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

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SUMMARY

This paper examines how beliefs about own HIV status affect decisions to engage in risky sexual behavior, as measured by having extramarital sex and/or multiple sex partners. The empirical analysis is based on a panel survey of males from the 2006 and 2008 rounds of the Malawi Diffusion and Ideational Change Project (MDICP). The paper develops a behavioral model of the belief-risky behavior relationship and estimates the causal effect of beliefs on risky behavior using the Arellano and Carrasco (2003) semiparametric panel data estimator, which accommodates both unobserved heterogeneity and belief endogeneity arising from a possible dependence of current beliefs on past risky behavior. Results show that downward revisions in the belief assigned to being HIV positive increase risky behavior and upward revisions decrease it. For example, based on a linear specification, a decrease in the perceived probability of being HIV positive from 10 to 0 percentage points increases the probability of engaging in risky behavior (extramarital affairs) from 8.3 to 14.1 percentage points. We also develop and implement a modified version of the Arellano and Carrasco (2003) estimator to allow for misreporting of risky behavior and find estimates to be robust to a range of plausible misreporting levels.

To prevent the further spread of HIV, government and nongovernmental organizations have implemented a variety of public health interventions, including increasing access to testing and treatment services, informational campaigns, and condom distribution programs. It is hoped that informing individuals about their own HIV status and about methods of avoiding transmission will reduce incidence rates, although the quantitative evidence on behavioral responses is scarce. A study by Thornton (2008), described in Section 2, finds that individuals in Malawi who received positive HIV test results modestly increased condom purchases but did not alter sexual behavior over a 2-month timeframe following test result dissemination. Oster (2012) also shows little response of sexual behavior to local prevalence rates using Demographic and Health Surveys data for a subset of African countries. Philipson and Posner (1995) report similar findings for the USA.

Two ingredients are necessary for a program intervention to effectively reduce HIV incidence. First, the intervention must alter individuals' beliefs about their own HIV status, HIV prevalence and/or about the technology for transmission; and, second, these belief changes must induce changes in behavior. In the context of rural Malawi, the link between HIV testing and beliefs has been tenuous. Table I shows the 2004 and 2006 test results given to males in the Malawi Diffusion and Ideational Change Project (MDICP) sample used in our analysis and their reported belief of being HIV-positive 2 years later (in 2006 and 2008). One would expect those receiving a positive test result to revise their belief of being positive upward (perhaps to 100%) and those receiving a negative test outcome to revise their belief downward. However, as seen in the table, the majority of individuals who tested positive in 2004 and 2006 report a zero probability of being positive 2 years later. There are also some individuals who test negative in 2004 and 2006 and assign a high probability to being positive 2 years later.

The evidence reported in this paper and in Delavande and Kohler (2009) indicate that beliefs are not completely revised in accordance with test results, although the reasons why are not fully understood. HIV-positive individuals are typically asymptomatic for many years and may therefore not believe that they carry the disease, particularly in the earlier years when testing was less prevalent. A high reported belief of being positive in 2006 despite a negative test result in 2004 could also reflect interim risky behavior. Lastly, the testing protocol required a second test whenever a positive result was obtained and a third test whenever the first and second tests were discordant, which induced a very low probability of a false positive. Nonetheless, some MDICP respondents expressed skepticism about the quality of the tests administered in 2004, which was likely exacerbated by an initial delay of one or more months in providing the test results. Tests administered in 2006 and 2008 used more rapid testing technology and did have this delay.

This paper focuses on the second ingredient mentioned above and analyzes how beliefs about own HIV status influence risky behavior. The effect of participating in HIV testing on risky behavior has been examined in previous studies, but the belief–behavior relationship has received less attention. This relationship is independently of interest, because the effects of many policy interventions, such as HIV testing programs or public awareness programs, are mediated through changes in beliefs.

Table I. HIV test results in 2004 and reported beliefs of own probability of infection 2 years later[a]

	HIV test outcome in 2004		HIV test outcome in 2006	
Reported belief category 2 years later	Negative	Positive	Negative	Positive
Zero probability	401	8	232	6
Low probability	77	6	144	5
Medium probability	12	2	31	2
High probability	15	4	8	2

[a]Sample of males who got tested and learned the test result.

