HIV Testing and Subjective Expectations in Rural Malawi

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About 6.1% of the adults living in Sub-Saharan Africa (SSA) are infected with HIV/AIDS, with HIV prevalence reaching 30% in some countries. Policies aiming at curtailing the epidemic are thus crucial. Voluntary HIV Counseling and Testing (VCT) programs are often part of national AIDS prevention strategies, and in many cases a key component of AIDS control programs. This roll-out of VCT is mostly driven by claims that informing individuals about their HIV status eliminates uncertainty about own – and, to the extent that information is shared – also family members' HIV status, and that individuals subsequently engage in less risky behavior or take precautions to reduce the risk of further sharing the virus. Yet, the existing empirical evidence on the effectiveness of VCT in reducing HIV transmission or risky behavior is mixed (e.g. Joseph Matovu et al., 2005). One potential reason for the lack of effect of VCT on behavior could be that testing does not result in persistently more accurate subjective beliefs about one's own infection status. In this paper, we investigate this possibility by using unique data on *probabilistic subjective expectations* about HIV infection that we have collected in rural Malawi from respondents who had been previously tested for HIV. We find differential effects of testing by HIV status. On the one hand, most of the individuals who are told they are HIV-positive do not persistently believe they are infected. On the other hand, individuals who learn they are HIV-negative have subsequent HIV expectations that reflect that (*i*) they believe their test result and (*ii*) they take into account their sexual behavior (and the one of their partners) since testing to revise their expectations about current infection.

I. Data

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This paper uses data collected in rural Malawi as part of the Malawi Diffusion and Ideational Change Project (MDICP). The MDICP gathers an unusually rich combination of panel survey data (1998, 2001, 2004, 2006) including among other aspects information on (a) sexual relations; (b) marriage and partnership histories; (c) respondent's HIV status for all consenting respondents and (d) subjective expectations about economic and health outcomes. In 2006, the MDICP included more than 3,200 male and female respondents aged 17 to 60.[1] The subjective expectations were collected for the first time in 2006 using an *interactive elicitation technique* based on asking respondents to allocate up to ten beans on a plate to express the likelihood that an event will be realized (Adeline Delavande and Hans-Peter Kohler 2007).[2] The bean format has the advantage of being visual, relatively intuitive and fairly engaging for respondents. After a short introduction, respondents were asked their expectations about a wide range of health and economic outcomes, including the likelihood about being *currently infected with HIV* and other AIDS-related outcomes. The expectations module was administered to all respondents, with item non-response ranging between .4 to 1.3%, thus substantially lower than non-response levels to expectation questions in surveys conducted in developed countries, such as the Health and Retirement Study. Delavande and Kohler (2007) show that, remarkably, almost all respondents are found to provide beliefs consistent with basic properties of probability theory. Moreover, for basically all the considered domains, we find that the central tendencies and percentiles of the distributions of elicited subjective probabilities vary with observable characteristics, such as gender, age, education, and region of residence in the same way that actual outcomes vary with these variables. For example, expectations about infant mortality exhibit regional differences that are similar to ac-

[1] Comparisons with the Malawi Demographic and Health Survey showed that the MDICP sample population is reasonably representative of the rural Malawi population (Philip Anglewicz et al. 2007). Detailed descriptions of the MDICP sample selection, data collection and data quality are provided in Anglewicz et al. (2007).
[2] After diving the number of beans by 10, the answers can be interpreted as probabilities.

tual outcomes, and expectations about economic outcomes vary with socio-economic status in the expected directions. Moreover, expectations about future events vary across individuals in the same way past experience does. These systematic relationships between elicited expectations and characteristics provide strong evidence that individuals in a developing country are able to provide meaningful answers when asked about their beliefs in a probabilistic manner. Yet, there is substantial heterogeneity in beliefs, even among respondents sharing similar characteristics.

