (0.024)	-0.014 (0.022)	-0.006 (0.024)	-0.013 (0.023)	0.005 (0.026)	-0.002 (0.024)
Polygamous			-0.022 (0.021)	-0.022 (0.021)	-0.013 (0.023)	-0.012 (0.023)	-0.011 (0.024)	-0.009 (0.023)
Number of children			0.007* (0.004)	0.008* (0.004)				
Number of children not reported			0.089 (0.075)	0.090 (0.075)				
Metal Roof			-0.007 (0.026)	-0.008 (0.025)	-0.002 (0.027)	-0.003 (0.026)	0.004 (0.029)	0.004 (0.028)
Desires more children							0.000 (0.001)	0.000 (0.001)
Pseudo R-Squared	0.066	0.069	0.144	0.151	0.134	0.140	0.141	0.148
Number of observations	643	644	641	642	641	642	607	608

* p < 10%, ** p < 5%, *** p < 1%

† The omitted categories are: Some years of higher education, resides in Mchinji, believe HIV prob is zero

Table VII
Probit estimation exploring correlates of condom use in 2006
(Std error in parentheses)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bean count measure of subjective belief	0.027*** (0.010)		0.022** (0.010)		0.021** (0.010)		0.027** (0.011)	
Believe HIV prob is low†		0.129** (0.056)		0.121** (0.057)		0.120** (0.057)		0.114* (0.059)
Believe HIV prob is medium or high†		0.146* (0.080)		0.129 (0.083)		0.119 (0.082)		0.173* (0.089)
Age in 2006			0.016 (0.013)	0.014 (0.013)	0.017 (0.012)	0.016 (0.012)	0.017 (0.013)	0.016 (0.013)
Age squared in 2006			-0.000** (0.000)	-0.000** (0.000)	-0.000** (0.000)	-0.000** (0.000)	-0.000** (0.000)	-0.000** (0.000)
Moslem			-0.033 (0.109)	-0.035 (0.109)	-0.022 (0.110)	-0.023 (0.110)	-0.031 (0.115)	-0.034 (0.115)
Christian			-0.229** (0.099)	-0.233** (0.099)	-0.208** (0.098)	-0.213** (0.098)	-0.199* (0.104)	-0.202* (0.104)
No school†			-0.280** (0.114)	-0.289*** (0.109)	-0.259** (0.125)	-0.268** (0.119)	-0.321*** (0.106)	-0.327*** (0.102)
Primary school†			-0.266 (0.261)	-0.280 (0.261)	-0.210 (0.251)	-0.222 (0.252)	-0.353 (0.299)	-0.362 (0.298)
Secondary school†			-0.161 (0.190)	-0.170 (0.186)	-0.130 (0.197)	-0.139 (0.194)	-0.235 (0.187)	-0.241 (0.184)
Resides in Balaka †			-0.051 (0.065)	-0.061 (0.065)	-0.043 (0.066)	-0.053 (0.065)	-0.046 (0.068)	-0.053 (0.068)
Resides in Rumphi†			0.137*** (0.051)	0.126** (0.051)	0.147*** (0.051)	0.136*** (0.051)	0.138*** (0.053)	0.127** (0.053)
Polygamous			-0.041 (0.052)	-0.040 (0.052)	-0.027 (0.050)	-0.025 (0.050)	-0.024 (0.052)	-0.021 (0.052)
Number of children			0.006 (0.009)	0.006 (0.010)				
Number of children not reported			-0.117 (0.076)	-0.117 (0.076)				
Metal Roof			-0.008 (0.054)	-0.007 (0.054)	0.001 (0.054)	0.003 (0.054)	-0.005 (0.055)	-0.005 (0.055)
Desires more children							0.001 (0.002)	0.001 (0.002)
Pseudo R-squared	0.009	0.011	0.105	0.108	0.101	0.103	0.100	0.101
Number of observations	621	622	619	620	619	620	585	586

* p < 10%, ** p < 5%, *** p < 1%

† The omitted categories are: Some years of higher education, resides in Mchinji, believe HIV prob is zero

Table VIII
Estimates of effects of beliefs on risky behavior based on
OLS and fixed effect/IV regression

Dependent variable: Extramarital Affairs indicator
(Std error in parentheses)