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Additionally, beliefs can change over time even in the absence of policy interventions, for example, in response to past risk exposure or to new information about the HIV status of previous sex partners.

Our empirical analysis is based on panel data from the MDICP survey, which contain unique measures of beliefs about own HIV status that vary substantially across people and over time. The sample covers rural populations from three different regions in Malawi, where overall HIV prevalence is approximately 7%. The survey is unusual in that it includes measures of individuals' reported beliefs about their own and their spouse's HIV status as well as information on whether they engaged in risky behaviors. We use data from the 2004, 2006 and 2008 survey waves. We focus on men, who are more likely than women to report risky behavior. The rate of risky behavior need not be the same for men and women. First, it is more socially acceptable for men to report having multiple partners and extramarital affairs than for women. Second, men engage in some practices that are not common for women, such as having transactional sexual relationships with younger women. Because our analysis focuses on men, the results may not apply to other demographic groups.

Of key concern in any analysis of the relationship between sexual behavior and beliefs is the potential for endogeneity arising from a likely dependence of current beliefs on past behavior. Such a dependence leads to bias for both cross-section and within estimators (in linear models). Other panel data estimators (e.g. conditional logit) are also inappropriate as they do not allow for feedback from lagged behavior on current beliefs (a violation of strict exogeneity). For this reason, we estimate our model using a semiparametric panel data estimator developed by Arellano and Carrasco (2003), which accommodates feedback from lagged behavior on current beliefs and unobservable heterogeneity. We also develop a modified version of the Aarellano Carrasco (2003) estimator that allows for potential under-reporting of risky behaviors.

Section 2 summarizes related literature. Section 3 presents a simple model of risky behavior that illustrates that the net effect of changing beliefs on risk-taking is theoretically ambiguous and which guides the choice of variables in our empirical analysis. Section 4 presents our empirical strategy for estimating the causal effect of beliefs about own HIV status on risk-taking behaviors. Section 5 describes the empirical results based on the Arellano and Carrasco (2003) estimator and on our modified version that allows for misreporting of risky behavior. Section 6 discusses policy implications.

2. RELATED LITERATURE

The notion that individuals change their behavior in response to communicable diseases is generally well accepted and there is a theoretical literature that explores the general equilibrium implications of this type of behavioral response. Philipson (2000), for example, surveys alternative 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 a disease (Dow and Philipson, 1996); models that relate prevalence rates and the demand for vaccination; models for the optimal timing of public health interventions; and models for studying the implications of information acquisition (e.g. testing) for asymptomatic diseases such as HIV. In another theoretical study, Mechoulan (2004) shows that without a sufficient fraction of altruistic individuals testing can increase disease incidence.

Thornton (2008) empirically examines the causal impact of receiving HIV test results on risky behavior. When the 2004 tests were administered, the MDICP project team carried out an experiment that randomized incentives to pick up the test results. Thornton (2008) analyzes data from this experiment along with data from a 2-month follow-up survey that gathered information on condom purchases and risky sexual behavior. Using the randomized incentive as an instrument for picking up the test results, she finds that learning a positive test result modestly increased condom purchases but did not alter sexual behavior. Individuals who tested negative tended to revise their subjective

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beliefs about being HIV-positive downward and those who tested positive did not significantly revise their beliefs.

Although also based on MDICP survey data, our study differs from Thornton's in a number of ways: (i) a focus on identifying the causal belief–behavior relationship rather than HIV testing–behavior relationship; (ii) the use of new data gathered in the 2006 and 2008 rounds of the MDICP sample that contain more detailed measures on beliefs than were available in the 2004 round and that is not conditioned on having picked up the test results in 2004; (iii) the use of a different modeling framework and estimation methodology; and (iv) the use of different measures of risky behavior (extramarital sex and multiple sex partners, measured annually).

Boozer and Philipson (2000) analyze the relationship between HIV status, testing and risky behavior using data from the San Francisco Home Health Study (SFHHS). Our identification strategy is similar to theirs in that we also make use of belief information gathered in two time periods, where individuals had the opportunity to get tested in the intervening period. 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 and find that decreases in the probability assigned to being HIV-positive 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 unlikely to be infected and discover otherwise reduce their number of partners. Our empirical findings are similar, despite the different study population and estimation approach.