II. HIV infection expectations subsequent to HIV testing

As part of the 2004 MDICP, respondents were offered a free HIV test.[3] The results of the tests were available 4-6 weeks after the test, so about 2/3 of the tested respondents obtained the result and learned their HIV status.[4] For our analysis, we focus on the 2006 HIV expectations of respondents who learned their results in 2004. In total, our sample is composed of 1,514 respondents. Out of those, 4.3% were HIV-positive in 2004. Table 1 presents the distributions of beliefs about current HIV infection elicited in 2006 according to the 2004 HIV-status. It shows that, surprisingly, only about 10% of the respondents who were told they were HIV positive in 2004 provided 10 beans, while 37% report 0 beans. The most common answers are 0, 1 and 3 beans. Though higher than the average among respondents who were HIV-negative in 2004 (0.91 beans), the average of 2.8 beans seems awfully low. These findings are astonishing and one may wonder if they are specific to the format we use to elicit beliefs. However, a similar pattern emerges with a verbal scale: 45% of the HIV-positive respondents report that they have "no likelihood" of being infected in 2006, while 15% report that they have a low likelihood. Moreover,

[3] Only 9% of the respondents refused to get tested.

[4] Respondents were offered a randomized financial incentive to pick up their test results. Rebecca Thornton (2006) finds that learning HIV results was highly responsive to the financial incentives and distance of the results center, which was also randomized, and VCT participation is significantly predicted by both. So, while there might be a potential selection issue such that individuals who went to pick their results may revise their beliefs differently than those who did not, the issue is to some extent mitigated by the randomized incentives: some respondents who would not have picked their results without incentives learned their HIV status.

there is a good correspondence between the two wordings. For example, out of the 28 respondents report that they have "no likelihood" of being currently infected, 21 allocated 0 beans. There are different hypotheses that can be advanced to explain this pattern: (*i*) Respondents may not trust the test result and have never believed that they were HIV-positive; (*ii*) Respondents may believe the test result at first but forget about it as time elapses, and especially if they feel healthy; (*iii*) Respondents actually believe that they are HIV-positive but are embarrassed to acknowledge it in front of the interviewer. Given the lack of data on expectations immediately after the HIV testing and the small sample size, it is hard to test these hypotheses.[5] However, self-reported health is definitely associated with HIV expectations for those respondents. Half of the HIV-positive respondents report that they feel in "excellent" or "very good" health and those have a lower average infection belief than the others (1.9 versus 3.8 beans[6]). No pattern emerges by education level.

Table 10 also shows that about two-third of the respondents who were told that they were HIV-negative in 2004 believe that their chance of being infected is very low in 2006 by allocating 0 beans on the plate. A third of them, however, have now provided strictly positive beliefs, most of them allocating 1 to 5 beans. We investigate which factors influence beliefs about current HIV infection for those respondents. In table 2, we present the best linear predictor under square loss of the HIV infection expectation using demographic characteristics, AIDS-related expectations (including the subjective probability that someone of the respondent's gender who is healthy would become HIV+ within 12 months under various scenarios), perceived local HIV prevalence and past sexual histories as dependent variables. For all respondents, demographic characteristics such as age, education or wealth have limited predictive power. However, sexual histories and

[5] Thornton (2006) who re-interviewed a subset of the respondents 2 months after testing found similarly that a large proportion of the HIV-positive who learned their results believed that they had a low likelihood of being infected.
[6] We can reject the hypothesis that the two averages are equal using a t-test (P-value=0.02).

AIDS-related expectations have statistically significant coefficients. For both men and women, having additional partners is perceived as increasing the likelihood of being infected. This is suggested by the facts that respondents with more partners, but also respondents with higher subjective probability of infection with extra-marital partners (with condom), have a higher infection belief. The coefficient associated with having more than 3 partners is large for both genders. For example, women with more than 3 partners allocated, on average, 2.9 additional beans compared to women who did not have sex in the last 12 months. Thus, those respondents seem to accurately identify whether they belong to a group with elevated risk of HIV infection. The results also suggest that women feel at risk of becoming infected by their spouse or main partner with limited control about it: everything else equal, women with higher beliefs about the likelihood of becoming infected with "normal" behavior or if one has a HIV+ spouse have higher infection expectations, while those AIDS-related beliefs are not statistically significant for men. In addition, women who report that they do not know how many partners their spouse had in the past 12 months or those who suspect their spouse to have several partners are more likely to report a higher subjective expectation of infection. As a result, women are likely to face more uncertainty about their infection. The fact that the perceived village HIV prevalence has a positive and statistically significant coefficient for women but not for men may be due to the fact that women incorporate their best predictor for the HIV risk of their spouse's partners, while men may feel they have more knowledge about the infection risk of their own extra-marital partners.

