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Learning from Others' HIV Testing: Updating Beliefs and Responding to Risk[†]

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Extending the seminal work of von Neumann and Morgenstern (1944), Savage (1954) advanced a theory that allows decision makers to maximize expected utility based on subjective probabilities of different states when objective probabilities are unknown. Since then, an extensive theoretical and empirical literature has explored how beliefs are formed or updated and how they affect behavior (Dominitz and Manski 1997; Manski 2004). One line of research has studied subjective beliefs in the context of testing and learning results for a variety of health conditions such as Huntington's disease, cervical cancer, and breast cancer (Oster, Shoulson, and Dorsey 2013; Okeke, Adepiti, and Ajenifuja 2013; and Lange 2011, among others). In this context, receiving a diagnosis provides objective information that individuals can use to make decisions, optimizing for the future. In contrast to noncommunicable diseases, some diseases such as HIV, allow for behavioral responses to testing that can affect the spread of the disease.

In this paper we examine how beliefs and behavior are affected by HIV testing in rural Malawi. We extend the existing literature by studying the impact of *others' testing* on individual perceptions of AIDS risk and subsequent decisions to practice safe sex.

Prior research on HIV testing has focused on measuring the effects of an individual learning her own test result. Several studies have found behavioral responses to changes in beliefs after testing (de Paula, Shapira, and Todd 2011) and that subjective expectations play an important role in the decision about risky or safe sexual behavior (Delavande and Kohler 2012). Thornton (2012) finds that learning HIV results has only short-term effects on subjective beliefs which do not persist after two years. Goldstein et al. (2008) find that HIV-positive mothers who learn their status are more likely to receive medication to prevent transmission to their children.

Test results may lead to behavior change when ex ante beliefs about probabilities of possible states are inaccurate or uncertain. Boozer and Philipson (2000) and Gong (2012) find behavior change only among those who learned new information after an HIV test.

Learning one's own HIV results can be informative for determining *personal HIV risk*. At the same time, as others learn their HIV results, information is revealed about *external HIV risk*. Research suggests that individuals overestimate HIV prevalence, transmission rates, as well as their own likelihood of infection; in high HIV prevalence areas in Africa, deaths are often attributed to AIDS even when the exact cause is unknown (Anglewicz and Kohler 2009). A Bayesian updater, who initially overestimates HIV risk, is likely to revise beliefs downward as more people in his community learn their results because the vast majority learns they are HIV-negative. If individuals revise their beliefs about risk downward, sexual behavior may become more risky in response.

Prior studies that examine the relationship between prevalence rates and beliefs or behavior are limited by the fact that prevalence rates are endogenous to beliefs and behavior. Some

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studies have used instruments for HIV rates (see, for example, Oster 2012).

In this paper, rather than measuring the response to prevalence rates, we measure the response to others' HIV testing which alters individuals' beliefs about the underlying prevalence. We measure the causal effect of others' testing by utilizing an experiment that randomly offered incentives to individuals to learn their HIV test results at randomly located results centers. We use the village-level average of these incentives and distance from results centers to instrument for the proportion of community HIV testing. In Godlonton and Thornton (2012) we show that others, testing impacts individual decisions to test. A natural follow-up is to measure the longer term impacts of others' testing on individual beliefs and behavior.

We find robust evidence of downward revisions of beliefs about HIV infections and find subsequent changes in sexual behavior, reducing condom use and having no impact on multiple partnerships. These results suggest mixed policy lessons. While learning information from others' testing and re-optimizing behavioral choices can be welfare increasing to the extent that there is a disutility to practicing safer sex, decreased condom use in high HIV-prevalence areas may be cause for concern for public health.

I. Data

We use data from the Malawi Diffusion and Ideational Change Project, conducted across the three regions of Malawi (Bignami-Van Assche et al. 2004). As part of the longitudinal data collection, respondents were interviewed and tested for HIV in 2004.[1] After testing, respondents were offered randomly assigned monetary incentives to learn their HIV results ranging from zero to three dollars. Two months later the HIV test results were available at mobile counseling centers that were randomly located within the study sites (Thornton 2008).

In 2006, approximately two years after the HIV test results were available, respondents were reinterviewed and asked questions about beliefs and sexual behavior. Several questions asked respondents to estimate the number of their relatives, friends, and acquaintances who may have died from AIDS.[2] A limited number of questions on sexual behavior were asked including condom use with current and up to three past sexual partners or whether the respondent had multiple sexual partners.[3]

Our analytical sample consists of those who had an HIV test in 2004, were offered financial incentives to learn their HIV results, and were interviewed in 2006. Behavioral responses to learning about community level risk are likely to depend on HIV status. To simplify the interpretation in this paper we limit the sample to HIV-negatives.

Table 1, panel A presents descriptive statistics of the exogenously assigned variables: incentives and distance. Almost 80 percent of the respondents were offered an incentive to learn their HIV results, worth an average of one dollar, and lived approximately two kilometers from the mobile HIV results center (column 1). We aggregate these across the 117 villages in our sample to construct our instrumental variables (column 3).[4] On average, approximately 72 percent learned their HIV results (standard deviation 0.44 at the individual-level and 0.19 at the village-level).