Coates et al. (2000) and Gong (2012) analyze data from a Voluntary Counseling and Testing (VCT) Efficacy Study: a randomized trial that took place in Kenya, Tanzania, and Trinidad in the mid 1990s. Study participants were randomly assigned to a treatment group that received VCT or to a control group that received basic health information. Data were gathered on self-reported sexual behavior. Sexually transmitted infections (STIs) were also diagnosed and treated at first follow-up. Coates et al.'s (2000) analysis finds that VCT reduced risky behavior, as measured by self-reported unprotected intercourse. More recently, though, Gong (2012) reanalyzed the data from the African sites, including the STI outcome data, and found that individuals who originally believed themselves to be HIV-negative and were surprised by a positive test result were more likely to contract an STI, while the reverse was true for those who were surprised by a negative test result. He concludes that informing people of a positive test has the unintended consequences of increasing risky behavior. Gong argues that biological STI measures are better indicators of risky behavior than self-report measures, because they are not affected by misreporting. However, misclassification of risky behavior is also possible when biological measures are used, as not all individuals who engage in risky behavior contract an STI. Comparing Gong's study population to ours, notable differences are that his sample is younger and contains a higher proportion of single and urban individuals. His data were also gathered at a time when there were fewer HIV treatment options, which may affect how individuals respond to testing and to changes in beliefs about own HIV status.

As we describe in detail later, the MDICP survey measured beliefs about own HIV status using two different measurement instruments. In the 2004, 2006 and 2008 surveys, individuals were asked to choose one of four categories: no likelihood, low likelihood, medium likelihood and high likelihood. In 2006 and 2008, the categorical measure was supplemented with a numerical measure, which is our main belief measure in this paper. Delavande and Kohler (2009) used the MDICP data to study the accuracy of individuals' reported numerical beliefs of being HIV-positive and provided detailed documentation of the method used in the surveys to elicit the probabilistic beliefs. They found that the probability assessments on HIV infection gathered in the 2006 round of the survey were remarkably well calibrated to local community prevalence

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rates. For the 2004 wave of the MDICP data, however, the likelihood of own infection is reported only in broader categories. Anglewicz and Kohler (2009) point out that individuals in the 2004 wave seem to overestimate 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 6% for men and 9% for women. In reconciling the 2004 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 still remain in translating the coarse categories into more precise assessments. [1] In this paper, we make use of both the coarse belief categories and the finer measurements gathered in 2006 and 2008, as further described in Section 4.

In a follow-up paper, Delavande and Kohler (2012) use the 2004 and 2006 MDICP data to

3. A MODEL OF RISKY BEHAVIOR CHOICES

As noted in the Introduction, theoretical models are usually ambiguous as to the direction of the relationship between beliefs about one's own HIV status and risk-taking behaviors. Downward revisions in beliefs, as may arise from learning a negative test result, should increase the expected length of life and thereby increase the benefits from risk avoidance. On the other hand, if, as in our sample, individuals tend to overestimate the probability of becoming HIV-infected from one sexual encounter with an infected person, then learning that they are HIV-negative despite a past life of risky behavior may increase their willingness to take risks. [2] This channel is not included in the theoretical model presented here but is allowed to operate in our empirical analysis, as later described. Altruism also plays an important role in HIV transmission; people who are altruistic should curtail risky behaviors after an upward revision in beliefs. Other factors that may also influence transmissive behavior are social or legal sanctions imposed on HIV-positive individuals.