III. How do individuals keep track of their HIV status?

After learning that one is HIV-negative, an individual would potentially revise her expectations about (1) her current HIV status; (2) the HIV status of her sexual partners; (3) the risk of HIV transmission associated with various behaviors, such as unprotected and protected sexual encounters. These revision processes are intricate as the individual may face a basic identification problem: if she had unprotected sex with a partner and learns that she is HIV-negative, she could infer that her partner is HIV-negative or that the infection risk per act is very low. Since we do not have repeated observations on expectations, we cannot make inference about the revisions to expectations (2) and (3). However, we can study the revision to (1) as time goes by, which depends on sexual behavior and the *revised* (2) and (3), all of which are observed in the 2006 survey.

Under the assumption that a respondent believes a 2004 negative HIV test result, we evaluate whether she revised her HIV infection beliefs in an *coherent* way by comparing the elicited subjective probability of being infected with a *computed* probability of being infected based on (*i*) her individual beliefs about HIV transmission, (*ii*) her sexual behavior and (*iii*) a standard model of infection risk (see e.g., UNAIDS 2007). The computed probability P_i of becoming infected is given by: $P_i = 1 - \prod_{j=1}^{n_i} \left[\pi_j (1-\beta_i)^{a_j(1-v_j)} + \left(1-\pi_j\right) \right]$, where n_i is i's reported number of partners since 2004; π_j is i's subjective probability about partner j being HIV-positive; β_i is the i's subjective risk of infection per act; a_j is the number of acts with partner j and v_j is the proportion of protected acts by condom with partner j. The intuition for the probability P_i is as follows: the probability that i does NOT become infected by partner j is 1 if j is HIV-negative (which is the case with probability 1- π_j); and $(1-\beta_i)^{aj(1-vj)}$ if j is HIV positive (which is the case with probability π_j). We use respondents' answers to obtain individual-specific parameters of the model and compute, for each respondent i, the probability P_i. Some of the parameters are elicited using a verbal scale and we present in the Appendix our behavioral assumptions. Figure 1 presents the histogram of the elicited probability and the computed probability P_i of being infected with HIV for respondents who were told they were HIV-negative in 2004.[7] The two histograms look extremely similar, with a huge spike at 0 and a decreasing frequency of answers as the probability increases. If we compare the elicited and computed beliefs at the individual-level, we find, remarkably, that they are equal for almost half of the respondents, and that they differ by less than 5 (respectively 10) percentage point for 54% (respectively 66%) of the respondents. This strongly suggests that individuals believe their test result and keep track of their infection risk in a coherent way by taking into account their sexual behavior, their beliefs about transmissions and the infection risk of their partners using an appropriate rule. A lot of the agreement between the computed P_i and the elicited beliefs comes from low-risk individuals: 86% of the respondents whose difference is less than 5 percentage points in absolute value allocated zero beans, and 95% of those report either having no or only one partner in the last 12 months. Among those having one partner, 99.6% believe there is no likelihood that their partner is infected with HIV. However, even excluding respondents whose updating is "easier" because they believe they face no risk, we still find that the elicited and the computed probabilities differ by less than 5 (respectively 10) percentage points for 27% (respectively 47%) of the respondents who provided more than 0 beans when asked about the likelihood of being infected with HIV. We investigate in the third column of table 2 which demographic characteristics are predictive of forming a "coherent" belief of HIV infection by estimating a probit model using an indicator equal to 1 if the difference between the elicited and the computed beliefs are below 5 percentage points. Respondents who have never been married, older respondents and men are more likely to formulate their beliefs about HIV infection in a coherent manner.

