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The Impact of HIV Testing on Subjective Expectations and Risky Behavior in Malawi

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Abstract We investigate the causal impact of learning HIV status on HIV/AIDS-related expectations and sexual behavior in the medium run. Our analyses document several unexpected results about the effect of learning one's own, or one's spouse's, HIV status. For example, receiving an HIV-negative test result implies higher subjective expectations about being HIV-positive after two years, and individuals tend to have larger prediction errors about their HIV status after learning their HIV status. If individuals in HIV-negative couples also learn the status of their spouse, these effects disappear. In terms of behavioral outcomes, our analyses document that HIV-positive individuals who learned their status reported having fewer partners and using condoms more often than those who did not learn their status. Among married respondents in HIV-negative couples, learning only one's own status increases risky behavior, while learning both statuses decreases risky behavior. In addition, individuals in sero-discordant couples who learned both statuses are more likely to report some condom use. Overall, our analyses suggest that ensuring that each spouse learns the HIV status of the other, either through couple's testing or through spousal communication, may be beneficial in high-prevalence environments.

Keywords Subjective expectations · HIV testing · Risky behavior · Malawi

Introduction

About 6.1% of the adults living in sub-Saharan Africa are estimated to be infected with HIV, with HIV prevalence reaching 30% in some countries (UNAIDS 2006, 2008). Policies seeking to curtail the epidemic are, thus, crucial; and in many

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countries, national HIV-prevention strategies include the promotion and expansion of HIV counseling and testing (HCT) services.[1] The rationale for this rollout of HCT is based mostly on claims that informing individuals about their HIV status eliminates uncertainty about one's own and—to the extent that information is shared—family members' HIV status, and that individuals subsequently engage in less risky behavior or take precautions to reduce the risk of further spreading the virus (UNAIDS 2006, 2008). For example, many studies—particularly those conducted before more recent data with randomized experiments that control for the selective participation in HCT became available—have found a decrease in risky behavior among HIV-positive individuals following testing, but either no change or an increase in risky behavior among HIV-negative individuals (e.g., Sherr et al. 2007; UNAIDS 2001; The Voluntary HIV-1 Counseling and Testing Efficacy Study Group 2000; Weinhardt et al. 1999). Based on these behavioral changes and the fact that HCT is a prerequisite for making antiretroviral treatment (ART) available to infected individuals, Granich et al. (2009) proposed universal HIV testing with immediate ART as a strategy for eliminating HIV transmission by accelerating the transition from the present *endemic* phase (in which most adults living with HIV are not receiving ART) to an *elimination* phase (in which most are on ART), within five years. These conclusions, however, are controversial. For example, Matovu et al. (2005) and Sherr et al. (2007) found no effect of testing on behavior using a cohort study of adults in Rakai (Uganda), and most importantly, no significant differences in sexual risk behaviors or in HIV incidence between acceptors of HCT and nonacceptors. Corbett et al. (2007) reached similar conclusions using a cluster-randomized trial of two strategies providing HCT at the workplace in Zimbabwe. In a meta-analysis of studies published during 1990–2005, Denison et al. (2008), for example, found only moderate evidence in support of HCT as an effective prevention strategy, and they emphasized that the current expansion of HIV testing services in many sub-Saharan countries must be accompanied by rigorous evaluation in order to test, refine, and maximize the preventive benefits of learning one's HIV infection status through HIV testing and counseling.

Achieving this careful evaluation of the effects of HCT on subsequent behaviors, however, is challenging. The selectivity of HCT uptake may bias the conclusions in many studies because they rely on samples of respondents who self-select into HCT participation, and studies that use randomized study designs remain rare (exceptions include Thornton (2008) and Gong (2010)). Thornton, for example, found that in Malawi, sexually active HIV-positive individuals who learn their status were more likely to purchase condoms two months after testing than those who did not learn their status. She did not find any effect of testing on condom purchase among HIV-negative individuals. In a related analysis for Kenya and Tanzania, Gong (2010) used data from a study that randomly assigns HIV testing, and examined the effects of testing on gonorrhea and chlamydia infections, as a proxy for risky sexual behaviors, after taking into account the individual's subjective beliefs about his/her HIV status. Gong found that individuals who are "surprised" by a positive HIV test have more than a 10-fold increase in the likelihood of contracting a sexually transmitted infection (STI), indicating riskier sexual behavior. In contrast, individuals who are

[1] The term "voluntary counseling and testing " (VCT) is also used to describe HIV counseling and testing services.