To explore the relationship between beliefs of own HIV status and sexual behavior, we next present a simple two-period model. It assumes that individuals choose their level of risky behavior in the first period and update their beliefs of own HIV status in a Bayesian way. Let $\widetilde{Y}_0 \in \mathbb{R}$ denote an individual's chosen level of risky sexual behavior (which represents activities such as engaging in extramarital sex or having multiple sex partners). The (perceived) probability of infection is an increasing function of risky behavior and we denote it by $g(\widetilde{Y}_0) \in [0, 1]$. In a multi-period context, this belief may also be updated through time but we take it as predetermined when the risky behavior decision is taken. Other factors, such as the prevalence rate in the community, modulate the link between sexual behavior and the likelihood of infection and could also be incorporated into the function $g(\cdot)$. We abstract 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, B_0, to directly affect utility: $U(\widetilde{Y}_0, , B_0)$. How beliefs affect the marginal utility of risky behavior can be regarded as a measure of altruism or the degree to which social sanctions on transmissive behavior by HIV-positive individuals affect the utility of sexual intensity. 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. The belief of being HIV-positive in the second period (B_1) depends on previous period beliefs (B_0) plus the probability of having contracted the disease in the last period:

$$B_1 = B_0 + (1 - B_0)g(\widetilde{Y}_0) \tag{1}$$

The individual's problem is

$$\max_{\widetilde{Y}_0} \left\{U(\widetilde{Y}_0, B_0) + \beta(1 - \lambda B_1)\overline{U}\right\}$$

or, equivalently,

$$\max_{\widetilde{Y}_0} \quad U \ \widetilde{Y}_0$$

The first-order condition yields

$$U_1\left(\widetilde{Y}_0, B_0\right) - \beta\lambda(1 - B_0)g'\left(\widetilde{Y}_0\right)\overline{U} = 0 \tag{2}$$

where $U_1(\cdot,\cdot)$ denotes the derivative of $U(\cdot,\cdot)$ with respect to its first argument. This condition implicitly defines $\widetilde{Y}_0$ as a function of the belief variable B_0. Furthermore,

$$\frac{d\widetilde{Y}_0}{dB_0} = -\frac{U_{12}\ \widetilde{Y}_0, B_0}{} \qquad 0 \qquad U$$

$\widetilde{Y}$

for misreporting in the variable $\widetilde{Y}_{it}$. B_{it} denotes an individuals' beliefs at time t about their own HIV status, measured on a 0–10 scale (with 0 being no likelihood of being HIV-positive and 10 being positive with certainty).

The empirical specification (without misreporting) can be written as

$$\widetilde{Y}_{it} = 1\ \alpha + \beta B \quad B \quad B$$

shocks (v_{it} s) invoked in nonlinear panel data settings (i.e. strict exogeneity). An advantage of the Arellano and Carrasco (2003) estimator is that it only requires that covariates be independent from current and future idiosyncratic shocks (v_{it} s), but not past ones (i.e. assumes weak

These are computed as in Arellano and Carrasco (2003), replacing population expectations and parameters by sample averages and estimates. In particular:

$$\mathbb{E}\left(\widehat{f\,i|W_i^t}\right) = \Lambda^{-1}\left(\widehat{h_t\left(W_i^t\right)}\right) - \hat{\alpha} - \hat{\beta}B^{''} - \hat{\gamma}X_{it}$$

This marginal effect measures the causal impact of beliefs on risky behavior, holding constant the individual effect (f_i) (similar considerations are discussed in Chamberlain (1984, pp. 1272–1274)).

Finally, in our robustness analysis we also consider the possibility that some fraction of individuals who engage in risky behavior report that they do not. To this end, we adapt ideas developed by Hausman et al. (1998) to the Arellano and Carrasco (2003) framework. We assume that individuals always report truthfully when they do not engage in extramarital sex and with a probability α_1 lie about having extramarital sex. Thus, letting Y_{it} denote reported behavior and $\widetilde{Y}_{it}$ denote true behavior:

$$\mathbb{P}\ Y_{it} = 1\ \widetilde{Y}_{it} = 0) = 0 \qquad \mathbb{P}\ Y_{it} = 0\ \widetilde{Y}0$$

information gathered from five rounds of a longitudinal survey (1998, 2001, 2004, 2006, 2008) that together contain extensive information on socio-economic indicators, household composition, sexual and partnership histories, and risk assessments of more than 2500 men and women. We primarily use the 2006 and 2008 survey rounds that include detailed information on beliefs about own HIV status combined with cruder measures on reported beliefs from the 2004 survey round. Also, for reasons described previously, we analyze data on men.