Variable	(1) OLS model	(2) OLS model	(3) IV model, instr. set (a)	(4) IV model, instr. set (b)	(5) IV model, instr. set (c)	(6) IV model, instr. set (d)
Constant	-0.085 (0.068)	-0.111* (0.062)	-0.112* (0.062)	-0.112* (0.062)	-0.095 (0.064)	-0.060 (0.070)
Age squared	$0.3x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.4x10^{-3}$ ($0.3x10^{-3}$)	$0.3x10^{-3}$ ($0.3x10^{-3}$)
Believe low prob of being HIV positive†	0.043 (0.038)	0.074** (0.031)	0.059 (0.042)	0.058 (0.042)	0.040 (0.049)	0.062 (0.045)
Believe medium or high probability of being HIV positive†	0.210*** (0.064)	0.162*** (0.051)	0.159*** (0.061)	0.159*** (0.061)	0.159** (0.077)	0.180*** (0.063)
Believe spouse status is low†	0.061 (0.044)				0.058 (0.053)	
Believe spouse status is medium or high†	-0.072 (0.085)				-0.027 (0.094)	
Number of children	-0.009 (0.010)					-0.059** (0.029)
R-squared	0.050	0.034	0.033	0.034	0.042	0.004
Number of observations	562	644	644	644	600	601

* p < 10%, ** p < 5%, *** p < 1%

†The omitted categories are: Believe zero probability of being HIV positive and believe that spouse has zero probability of being positive. The specification also includes an indicator for whether the number of children is missing. The age term is eliminated by the differencing to remove the fixed effect.

†† Instrument set (a) includes the lagged (2004) belief coarse categories (low and medium/high), the randomized incentive amount (for those that received an incentive), and the distance to the testing results center. Instrument set (b) adds a dummy for the randomized incentive amount equaling zero. Instrument set (c) includes lagged belief coarse categories (low, medium, and high), lagged spouse belief categories (low and medium/high), randomized incentive amount, and distance to the testing results center. Instrument set (d) adds the lagged number of children to instrument set (a).

Table IX

First stage IV estimates, for three sets of instruments ((a), (b), (c) and (d))

(Std error in parentheses)

Variable	(1) Dep Var: Difference in own belief category low				(2) Dep Var: Difference in own belief category med or high				(1) Dep Var: Difference in belief about spouse category low	(2) Dep Var: Difference in belief about spouse category med or high	(3) Dep Var: Difference in the number of children
Instrument set	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(c)	(c)	(d)
Constant	0.243*** (0.058)	0.247*** (0.060)	0.255*** (0.059)	0.270*** (0.073)	0.147*** (0.041)	0.147*** (0.042)	0.146*** (0.042)	0.155*** (0.041)	0.221*** (0.051)	0.027 (0.033)	0.559** (0.259)
Age squared	-0.4x10^{-3} (0.2x10^{-3})	-0.4x10^{-3} (0.2x10^{-3})	-0.5x10^{-3**} (0.2x10^{-3})	-0.8x10^{-3**} (0.3x10^{-3})	-0.4x10^{-3**} (0.2x10^{-3})	-0.4x10^{-3**} (0.2x10^{-3})	-0.3x10^{-3**} (0.2x10^{-3})	-0.6x10^{-3***} (0.3x10^{-3})	-0.5x10^{-3**} (0.2x10^{-3})	-0.1x10^{-3} (0.2x10^{-3})	0.005*** (0.002)
Believe own prob is low in 2004†	-0.937*** (0.034)	-0.937*** (0.034)	-0.941*** (0.041)	-0.934*** (0.036)	-0.012 (0.024)	-0.012 (0.024)	-0.035 (0.029)	-0.006 (0.024)	0.015 (0.035)	-0.024 (0.023)	0.166 (0.151)
Believe own prob is medium or high in 2004†	0.051 (0.047)	0.050 (0.047)		0.062 (0.050)	-0.998*** (0.033)	-0.998*** (0.033)		-1.015*** (0.034)			0.191 (0.212)
Believe own prob is medium in 2004†			0.046 (0.070)				-1.020*** (0.049)		-0.009 (0.060)	0.014 (0.038)	
Believe own prob is high in 2004†			-0.117 (0.076)				-1.023*** (0.054)		-0.110* (0.067)	0.001 (0.043)	
Believe spouse status is low†			-0.016 (0.045)				0.053* (0.032)		-0.991*** (0.038)	0.038 (0.025)	
Believe spouse status is medium or high†			0.234*** (0.072)				0.006 (0.051)		0.201*** (0.063)	-1.009*** (0.041)	
Distance to testing clinic	-0.028** (0.011)	-0.027** (0.012)	-0.028** (0.012)	-0.028 (0.012)	-0.005 (0.008)	-0.005 (0.008)	-0.005 (0.008)	-0.003 (0.008)	-0.021** (0.010)	-0.002 (0.006)	0.027 (0.050)
Randomized incentive amount	0.1x10^{-3} (0.1x10^{-3})	0.1x10^{-3} (0.1x10^{-3})	0.1x10^{-3} (0.1x10^{-3})	0.9x10^{-4} (0.2x10^{-3})	0.1x10^{-6} (0.1x10^{-3})	0.2x10^{-5} (0.1x10^{-3})	0.3x10^{-4} (0.1x10^{-3})	0.8x10^{-4} (0.1x10^{-3})	0.1x10^{-4} (0.1x10^{-3})	-0.7x10^{-4} (0.8x10^{-4})	-0.015 0.066
No incentive amount		-0.008 (0.038)				0.001 (0.027)					
Number of children in 2004				0.008 (0.006)				0.006 (0.004)			-0.225*** (0.025)
R-squared	0.553	0.552	0.554	0.547	0.599	0.599	0.598	0.611	0.610	0.601	0.124
F-Statistic	160.02	133.15	96.90	121.99	193.45	160.96	115.76	158.39	118.22	113.82	15.13
Number of observations	644	644	600	601	644	644	600	601	600	600	601