"surprised" by a negative HIV test have more than a 90% decrease in their likelihood of contracting an STI, indicating safer sexual behavior. When HIV tests agreed with a person's belief of serostatus, the study found no statistically significant change in contracting an STI. Gong's findings thus suggest that testing affects people only if it changes their beliefs about their HIV status. In addition, he found that the effects of being surprised by a positive HIV test result are completely mitigated when testing is done with one's partner. In terms of mother-to-child transmission, using a study design that uses health worker absence as an instrument for testing among pregnant women seeking prenatal care, Goldstein et al. (2008) found that learning one's status results in a higher probability of receiving medication that can lower mother-to-child transmission.

Understanding the mechanisms through which HCT impacts behavior is critical in order to devise appropriate interventions in high-prevalence environments. In this article, we investigate the *causal* impact of learning one's current HIV status on HIV/AIDS-related subjective expectations—that is, the expectations that are critical for shaping an individual's decision-making about sexual and related behaviors, as well as sexual behavior in the medium run (i.e., two years after testing). We use rich data on probabilistic subjective expectations about HIV/AIDS-related outcomes and sexual behavior that were collected in 2006 in rural Malawi from respondents aged 17 to 60. Respondents had previously been tested for HIV in 2004 as part of a randomized experiment to study the determinants of HCT uptake (Thornton 2008). At the time of testing, respondents were given randomly assigned vouchers redeemable upon picking up their HIV test results at local HCT clinics. In addition, the location of the HCT clinics was randomly varied within geographic zones, resulting in random variation in the distance between respondents' home and the place where the results could be obtained.

Our analyses focus on respondents who were tested for HIV in 2004 and were reinterviewed in 2006. Most important in this longitudinal design for our analyses is that it enables us to use the 2004 randomized design and implement instrumental variables (IV) techniques to control for the potential selection associated with respondents choosing to learn their HIV status in 2004. Our analyses therefore identify, for the first time, the causal consequences of providing individuals with information about their current HIV status on their medium-term subjective beliefs about being infected with HIV and other HIV/AIDS-related expectations. It also provides a rigorously identified test of the impact of HIV testing on sexual behavior two years after testing.

Theoretical Framework

The theoretical models guiding most research on the effects of HIV testing on subsequent AIDS-related behaviors—such as sexual behaviors, marriage, fertility, or human capital investments—are generally based on economic intertemporal choice frameworks that explicitly recognize uncertainty and incorporate subjective expectations to reflect individuals' perceptions of this uncertainty.

To motivate our analyses more formally, we present in the online supplement (Online Resource 1) an economic framework that highlights how subjective expectations about own and partner's HIV status may influence the decision to engage in risky behavior, and we discuss the implications of learning one's own status. Providing people with information about their HIV status may reduce uncertainty about health and survival probabilities and may also change expectations about future income streams and productivity. In turn, this may lead individuals to make different decisions regarding various resource allocations and their sexual behaviors. Overall, the key insight from the theoretical framework is that the impact of HIV testing on subjective beliefs and risky behavior is overall ambiguous and ultimately an empirical question that will be addressed in the remainder of this article.

Data

This research uses data collected in three regions of rural Malawi as part of the Malawi Longitudinal Study of Families and Health (MLSFH, formerly Malawi Diffusion and Ideational Change Project), a panel survey started in 1998.[2] In 2006, the MLSFH included more than 3,200 male and female respondents aged 17 to 60 who were asked about a wide range of demographic, health, and socioeconomic characteristics. Comparisons with the Malawi Demographic and Health Survey showed that the MLSFH sample population is reasonably representative of the rural Malawi population (Anglewicz et al. 2009).