Recent studies on the quality of this survey have compared the MDICP sample to other survey samples from rural Malawi. Anglewicz et al. (2009) compare the MDICP participants in 2004 to the 2004 rural population in the Malawi Demographic Health Survey (DHS). MDICP subjects tend to be older (see Table 1.1 in that paper), more educated, more likely to be married, more likely to have known individuals with AIDS but somewhat less knowledgeable about the disease. The authors conjecture that the difference might be explained by the fact that the Malawi DHS includes rural townships, whereas the whole MDICP sample resides in villages. The supplementary Web Appendix provides further information about Malawi and the survey (see also Watkins et al., 2003).

The MDICP survey measured beliefs about own HIV status using two different measurement instruments. In the 2004, 2006 and 2008 surveys, individuals were asked to choose one of four categories: no likelihood, low likelihood, medium likelihood and high likelihood. In 2006 and 2008, the categorical measure was supplemented with a probability measure. One might be concerned that low-education populations would have difficulty in reporting probabilities. For this reason, the MDICP survey used a novel bean-counting approach to elicit probabilities, in which these were measured on a 0–10 bean scale, where more beans for a particular event correspond to a higher probability assessment for that event (see the supplementary Web Appendix for details). The measures of subjective beliefs are valuable, because decision making is affected by how individuals perceive their environment, whether their perceptions are correct or not. Although we cannot directly validate whether reported beliefs correspond to actual perceptions, Delavande and Kohler (2009) show that the beliefs correlate as expected with the variables associated with HIV infection likelihood. As with other empirical studies using belief data, our analysis assumes that subjective beliefs are accurately reported. If people do not accurately report subjective beliefs because of fear of stigma, for example, then the estimates could be biased.

Finally, we note that beliefs are measured at the time of the interview (in 2006 and 2008), whereas the risky behavior measure pertains to the preceding 12 months of each interview. We therefore assume, in terms of timing, that the beliefs reported at the interview are roughly stable over the pumeseo[(the)mes

Table II. Descriptive statistics. Sample: males in 2006 and 2008 MDICP samples

Variable	Mean	SD
Age (in 2008)	45.739	11.639
Muslim	0.239	0.427
Christian	0.717	0.451
No school	0.102	0.303
Primary education only	0.702	0.458
Secondary education	0.184	0.388
Higher education	0.012	0.109
Reside in Balaka	0.318	0.466
Reside in Rumphi	0.372	0.484
Reside in Mchinji	0.310	0.463
Polygamous (2006)	0.173	0.379
Polygamous (2008)	0.168	0.375
Number of children (2006)	5.050	3.032
Number of children (2008)	5.538	2.802
Number of children not reported (2006)	0.046	0.210
Number of children not reported (2008)	0.000	0.000
Metal roof 2006	0.152	0.359
Metal roof 2008	0.201	0.401
Believe that own prob. of HIV is zero in 2006	0.792	0.406
Believe that own prob. of HIV is low in 2006	0.152	0.359
Believe that own prob. of HIV is medium in 2006	0.029	0.168
Believe that own prob. of HIV is high in 2006	0.027	0.163
Believe that own prob. of HIV is zero in 2008	0.551	0.498
Believe that own prob. of HIV is low in 2008	0.341	0.475
Believe that own prob. of HIV is medium in 2008	0.081	0.272
Believe that own prob. of HIV is high in 2008	0.027	0.164
Subjective prob. of being HIV positive, bean count measure (2006)	0.734	1.701
Subjective prob. of being HIV positive, bean count measure (2008)	1.371	1.824
Subjective prob. of spouse being HIV positive, bean count measure (2006)	0.663	1.552
Subjective prob. of spouse being HIV positive, bean count measure (2008)	1.430	1.923
Extramarital sex in last 12 months in 2006[a]	0.079	0.270
Extramarital sex in last 12 months in 2008[a]	0.109	0.312
Number of partners in 2006	1.276	1.444
Number of partners in 2008	1.342	1.821
More than one partner in 2006	0.201	0.401
More than one partner in 2008	0.210	0.407
Took HIV test in 2006	0.937	0.243
Took HIV test in 2008	0.816	0.388
Number of observations	587	—

[a]This variable defined conditional on being married.