* p < 10%, ** p < 5%, *** p < 1%

†The omitted categories are: Believe zero probability of being HIV positive and believe that spouse has zero probability of being positive. The specification also includes an indicator for whether the number of children is missing. The age term is eliminated by the differencing to remove the fixed effect.

†† Instrument set (a) includes the lagged (2004) belief coarse categories (low and medium/high), the randomized incentive amount (for those that received an incentive), and the distance to the testing results center. Instrument set (b) adds a dummy for the randomized incentive amount equaling zero. Instrument set (c) includes lagged belief coarse categories (low, medium, and high), lagged spouse belief categories (low and medium/high), randomized incentive amount, and distance to the testing results center. Instrument set (d) adds the lagged number of children to instrument set (a).

Table X
Estimates of effects of beliefs on risky behavior based on
OLS and fixed effect/IV regression
Dependent variable: Condom use indicator
(Std error in parentheses)

Variable	(1) OLS model	(2) OLS model	(3) IV model, IV set (a)	(4) IV model, IV set (b)	(5) IV model, IV set (c)	(6) IV model, IV set (d)
Constant	0.174** (0.084)	0.119 (0.076)	0.119 (0.076)	0.119 (0.076)	0.133** (0.079)	0.159** (0.083)
Age squared	-0.3×10^{-3} (0.4×10^{-3})	-0.1×10^{-3} (0.4×10^{-3})	-0.1×10^{-3} (0.4×10^{-3})	-0.1×10^{-3} (0.4×10^{-3})	-0.1×10^{-3} (0.4×10^{-3})	-0.2×10^{-3} (0.4×10^{-3})
Believe low prob of being HIV positive†	0.021 (0.051)	-0.016 (0.039)	-0.024 (0.055)	-0.024 (0.055)	0.018 (0.066)	-0.020 (0.059)
Believe medium or high probability of being HIV positive†	-0.011 (0.077)	-0.002 (0.055)	-0.7×10^{-3} (0.071)	-0.7×10^{-3} (0.071)	0.006 (0.089)	-0.026 (0.077)
Believe spouse status is low†	-0.051 (0.056)				-0.062 (0.068)	
Believe spouse status is medium or high†	0.060 (0.106)				0.052 (0.112)	
Number of children	-0.014 (0.012)					-0.018 (0.036)
R-squared	0.006	0.004	0.0003	0.0003	0.002	
Number of observations	548	624	624	624	584	583

* p < 10%, ** p < 5%, *** p < 1%

†The omitted categories are: Believe zero probability of being HIV positive and believe that spouse has zero probability of being positive. The specification also includes an indicator for whether the number of children is missing. The age term is eliminated by the differencing to remove the fixed effect.