Subjective Probabilities Data

An innovation of the 2006 round of MLSFH data collection was the inclusion of an interactive elicitation technique for subjective expectations that was based on asking respondents ($N \approx 3{,}200$) to allocate up to 10 beans on a plate to express the likelihood that an event will be realized (Delavande and Kohler 2009).[3] In particular, after a short introduction to subjective beliefs and uncertainty assessments, respondents were asked their subjective expectations about a wide range of health and economic outcomes, including the subjective likelihood of being currently infected with HIV (see the online supplement for exact wording of the questions).[4] Respondents were instructed that 1 bean reflects one chance out of 10, and that allocating 0 or 10 beans reflects certainty that a specific event does not or does occur, respectively. To measure respondents' subjective probability of being infected with HIV, for example, respondents were instructed, "Pick the number of beans that reflects how likely you think it is that you are infected with HIV/AIDS now." The response to this and related questions can be interpreted as a subjective probability after dividing the number of allocated beans by 10 (see also Manski 2004).

Delavande and Kohler (2009) provided a detailed analysis and evaluation of the probabilistic expectations collected using the aforementioned interactive elicitation

[2] Detailed descriptions of the MLSFH sample selection, data collection, and data quality are provided on the project website (http://www.malawi.pop.upenn.edu/), in a Special Collection of the online journal *Demographic Research* that is devoted to the MLSFH (Watkins et al. 2003), and in a follow-up publication that incorporates the 2004 and 2006 rounds of the MLSFH data (Anglewicz et al. 2009).

[3] See Delavande et al. (2011) for an overview about expectations data in developing countries.

[4] The English questionnaire is translated and administered in Chichewa, Yao, or Tumbuka.

technique. Key findings are reported in greater details in the online supplement and include: (a) item nonresponse in these expectation questions ranges is low (less than 1.3%); (b) about 99% of the respondents are found to provide beliefs consistent with basic properties of probability theory when asked nested events; (c) the pattern of focal answers—0, 5, and 10 beans—varies considerably across domains, but is quite similar to those found in surveys conducted in developed countries; (d) average elicited expectations are well calibrated compared with actual probabilities for some events, but not for all; (e) in basically all domains considered, subjective beliefs vary considerably across individuals; and (f) subjective expectations are systematically correlated with observable characteristics—such as gender, age, education, and region of residence—in the same way that actual outcomes vary with these variables.

The HIV Testing Experimental Design

The 2004 MLSFH asked all respondents—the overwhelming majority (82%) of whom had not previously participated in HCT—to provide a biomarker sample for a lab-based HIV test as part of a randomized experiment to study the determinants of HCT uptake (for more details on the protocol, see Obare et al. (2009); and Thornton (2008)). As part of the experimental design, respondents were given randomly assigned vouchers between 0 and 3 dollars (between 0 to 300 Kwacha)—the latter corresponding to local wages for about two days—at the time of the biomarker collection. Respondents could redeem these vouchers upon picking up their HIV test results at local HCT clinics, which were established by the MLSFH about 2–4 months after the biomarker collection. In addition to the monetary incentives, the location of the HCT clinics was randomly varied relative to the village center, resulting in random variation in the distance between respondents' home and the HCT clinic where the results could be obtained.[5] Regardless of HIV status, respondents also received counseling about safe-sex practices when they obtained their test results.[6]

Overall, 91% of MLSFH respondents provided biomarkers for the lab-based HIV test, and among them, 68% attended a local MLSFH HCT clinic to learn their HIV test result (Obare et al. 2009). Moreover, Thornton (2008) found that learning one's HIV results was highly responsive to the financial incentives and the distance to the results center, with respondents receiving higher financial incentives and facing shorter distances being more likely to learn their HIV test result.[7] Six percent of the

[5] The average distance to a clinic is 2 km, and more than 95% of those tested lived within 5 km. Distance to the clinic is calculated as a straight line.

[6] Because everybody received counseling, our analysis measures the impact of HCT rather than testing alone.

[7] HIV testing outside of the MLSFH is a possibility. When respondents were visited by the MLSFH VCT team for an HIV test in 2006, they were asked about all their previous HIV testing experiences. Note that 15% of our analytical sample were not found by the MLSFH HCT team in 2006. About 13% of the respondents who learned their HIV status in 2004 were retested in 2004, 2005, and 2006 outside the 2004 MLSFH. Because sero-conversion is rare (less than 2% between the waves), most of the individuals who were retested were still of the same HIV status, so for them, testing outside our study is unlikely to have an impact on our analysis. Of those who did not learn their HIV status in 2004, 14.9% reported being tested outside the MLSFH 2004 in 2004, 2005, and 2006 (46% of them in 2005 and 52% of them in 2006, but we do not know the exact month). As a result, we may wrongly classify some individuals as not knowing their HIV status when they engaged in the various behaviors in the past 12 months. This suggests that our estimates of the impact of testing on behavior are conservative.

respondents tested were HIV positive in 2004. This relatively low prevalence in our data, which is below the 2004 Malawi DHS estimate of 11% for rural Malawi, is due to the rural nature of the sample, which excludes peri-urban areas with high prevalence (Obare et al. 2009).