Note that these results do not imply that respondents have *accurate* beliefs about their infection risk since the computed probability is based on respondents' subjective beliefs about the risk of

[7] Sexual histories are incomplete for about 9% of the respondents.

infection per act. The expectation of becoming infected "*during a single intercourse without condom with someone who has HIV/AIDS*" is widely over-estimated: the average expectation is 8.6 beans and the median is 10 beans, implying rates of infection of 86% or 100%, while this rate is typically estimated at around 0.3% (UNAIDS 2007). Women provide on average a higher subjective transmission rate than men, which is consistent with the fact that women are more likely to get infected than men during unprotected sex. Other studies have shown similar over-estimation of the per act transmission risk in the US among educated subjects (Baruch Fischhoff, 1989), but found that people were better at estimating cumulated infection risks.[8]

IV. **Conclusion**

HIV testing may be an important tool for facilitating long-term behavior change if individuals who get tested revise their beliefs upon learning their status, and if those beliefs evolve in a manner that is consistent with engagement in risk-taking behaviors subsequent to testing. We find that HIV-positive respondents do not persistently believe that they are infected after learning their status. This might explain why there is so little evidence of change in behavior among HIV-positive individuals subsequent to VCT. In contrast, a large proportion of the HIV-negative individuals (especially men, older individuals and those at low risk of infection) seem to keep track of their infection risk in a manner that is consistent with engagement in risk-taking behaviors and own beliefs about transmission risk. Women's expectations reflect their belief that a primary source of infection for many is their spouse, which may limit their ability to engage in risk-reduction strategy as condom use within marriage is still very uncommon (Agnes Chimbiri, 2007), and may even discourage them to protect themselves with other partners. VCT is thus more likely to yield change in risky behavior among males who learn they are HIV-negative.

Appendix: Behavioral assumptions to compute *Pi*

[8] Median per act transmission rate was about 50% from male to female and 40% from female to male.

***π_j* *i*'s subjective probability about j being HIV+:** Average between subjective beliefs about partner's HIV status at the beginning of relationship and now (or at end of relationship if relationship is over). If beliefs elicited using beans: # beans/10; If beliefs elicited using verbal scale: use modal number of beans when comparing quantitative and qualitative scale *(No likelihood: 0%; Low likelihood: 10%; medium: 50%, high: 90%, Don't know: 50%)*
β_i* *i's subjective risk of infection per act: Subjective probability of becoming infected *during a single intercourse without a condom with someone who has HIV/AIDS* (# beans/10)
a_i* *number of acts with partner j in the past 2 years = number of sex act per months * number of months in relationship or =1 if j is a one-night-stand - Number of sex acts per month is 16 if respondent reports "4 or more times per week"; 8 if "1-3 times per week"; 2 if "A couple of time a months";1 if "Less than twice per month"
v_i* *share of protected acts by condom with partner j*:* Share of protected acts is 0 if respondent reports "never" used condom, 0.1 if "at the beginning", 0.4 if "sometimes", 0.75 if "almost every time", 1 if "every time", 0.5 if "don't remember"
***If i has more than 3 partners*:** 0.7% of the respondents have more than 3 partners in the last 12 months but we have information for up to 3 partners only. For other partners, we assume that the probability that each infects *i* is the average probability that all non-spouse partners for whom we have information infect *i.*

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Table 1: Distribution of 2006 expectations about current HIV infection

Number of beans	HIV-positive in 2004	HIV-negative in 2004
0	37.10	68.73
1	14.52	9.99
2	1.61	7.09
3	12.90	4.48
4	6.45	2.27
5	11.29	4.82
6	1.61	0.55
7	1.61	0.48
8	3.23	0.69
9	0.00	0.55
10	9.68	0.34
N	*62*	*1,452*

Figure 1: Elicited and computed beliefs about HIV infection for same respondents (N=1,332)