†† Instrument set (a) includes the lagged (2004) belief coarse categories (low and medium/high), the randomized incentive amount (for those that received an incentive), and the distance to the testing results center. Instrument set (b) adds a dummy for the randomized incentive amount equaling zero. Instrument set (c) includes lagged belief coarse categories (low, medium, and high), lagged spouse belief categories (low and medium/high), randomized incentive amount, and distance to the testing results center. Instrument set (d) adds the lagged number of children to instrument set (a).

Table XI
Estimates of effects of beliefs on risky behavior based on
OLS and fixed effect/IV regression and Bean Measure
Dependent variable: extramarital affairs indicator
(Std error in parentheses)

Variable	(1) OLS model	(2) OLS model	(3) IV model, instr. set (a)	(4) IV model, instr. set (a)	(5) IV model, instr. set (b)	(6) IV model, instr. set (b)	(7) IV model, instr. set (c)
Constant	-0.110* (0.062)	-0.113* (0.062)	-0.111* (0.062)	-0.115* (0.062)	-0.111* (0.062)	-0.108* (0.063)	-0.043 (0.071)
Age squared	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$* ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.5x10^{-3}$ ($0.3x10^{-3}$)	$0.3x10^{-3}$ ($0.4x10^{-3}$)
Mode beans of belief	0.021*** (0.007)	0.067*** (0.025)	0.018** (0.009)	0.088*** (0.032)	0.017** (0.009)	-0.044 (0.190)	0.022** (0.009)
Squared mode beans of belief		-0.006* (0.003)		-0.009** (0.004)		0.007 (0.023)	
Number of children							-0.068** (0.030)
R-squared	0.023	0.034	0.026	0.031	0.025		
Number of observations	644	644	644	644	644	644	601

* p < 10%, ** p < 5%, *** p < 1%

†The omitted categories are: Believe zero probability of being HIV positive. The specification also includes an indicator for whether the number of children is missing. The age term is eliminated by the differencing to remove the fixed effect.

†† Instrument set (a) includes the lagged (2004) belief coarse categories (low, medium and high), the randomized incentive amount (for those that received an incentive), and the distance to the testing results center. Instrument set (b) uses the lagged (2004) mode bean of beliefs instead the coarse categories. Instrument set (c) adds the lagged number of children to instrument set (a).

Table XII
First stage IV estimates, for three sets of instruments ((a) and (b))
(Std error in parentheses)

	(1) Dep Var: Difference in mode beans of beliefs			(2) Dep Var: Difference in squared mode beans of beliefs		(3) Dep Var: Number of children
	(a)	(b)	(c)	(a)	(b)	(c)
Constant	1.316*** (0.308)	1.295*** (0.304)	1.537*** (0.367)	8.612*** (2.549)	11.080*** (2.607)	0.376 (0.318)
Age squared	-0.004** (0.001)	-0.004** (0.001)	-0.005*** (0.002)	-0.026** (0.012)	-0.023* (0.013)	0.005*** (0.002)
Believe own prob is low in 2004†	-1.017*** (0.174)		-0.966*** (0.175)	-1.539 (1.443)		0.168 (0.152)
Believe own prob is medium in 2004†	-5.063*** (0.332)		-5.129*** (0.343)	-26.880*** (2.747)		0.302 (0.297)
Believe own prob is high in 2004†	-8.737*** (0.323)		-8.915*** (0.333)	-77.857*** (2.675)		0.119 (0.289)
Mode beans belief in 2004		-0.98*** (0.032)			-7.944*** (0.277)	
Distance to result center	-0.066 (0.059)	-0.064 (0.059)	-0.194 (0.210)	-0.367 (0.486)	-0.532 (0.502)	0.204 (0.182)
Randomized incentive amount	$0.8x10^{-4}$ ($0.9x10^{-3}$)	$0.2x10^{-3}$ ($0.9x10^{-3}$)	$0.1x10^{-3}$ ($0.9x10^{-3}$)	$-0.7x10^{-3}$ (0.007)	-0.008 (0.008)	$-0.4x10^{-4}$ ($-0.8x10^{-3}$)
No incentive amount	0.055 (0.198)	0.071 (0.195)	-0.015 (0.210)	0.814 (1.635)	-0.256 (1.670)	0.036 (0.173)
Number of children			0.039 (0.029)			-0.226*** (0.025)
R-squared	0.587	0.588	0.601	0.591	0.562	0.121
F-Statistic	131.74	184.84	101.28	133.58	165.89	10.19
Number of observations	644	644	601	644	644	601