Table 1, panel B, column 1 presents baseline summary statistics among the 1,995 respondents in our analytical sample. The average age in the sample was 34 years. Seventy-five percent of the respondents were married with an average of 3.5 years of education. At the baseline, respondents believed that seven people known to them had died from AIDS with an average of 2.4 dying in the past year. Respondents reported approximately one of their relatives were thought to be sick or had died from AIDS. On average 12.6 percent of the respondents had used a condom with a recent sexual partner at

[1] Ninety-one percent accepted an HIV test; 6.4 percent were HIV-positive.

[2] These questions are: "How many people known to you do you suspect have died from AIDS overall?," "Overall, how many people known to you do you suspect have died from AIDS in the past 12 months?," and "How many of your relatives do some people say have died or are sick with AIDS now?".

[3] Respondents were asked for their three most recent sexual partners: "Have you ever used a condom with [NAME]? If so, how often do you use a condom with [NAME]?" Potential responses include: Never, At the beginning, Sometimes, Almost every time, Every time, Don't remember.

[4] Village averages are constructed unconditional on a successful follow-up survey in 2006.

TABLE 1—SAMPLE CHARACTERISTICS, BALANCING TESTS, AND ATTRITION

	Individual-level sample means		Village-level sample means	
	Mean (1)	SD (2)	Mean (3)	SD (4)
Panel A. Incentives, distance, and learning HIV results				
Received a non-zero incentive	0.782	0.413	0.763	0.159
Amount of incentive (in USD)	1.016	0.897	0.959	0.255
Distance from HIV results center	1.993	1.242	1.864	1.066
Learned HIV results	0.729	0.444	0.723	0.186
Village size	—	—	40.684	33.999
	$N = 1{,}995$		$N = 117$	

	Individual-level sample means		*P*-value on joint *F*-test	
	Mean (1)	SD (2)	Balance (3)	Attrition (4)
Panel B. Sample means, balance, and attrition				
Male	0.455	0.498	0.155	0.010
Age	34.270	13.737	0.155	0.314
Married	0.745	0.436	0.508	0.760
Years of education	3.494	3.528	0.000	0.729
People you know ever died of HIV	6.372	11.508	0.000	0.733
People you know died of HIV in last year	2.194	2.941	0.000	0.071
Relatives others say died of HIV	0.957	1.637	0.013	0.217
Multiple sexual partners in last year	0.071	0.257	0.648	0.885
Current condom use with spouse	0.114	0.318	0.003	0.283
Recent condom use with spouse/partners	0.126	0.332	0.003	0.373
	$N = 995$		$N = 1{,}995$	$N = 2{,}654$

Notes: The sample of 2,654 individuals consists of those who accepted an HIV test, did not test as indeterminant and was assigned financial incentives to learn HIV results in 2004. The sample of 1995 individual consists of those who were also surveyed in 2006. Panel A presents individual and village-level sample means. Village-level sample means in panel A, columns 3 and 4 are constructed from the sample of 2,654 individuals not conditioning on being surveyed in 2006. Panel B presents individual sample means of baseline variables in columns 1 and 2. Each row in panel B, column 3 presents *p*-values testing the joint significance of each coefficient estimated from separate regressions of the baseline variable on "village average offered any incentive," "village average incentive amount," and "village average distance from the HIV results center." Columns 4 presents the *p*-value of the joint *F*-test of significance of each baseline variable interacted with "village average offered any incentive", "village average incentive amount," and "village average distance from the HIV results center" in a regression of being interviewed in 2006 on these interactions, the baseline variable, and the incentive and distance variables at the village-level. Columns 3 and 4 in panel B are weighted according to 2004 village size.

baseline and 7.1 percent reported having had multiple partnerships in the last 12 months.

Column 3 of Table 1, panel B tests for balance across these variables. We regress each baseline variable on the proportion of the village receiving any incentive, the village-average incentive amount, and the village-average distance from the HIV results center, including probability weights to account for different sizes of villages. For each regression we report the *p*-value of the joint test of significance of these village-average variables. There is some imbalance across village-level averages of randomly assigned variables; to control for some of this imbalance, we include baseline controls in our analyses.[5]

Although the rate of attrition from 2004 to 2006 was 0.25, there was no differential attrition by village-level incentives or village-level distance from HIV result centers (*p*-value of

[5] There is balance across individual-level incentives and distance, the unit at which randomization occurred (not shown).