HIV Infection Expectations Subsequent to HIV Testing

Table 1 presents the distributions of the 2006 subjective beliefs about HIV infection for all respondents who learned their HIV status in 2004. This sample is composed of 1,524 respondents, of whom 4% were HIV positive in 2004. On the one hand, Table 1 shows that among respondents who were told that they were HIV negative in 2004, about two-thirds allocated 0 beans, thereby expressing a very low probability of being infected with HIV as of 2006; one-third of respondents, however, allocated between 1 and 5 beans, thereby expressing a strictly positive probability of being HIV positive in 2006—that is, two years after being told that they were HIV negative. On the other hand, Table 1 surprisingly shows that only 10% of the respondents who were told they were HIV positive in 2004 provided 10 beans in response to the question about their subjective probability of being infected with HIV, while 37% reported 0 beans. The most common answers are 0, 1, and 3 beans. Although these bean allocations by HIV-positive respondents are, on average, higher than those of HIV-negative respondents (2.8 versus 0.9 beans),[8] the average allocation of 2.8 beans—corresponding to a 28% subjective probability of being infected with HIV in 2006—seems remarkably low given that these respondents learned their positive HIV test result in 2004. We discuss potential reasons for this puzzling response pattern in the online supplement.

The Analysis Sample

Our analyses focus on respondents who were tested for HIV in 2004 and reinterviewed in 2006 when our data on subjective expectations were collected. There are 2,879 respondents for whom the 2004 HIV status is known based on the 2004 biomarker collection and lab-based HIV test. Among them, 68.4% went to an MLSFH HCT clinic to learn their test result. Seventy-four percent of the respondents with known test results were reinterviewed in 2006. Anglewicz et al. (2009) showed that HIV-positive respondents were more likely to attrite, partially related to mortality and partially related to higher propensities to migrate outside the survey villages, but those who obtained their HIV test results in 2004 (either positive or negative) were less likely to attrite. We explicitly take into account potential biases from attrition in our analysis (see the Econometric Specification section).

We make inferences on the 2,131 respondents who were tested for HIV in 2004 and reinterviewed in 2006.[9] Table 2 reports descriptive statistics for this sample of analysis.

[8] Using a *t* test, we can reject the hypothesis that the two means are equal (p<.001).

[9] We exclude two respondents of unknown gender.

Table 1 Distribution of 2006 expectations about current HIV infection among those who learned their HIV status in 2004

Number of Beans	HIV+ in 2004	HIV– in 2004
0	37.1	68.7
1	14.5	10.0
2	1.6	7.2
3	12.9	4.5
4	6.5	2.3
5	11.3	4.9
6	1.6	0.6
7	1.6	0.5
8	3.2	0.7
9	0.0	0.6
10	9.7	0.3
Mean	2.82	0.91
SD	3.25	1.78
N	62	1,462

Empirical Strategy

Econometric Specification

Our goal is to determine whether learning one's HIV status in 2004 had a causal impact on one's 2006 HIV/AIDS-related subjective expectations and on subsequent risky behavior.

To deal with potential selection biases caused by attrition between the 2004 and 2006 waves, we introduce a control function (e.g., Wooldridge 2002). The model in the population is as follows:

$$\begin{aligned}
y_1 &= z_1\boldsymbol{\delta}_1 + \alpha_N LearnHIVneg + \alpha_P LearnHIVpos + \beta_{HIV} HIV + v_1\\
LearnHIVneg &= z\boldsymbol{\delta}_2 + v_2\\
LearnHIVpos &= z\boldsymbol{\delta}_3 + v_3\\
A &= 1(z\boldsymbol{\delta}_4 + v_4 > 0),
\end{aligned}$$