* p < 10%, ** p < 5%, *** p < 1%

†The omitted categories are: Believe zero probability of being HIV positiv. The specification also includes an indicator for whether the number of children is missing. The age term is eliminated by the differencing to remove the fixed effect.

†† Instrument set (a) includes the lagged (2004) belief coarse categories (low, medium and high), the randomized incentive amount (for those that received an incentive), and the distance to the testing results center. Instrument set (b) uses the lagged (2004) mode bean of beliefs instead the coarse categories. Instrument set (c) adds the lagged number of children to instrument set (a).

Table XIII
Estimates of effects of beliefs on risky behavior based on
Heckman two step selection model
(Std error in parentheses)

	Variable	(1)	(2)	(3)	(4)	(5)
Outcome equation Dependent variable: Extramarital affairs indicator	Constant	-0.022 (0.073)	0.013 (0.086)	0.020 (0.082)	-0.032 (0.073)	-0.027 (0.072)
	Age squared	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
	Believe own prob is low in 2004	0.074^{**} (0.032)	0.074^{**} (0.032)	0.074^{**} (0.032)	0.073^{**} (0.032)	0.080^{**} (0.032)
	Believe own prob is medium or high in 2004	0.186^{***} (0.045)	0.186^{***} (0.045)	0.187^{***} (0.045)	0.186^{***} (0.045)	0.196^{***} (0.046)
	N	525	525	525	524	515
Selection equation Dependent variable: Staying in the 2006 sample	Constant	0.801^{***} (0.100)	0.361^{*} (0.193)	-0.993^{*} (0.524)	0.739^{**} (0.369)	-0.470 (0.684)
	Balaka	-0.325^{**} (0.129)	-0.361^{***} (0.130)	-0.338^{**} (0.131)	-0.702^{***} (0.189)	-0.766^{***} (0.195)
	Rumphi	0.354^{**} (0.141)	0.321^{**} (0.142)	0.321^{**} (0.143)	0.251 (0.174)	0.281 (0.185)
	Final HIV result	-1.097^{***} (0.186)	-1.111^{***} (0.187)	-1.187^{***} (0.189)	-1.215^{***} (0.203)	-1.251^{***} (0.209)
	Age		0.012^{***} (0.004)	0.083^{***} (0.026)	0.010^{*} (0.005)	0.072^{**} (0.030)
	Age Squared			-0.001^{***} (0.000)		-0.001^{**} (0.000)
	Muslim				0.215 (0.348)	0.365 (0.355)
	Christian				0.122 (0.306)	0.172 (0.310)
	Metal Roof					-0.310 (0.193)
	Polygamous					0.107 (0.199)
	N	699	699	699	641	628
Mills Ratio		-0.172^{*} (0.103)	-0.173^{*} (0.102)	-0.193^{**} (0.094)	-0.136 (0.096)	-0.144 (0.091)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1a,b: Histogram of beliefs in 2004 and 2006