Table 2—Impact of Others' Testing

	Attitudes on deaths Attributable to HIV			Sexual behavior		
Dependent variable	Died ever HIV (1)	Died in last year HIV (2)	Relatives died HIV (3)	MCP last year (4)	Current condom use (spouse) (5)	Recent condom use (any partner) (6)
Proportion of village got HIV results	−12.72*** (2.892)	−0.863 (0.699)	−1.433** (0.590)	−0.008 (0.107)	−0.382*** (0.132)	−0.385*** (0.132)
Dependent variable in 2004	0.129*** (0.0207)	0.162*** (0.0313)	0.304*** (0.0362)	0.290*** (0.0429)	0.280*** (0.0424)	0.237*** (0.0387)
Observations	1,991	1,989	1,984	1,995	1,995	1,995
R^2	0.078	0.076	0.104	0.197	0.127	0.155
Average of dependent variable	8.852	1.971	1.455	0.194	0.225	0.267

Notes: Robust standard errors in brackets. Standard errors are clustered by village. Controls include: age, age square, HIV status in 2004, years of schooling in 2004, marital status in 2004 and a male indicator. Missing covariates are imputed with the mean of the covariate, and a missing dummy indicator is included in the set of controls. Regressions are weighted according to 2004 village size. MCP = Multiple Concurrent Partners.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

joint significance test 0.14; not shown). We also examine whether attrition is differentially correlated to baseline characteristics across incentives and distance. For each baseline variable in Table 1, panel B we regress an indicator of being surveyed in 2006 on village-level incentives and distance, the baseline variable, and the baseline variable interacted with village-level incentives and distance. We report the *p*-values of the joint test of significance of the three interaction terms. Across most baseline variables there is no significant differential attrition (column 4).

II. Results

To estimate the effects of community HIV testing on individual beliefs and behavior we estimate the following regression:

$$(1)\quad Y_{ij} = \alpha + \beta_1 \widehat{MeanGot}_{ij} + X'_{ij}\,\gamma + \varepsilon_{ij},$$

where "*MeanGot*" is the percent of those in individual *i*'s village, *j*, who learned their HIV results and Y_{ij} are answers to questions about beliefs and sexual behavior. Across villages, the average proportion of individuals learning their HIV results is 0.72 (standard deviation 0.19; Table 1, panel A, columns 3 and 4). X_{ij} is a vector of controls from 2004 that include age, age squared, years of schooling, marital status, an indicator for gender, and village size (number of respondents). In each regression we also include a control for the 2004 baseline level of *Y*, for each different outcome. Missing covariates are imputed with the mean of the covariate, and a missing dummy indicator is included in the set of controls. Our main coefficient of interest is β_1 indicating the impact of village-level HIV knowledge on beliefs and sexual behavior.

The decision to learn HIV results is likely correlated with individual characteristics. Similarly, the village-level rate of learning results is likely to be correlated to both individual and village-level characteristics. Because of this we use the randomly assigned incentives and distance to results center to instrument for the village-level rate of results-seeking. Our first stage estimate of the rate of the village learning results is

$$(2)\quad MeanGot_{ij} = \alpha + \gamma_1\, MeanAny_{ij} + \gamma_2\, MeanAmt_{ij} + \gamma_3\, MeanDist_{ij} + X'_{ij}\,\gamma + \varepsilon_{ij}.$$

MeanAny, *MeanAmt*, and *MeanDist* are village-averages of being offered any incentive, the amount of the incentive, and the distance to the HIV results center, respectively. The first stage estimate without controls yields an *F*-statistic of 23.98 (not shown). We cluster our standard errors by village and run linear OLS regressions, including village weights in each specification.

Table 2 presents the effects of increased community members learning HIV-negative results on beliefs about sickness and death attributed to AIDS.

As more people in the village learn their HIV results, individuals revise their beliefs about friends, family, and acquaintances who they suspect to have died from AIDS. A 10 percentage point increase in the proportion of the village learning their HIV results leads to respondents attributing 1.27 fewer deaths to AIDS, (Table 2, column 1). While there is no statistically significant effect on the reported number of people who have died from AIDS in the past year (coefficient −0.863, standard error 0.699; column 2), there is a significant effect on the number of relatives suspected to be sick from or have died from AIDS. With each 10 percentage point increase in the proportion of the village learning their HIV results, 0.14 fewer relatives are suspected to have died from AIDS (column 3).

As beliefs about HIV infections among friends and acquaintances decreases, the perceived external HIV risk decreases and therefore individuals may re-optimize their own sexual behavior. Table 2, columns 4–6 presents the impact of others' testing on multiple partnerships and condom use.

As more people in the village learned their HIV results and beliefs about overall AIDS risk decreases, behavior responds with a significant decrease in the likelihood of using condoms and no change in multiple partnerships (column 4). The coefficient on condom use is −0.382 (standard error 0.132) on the use of condoms with a current partner and −0.385 (standard error 0.132) on condom use for any of the past three partners (columns 5 and 6). In other words, if 10 percent more community members learn their HIV results (approximately four people), individuals are 38 percentage points less likely to use a condom.

III. Conclusion

As access to HIV testing increases across Africa, more people are learning their HIV status and overwhelmingly, they are learning that they are HIV-negative. While HIV testing is important for enrolling individuals who are HIV-positive into treatment, both for themselves, and to protect their partner or unborn children, behavioral responses to information acquired by community-based testing is important to consider.

Learning that more friends or neighbors may not be infected or may not have died from AIDS reduces perceptions of HIV risk within the pool of potential sexual partners. From a strictly individual welfare-maximizing perspective, more accurate beliefs allows for optimal decisions, and in fact, for many whose risk of HIV is low, reduction of condom use may increase personal utility. However, given the negative externalities of HIV/AIDS, reductions in condom use could be a concern for social welfare.

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