where y_1 is the outcome of interest (subjective beliefs or risky behavior elicited in 2006), and 1(.) is the indicator function. Learning HIV status is interacted with the 2004 HIV status to obtain *LearnHIVneg* and *LearnHIVpos* to allow for a differential impact of learning one's test result by HIV status. *LearnHIVneg* is, therefore, an indicator equal to 1 if the respondent learned of an HIV-negative status in 2004 and 0 otherwise; *LearnHIVpos* is an indicator equal to 1 if the respondent learned of an HIV-positive status and 0 otherwise; and the variable *HIV* is an indicator equal to 1 if the respondent was HIV positive in 2004. The variable A is an indicator of attrition between 2004 and 2006. In particular, $A = 1$ if the respondent was tested for HIV in 2004 and was reinterviewed in 2006, and 0 otherwise. So y_1 is observed only when $A = 1$. The vector z is such that $z = [z_1,z_2]$, where z_1 includes respondents'

Table 2 Descriptive statistics: Respondents who were tested for HIV in 2004 and were reinterviewed in 2006

Variable	Mean
Female	55.07
Marital Status	
Married/living together	79.26
Separated/divorced/widowed	7.13
Never married	13.61
Age Categories	
<20 years old	10.79
20 to 29	26.23
30 to 39	23.42
40 to 49	19.05
50+	16.80
Missing	3.71
Education	
Primary level	63.87
Size of Owned Land Categories	
<2 acres	40.59
2 to 4 acres	33.46
>4 acres	25.95
HIV-Positive in 2004	0.05
Learned HIV Status in 2004	0.72
Learned HIV-negative status in 2004	0.69
Learned HIV-positive status in 2004	0.03
Distance to HCT Center (in km)	1.97
Incentive Amount (in Kwacha)	104.20
N	2,131

characteristics (female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables), and z_2 is a set of instruments (based on the financial incentive and the distance to the HCT clinic). The coefficient α_N captures the causal effect of learning HIV status among HIV-negative individuals on the outcome y_1, while the coefficient α_P captures the causal effect of learning HIV status among HIV-positive individuals on the outcome y_1.

To estimate the model, we follow the procedure described by Wooldridge (2002:568):[10]

(a) Obtain $\hat{\delta}_4$ from probit of A on z using all observations. Obtain the inverse Mills ratio $\lambda_{i3} = \dfrac{\phi(z_i\hat{\delta}_4)}{\Phi(z_i\hat{\delta}_4)}$, where ϕ and Φ are the density and cumulative function of the standard normal distribution.

[10] We maintain the assumption 17.2 of Wooldridge (2002) to ensure identification and consistency.

(b) Use the sample observed in 2006 and estimate the equation:

$$y_{i1} = z_{i1}\delta_1 + \alpha_N LearnHIVneg_i + \alpha_P LearnHIVpos_i + \beta_{HIV} HIV_i + \gamma_1 \hat{\lambda}_{i3} + error_i \quad (1)$$

using instruments $\left(z_i, \hat{\lambda}_{i3}\right)$ for predicting $LearnHIVneg_i$ and $LearnHIVpos_i$.

To deal with potential heteroskedasticity, we estimate Eq. (1) using the generalized method of moments (GMM). The hypothesis of no selection (H_0:γ_1 = 0) is tested using usual t statistics. When we do not reject H_0, we present the IV GMM standard errors from Eq. (1). When we reject H_0, standard errors are corrected for the generated regressors problem.[11] We use the method of moments approach proposed by Meijer and Wansbeek (2007) to correct the standard errors. This approach is based on writing the estimation procedure (steps (a) and (b)) as a method of moments estimator and then applying standard GMM theory. The coefficients are the same as those obtained by two-stage least squares for step (b), and the standard errors are corrected for the generated regressors problem. In addition, standard errors are clustered at the village level to deal with the fact that subjective expectations and risky behavior may be affected by the HIV prevalence in one's sexual network. There are 118 villages in the data. We include indicators for missing values when region and age are missing.

Validity of the Instruments

We use the financial incentive and distance to the HCT clinic as instruments for learning HIV status. In principle, the randomized design ensures that the instruments are not directly correlated with the outcomes of interest (respondents' beliefs and risky behavior). Table 3 evaluates whether the instruments are orthogonal to individual's characteristics that are used as covariates in our estimations and to the total number of sex partners reported in 2004 before testing. The regressions include dummy variables for region because the distribution of incentives differed slightly across region. The sample for each of these regressions is composed of individuals with a known HIV test result and with nonmissing dependent variables. We use a probit specification for the binary dependent variables, an ordered probit for the ordered categorical variables, and ordinary least squares (OLS) for the continuous variable. Table 3 shows that individuals' characteristics are similar across groups receiving various incentive amounts and those living within various distances of the HCT clinic center.