with them. For example, out of the 580 men in our sample who were married in 2006, 67% report that their spouse has been tested, and, of those, 97% report that the test result was shared. With regard to risky behavior, 7.9% in 2006 and 10.9% in 2008 reported having extramarital sex in the last 12 months. For those married in both rounds, the numbers are 4.3% and 10.5%.[6]

The average number of sex partners was about 1.27 in 2006 and 1.34 in 2008, with monogamous men reporting on average 1.05 and 1.18, respectively. The average number of partners for younger men (men under the age of 50) is similar to that for the overall sample. The proportion of men reporting more than one partner in 2006 was 20% and in 2008 was 21%. For monogamous men the numbers go down to around 5% in both years. As previously noted, HIV testing was offered in 2006 and 2008. 93.7% of the sample was tested in 2006, in comparison with 81.6% in 2008.

Table III explores the potential determinants of decisions about extramarital sex and having more than one sexual partner, using a standard logit regression applied to 2006 and 2008 data. The bean

[6] A number of individuals engaging in extramarital sex are only married in one of the rounds and thus are not used in the estimation sample for analyzing the extramarital affairs outcome. However, they are included in the analysis of the other risky behavior measure 0.2(0.201)o6ramaM(0.201rtal)wple partners.

count measure (reported in columns (1) and (5)) is the regressor used later in our implementation of Arellano and Carrasco (2003). The disaggregated measures (columns (2), (3), (6) and (7)) are also used later in the Arellano

Table III. Logistic estimation of risky sex determinants in 2006 and 2008 (Standard errors in parentheses)

	Extramarital sex						More than one sex partner					
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Bean Count[(a)]	0.139**			0.138**			0.105***			0.197**		
	(0.055)			(0.061)			(0.037)			(0.080)		
One Bean[a]		0.297	0.295		0.268	0.264		0.137	0.137		0.662	0.665
		(0.384)	(0.384)		(0.392)	(0.393)		(0.223)	(0.223)		(0.414)	(0.413)
2-10 Beans[a]		0.753***			0.616**			0.585***			1.285***	
		(0.289)			(0.307)			(0.174)			(0.369)	
2-4 Beans[a]			0.625*			0.402			0.586***			1.345***
			(0.323)			(0.348)			(0.196)			(0.365)

individuals who revise their beliefs downward in response to a negative test would increase risk-taking

5.4. R

5.4.1. Misreporting

Because risky sexual behavior may be considered a sensitive subject, an obvious concern is misreporting. In this subsection, we explore the robustness of the previously estimated specification to allow for misreporting of risky behavior. To investigate the potential problem of misreporting, the MDICP team carried out a small set of qualitative interviews with men who had reported not having extramarital sex during the 1998 round of the survey. 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. Slightly over 9% of those who had originally denied infidelity admitted otherwise in these informal interviews. Even though the reference period in the 1998 survey was longer and the men may tend to exaggerate in these casual conversations, this provides some evidence of under-reporting by the respondents during the more formal interviews.

To gain intuition into why misreporting leads to an attenuation bias in the estimated coefficients, consider a linear model. Under linearity, $\mathbb{E}\left(Y \middle| X\right) = ((1-\alpha_1)\beta)' X$ and the estimated parameters are attenuated by $\alpha_1 > 0$. In our nonlinear case, procedure some, because the cells used in the estimation now need to be constructed using these additional covariates. We base the new cells on quartiles of perceived prevalence, but the average number of individuals per cell still drops from 21 to less than 10 in the extramarital sex regressions, once prevalence is included for example. The estimated effect of beliefs on risky behavior is still negative once prevalence is added and the coefficient is highly significant in the linear specification and jointly significant in the quadratic specification.

6. CONCLUSIONS

This paper examines how beliefs about own HIV status affect decisions to engage in risky behavior, as measured by extramarital sex and having multiple sexual partners. We use a unique panel survey from Malawi that includes detailed longitudinal measures of subjective beliefs and behaviors. The men in our sample were given the opportunity to get tested for HIV in 2004, 2006 and 2008 and most availed themselves of the opportunity, often multiple times. Reported beliefs about the probability of being HIV-posi

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