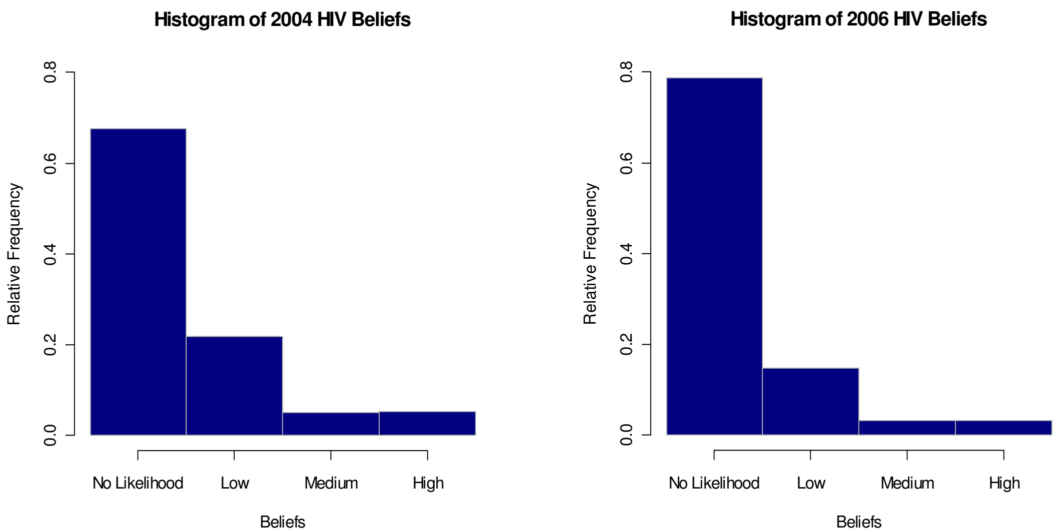

Figure II: Histogram of changes in beliefs

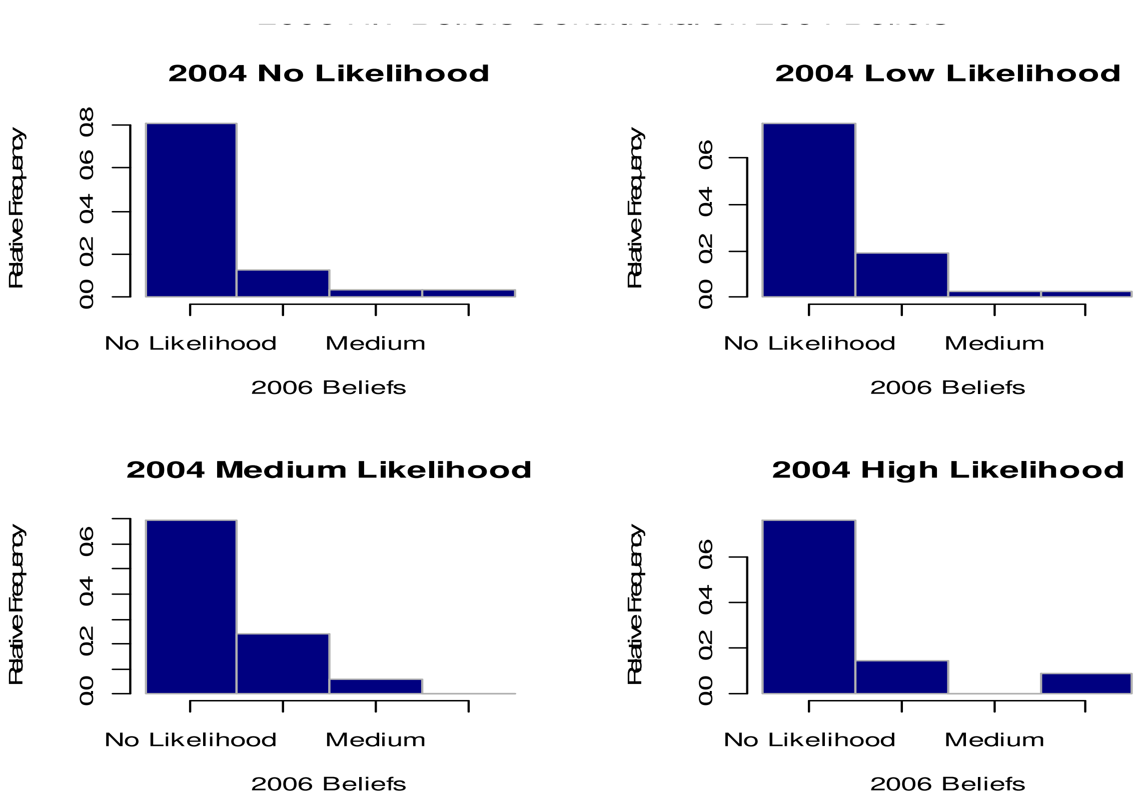

Figure III: Histogram of incentive amounts