In the upcoming specifications, we instrument learning HIV-negative status and learning HIV-positive status with being offered any incentive, the amount of the incentive, the amount of the incentive squared, the distance from the HCT clinic, and the distance squared. We interact these with the 2004 HIV status to allow for a differential effect of leaning one's HIV status for HIV-positive and HIV-negative individuals.

[11] Wooldridge (2002) pointed out that the hypothesis of selection should be tested with the uncorrected t statistics obtained from the IV estimation. Standard errors need to be corrected for the generated regressor problem when the hypothesis of no selection is rejected.

Table 3 Orthogonality of the instruments

Dependent Variables	Female	Less Than Primary Schooling	Married	Size of Owned Land Categories	Age Categories	Total Number of Sex Partners Reported in 2004
Specification	Probit	Probit	Probit	Ordered Probit	Ordered Probit	OLS
Any Incentive	0.145	0.002	–0.139	–0.114	0.109	–3.037
	[0.094]	[0.096]	[0.103]	[0.089]	[0.081]	[2.014]
Incentive	–0.001	0.001	0.002	0.001	0.000	0.033
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.026]
Incentive Squared	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Distance	0.085	0.069	–0.024	–0.033	–0.077	–0.540
	[0.070]	[0.072]	[0.077]	[0.066]	[0.060]	[1.526]
Distance Squared	–0.020	–0.019	0.001	0.011	0.020*	0.013
	[0.014]	[0.014]	[0.015]	[0.013]	[0.012]	[0.300]
Constant	0.002	0.306*	0.862**			10.874**
	[0.091]	[0.093]	[0.102]			[1.984]
N	2,879	2,879	2,879	2,770	2,725	2,499

Notes: Standard errors are in brackets. All regressions include region dummy variables. The size of owned land categories are less than 2 acres, 2 to 4 acres, and more than 4 acres. The age categories are less than 20 years old, 20 to 29, 30 to 39, 40 to 49, and 50+.

$^{*}p < .05$; $^{**}p < .01$

The Causal Impact of HIV Testing on Subjective Expectations

Infection Expectations

Table 4 reports the OLS and IV regression analyses of respondents' 2006 subjective probability of being infected with HIV. We first present results without any covariates, and then add controls for basic demographic characteristics (coefficients of the latter are not shown). Table S1 in the online supplement presents the selection equation from which we derive the inverse Mills ratio when there are covariates, and Table S2 shows the first stage of the IV regression with covariates.

The OLS and IV regressions show that the coefficient associated with learning HIV-positive status in 2004 is not statistically significantly different from 0. This is surprising, particularly in the IV analyses because one would *a priori* expect a large positive effect of learning about an HIV-positive status on subjective probabilities of being infected. Table 4 thus suggests that HCT has no sustained impact on subjective infection expectations among HIV-positive individuals across a two-year time period.[12] This is consistent with the findings reported earlier that HIV-positive individuals who learned their status report very low subjective probabilities of being infected with HIV.

The IV regression results for those who learn their HIV-negative status show that HIV-negative respondents who learned their HIV status in 2004 tend to report a

[12] Note also that only 97 respondents in the analytical sample are HIV positive.

Table 4 The impact of learning HIV status on subsequent beliefs about own infection and error in prediction

	Subjective Beliefs About Own HIV Status (in no. of beans)				Error in Prediction
Dependent Variables	OLS	IV	OLS	IV	IV
Mean Dependent Variable	1.06	1.06	1.06	1.06	0.13
Learn HIV–	–0.185	0.382*	–0.234*	0.316†	0.058*
	[0.116]	[0.191]	[0.114]	[0.188]	[0.020]
Learn HIV+	–0.379	–0.225	–0.508	–0.356	0.037
	[0.693]	[1.026]	[0.711]	[0.993]	[0.107]
HIV+ in 2004	2.502**	2.518**	1.996**	2.103*	0.596**
	[0.578]	[0.693]	[0.585]	[0.708]	[0.074]
Inverse Mills Ratio (no control)	–1.15	–1.021			
	[0.943]	[0.904]			
Inverse Mills Ratio (with additional controls)			0.014	–0.035	–0.032
			[0.223]	[0.196]	[0.025]
N	2,118	2,118	2,118	2,118	1,869
Additional Controls	No	No	Yes	Yes	Yes
No Selection Rejected and SEs Corrected	No	No	No	No	Yes

Notes: Robust standard errors, shown in brackets, are clustered at the village level. Controls include female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV– and Learn HIV+ are instrumented in the IV specification by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004), and by the controls in columns 5 and 6.