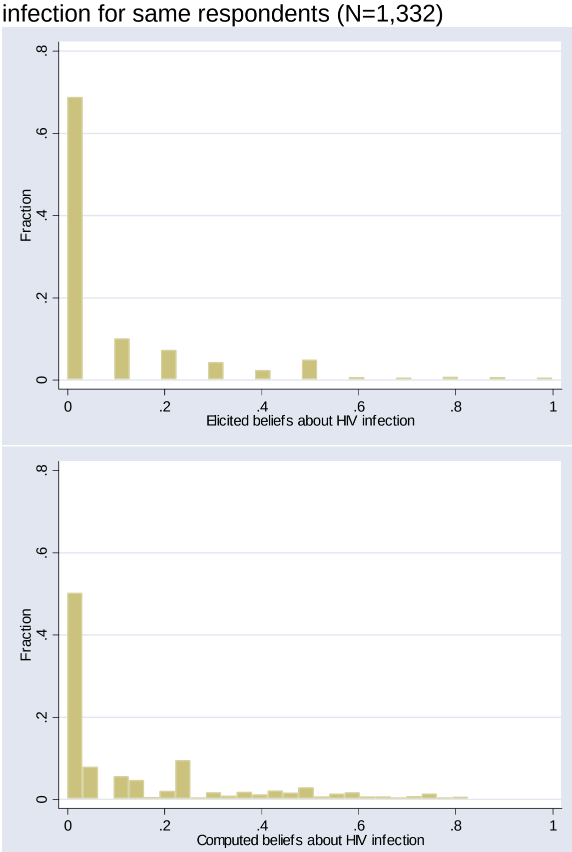

Table 2: Estimation results

Dependent variables	Elicited HIV infection expectation (# beans)		Coherent updating
	Coefficients		*Marginal effects*
	Women	**Men**	
married/partnered	-	-	-
separated/divorced/widowed	0.198	0.317	0.032
	[0.290]	[0.370]	[0.057]
never married	-0.406	0.047	0.195
	[0.396]	[0.217]	[0.054]**
less than 20 years old	-	-	-
20 to 29	-0.371	0.24	0.002
	[0.307]	[0.217]	[0.061]
30 to 39	-0.34	0.299	0.093
	[0.314]	[0.280]	[0.065]
40 to 49	-0.357	0.384	0.06
	[0.324]	[0.286]	[0.068]
50+	-0.471	-0.018	0.179
	[0.343]	[0.277]	[0.066]**
No School	-	-	
Primary level	0.199	-0.069	0.012
	[0.179]	[0.180]	[0.039]
Secondary level +	0.103	0.03	0.009
	[0.334]	[0.230]	[0.062]
lower tercile of land ownership	-	-	-
second tercile	-0.323	-0.055	0.065
	[0.166]	[0.139]	[0.035]
highest tercile	-0.264	0.037	0.046
	[0.207]	[0.147]	[0.040]
female			-0.063
			[0.032]*
subjective likelihood that a healthy individual becomes HIV+ within 12 months (0 to 10)			
with normal behavior	0.102	0.035	
	[0.036]**	[0.027]	
if married to HIV+ individual	0.113	-0.021	
	[0.049]*	[0.041]	
if several partners in addition to spouse	-0.021	0.019	
	[0.039]	[0.029]	
if several partners but use condom	0.117	0.097	
	[0.035]**	[0.026]**	
subjective HIV village prevalence (0 to 10)	0.248	0.029	
	[0.044]**	[0.034]	
No sexual partner in the last year	-	-	
1 partner	0.281	-0.013	
	[0.279]	[0.232]	
2 partners	0.878	0.364	
	[0.644]	[0.269]	
3 partners of more	2.872	1.101	
	[1.368]*	[0.349]**	
suspected number of partners of spouse/boyfriend	0.115	-0.135	
	[0.042]**	[0.132]	
Don't know number of partners of spouse/boyfriend	1.689	-0.172	
	[0.388]**	[0.270]	
Constant	-1.366	0.092	
	[0.687]*	[0.596]	
Observations	*797*	*654*	*1,331*

Standard errors in brackets. * significant at 5% level; ** significant at 1% level. Regressions include indicators for missing variables and region dummies.