† $p < .10$; * $p < .05$; ** $p < .01$

higher probability of being infected in 2006 than those who did not learn their status, and this effect of learning one's HIV-negative status is statistically significant at 10%, although small in magnitude. Controlling for additional covariates does not change the magnitude of the result. In the most complete specification, the IV estimates suggest that HIV-negative respondents who learned they were HIV negative in 2004 allocated, on average, 0.32 additional beans when asked about their infection status in 2006, indicating that learning an HIV-negative status in 2004 is associated with a 3.2 percentage point higher subjective probability of being HIV positive in 2006. This IV regression result is in sharp contrast to the OLS results that suggest a lower 2006 subjective infection risk for those who learned their HIV-negative status in 2004 as compared with those who did not. This downward bias of the OLS versus IV results is consistent with the hypothesis that HCT uptake is selective, and that individuals in 2004 who believed they had a higher chance of being infected were less likely to attend an MLSFH HCT clinic to learn their HIV status.

A key question in interpreting these results is whether, given the changes in HIV risk perception as a result of HCT, individuals' perceptions about their HIV status have become more accurate. Within the intertemporal choice frameworks outlined at the beginning of this article, more accurate expectations could possibly lead to more optimal life-cycle decisions. Because our data include measures about the actual and the perceived HIV status of individuals, we therefore conclude this subsection by investigating whether learning HIV status in 2004 helped respondents to have more accurate subjective beliefs about their HIV status two years later. For this purpose, we focus on respondents who were tested for HIV in 2006 (regardless of whether they learned their results in 2006), and investigate the accuracy of knowledge about HIV status (or error in prediction about one's HIV status) by using the absolute value of the difference between a respondent's actual HIV status in 2006 and his/her subjective probability of being HIV positive in 2006.[13] About 1.2% of the respondents who were HIV negative in 2004 became HIV positive by 2006, and the average error in predicting their 2006 HIV status is .13. Our IV analyses in the last column of Table 4 reveal that among 2004 HIV-negative respondents, those who learned their HIV status in 2004 tend to have a larger prediction error about their 2006 HIV status than those who did not. This result is driven by the fact that HIV-negative respondents who learned their results in 2004 believed themselves to be at a higher risk in 2006 than respondents who did not learn their results in 2004, while very few of the 2004 HIV-negative respondents actually became infected by 2006.

The inverse Mills ratio is not statistically significantly different from 0 at conventional levels in the IV regressions using infection expectations, so we do not reject the hypothesis of no selection attributable to attrition between 2004 and 2006 when the outcome is infection expectation. It is, however, negative and statistically significant at 10% in the prediction error regression when using the GMM IV standard errors (not shown). To correct for the generated regressor problem, the results presented in column 5 of Table 4 are derived as described in the Econometric Specification section.

Summarizing, the primary finding of our analyses in Table 4 is that among respondents who tested negative for HIV in 2004, learning their HIV-negative status in 2004 resulted in higher and less accurate expectations of being HIV positive in 2006. This result is contrary to our initial expectations and suggests that providing HIV-negative individuals with knowledge about their HIV status does not result in better risk perception of subsequent status. This counterintuitive effect is potentially caused by two factors: differences in HIV/AIDS-related expectations between individuals who learned or did not learn their status in 2004, or differences in risk behaviors since testing. We discuss these possible factors in the subsequent sections.

HIV/AIDS-Related Expectations

In Table 5, we evaluate the causal impact of learning HIV status on beliefs about transmission rates associated with various sexual behaviors and on beliefs regarding the HIV status of potential or actual partners. Respondents were asked the likelihood that an HIV-negative hypothetical person of the respondent's gender would become HIV positive following (1) a single unprotected event of intercourse with someone who is HIV positive; and (2) in the next 12 months with (a) normal sexual behavior, (b) being married to an HIV-positive spouse, or (c) several sexual partners in addition to a spouse. Respondents were also asked to indicate their

[13] For this purpose, we allocated a 2006 HIV-positive status to respondents who were found to be HIV-positive in 2004, even for those who were not tested in 2006.

Table 5 The causal impact of learning HIV status on HIV/AIDS-related expectations (IV)

Dependent Variables	Chance of Contracting HIV (in no. of beans): During a Single Intercourse Without Condom With Someone Who Has HIV/AIDS	Within the Next 12 Months (with normal behavior)	Within the Next 12 Months if Married to Someone Who is Infected With HIV/AIDS	Within the Next 12 Months if Several Sexual Partners in Addition to Spouse	Village Prevalence (from 0 to 10)	Chance That Spouse/Romantic Partner Is Infected (in no. of beans)
Mean Dependent Variable	8.68	2.18	9.28	7.73	2.88	1.12
Learn HIV–	–0.039	–0.269	–0.175	–0.207	0.151	0.448*
	[0.186]	[0.238]	[0.115]	[0.192]	[0.172]	[0.203]
Learn HIV+	–1.252*	–1.211*	–1.082*	–1.044	0.313	0.288
	[0.462]	[0.539]	[0.389]	[0.661]	[0.458]	[1.148]
HIV+ in 2004	0.981*	1.005*	0.487*	0.769	0.202	1.733*
	[0.314]	[0.455]	[0.223]	[0.524]	[0.364]	[0.785]
Inverse Mills ratio	0.056	0.122	–0.133	–0.027	0.246	–0.139
	[0.195]	[0.192]	[0.110]	[0.194]	[0.189]	[0.274]
N	2,123	2,121	2,122	2,121	2,112	1,874
No Selection Rejected and SEs Corrected	No	No	No	No	No	No

Notes: Robust standard errors, shown in brackets, are clustered at the village level. All regressions include controls for female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV– and Learn HIV+ are instrumented by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004), and the controls.

$^*p < .05$

perceptions of the village prevalence (from 0 to 10) and the likelihood that their spouse/partner is currently infected.

The IV regressions for transmission rates—following the same methodology as outlined in the Econometric Specification section—suggest that among 2004 HIV-positive respondents, learning one's HIV status resulted in lower subjective beliefs about the chance of contracting HIV. Those who learned their status allocated, on average, from 1 to 1.2 beans fewer for each of the transmission expectations compared with those who did not learn their status. This may be due to the fact that some respondents found out that they were HIV positive, while some of their partners (who were also tested) told them that they were HIV negative, leading them to revise downward their beliefs about transmission rates.[14] In contrast, Table 5 shows that learning an HIV-negative status has no impact on beliefs about transmission rates. However, it does have an impact on beliefs about partner's status: among HIV-negative individuals, learning one's status is associated with a 4.6 percentage point higher subjective probability of spouse or partner's infection in 2006. Given the fact that own and partner's HIV status are highly correlated, this result is consistent with the fact that learning one's own status is associated with a higher subjective probability of infection among HIV-negative individuals.

The Causal Impact of HIV Testing on Risky Behavior

After emphasizing the effects of HCT on individual's subjective expectations about their HIV status, our subsequent analyses focus on potential behavioral changes in response to learning one's HIV status. We begin our analyses in Table 6 by investigating the impact of learning one's HIV status on various measures of risky behaviors. All these measures are self-reported by the respondents in 2006. The table presents the results of the IV regressions for the following dependent variables: the number of partners in the past 12 months; an indicator for whether the respondent had a new sex partner in the past 12 months; whether a respondent has condoms at home; whether (s)he used a condom every time with at least one partner (of the three most recent partners) in the past 12 months; and whether (s)he used a condom sometimes, almost every time, or every time with at least one partner (of the three most recent partners) in the past 12 months.[15]

Providing HIV-positive individuals with knowledge about their HIV status brings on some behavioral changes that reduce the transmission risk to other individuals. This reduction in risky behaviors occurs despite the fact that testing has no impact on the reported infection expectations in the medium run and decreases expectations about transmission rates. Among HIV-positive individuals, those who learned their status had about 0.4 fewer partners in the past 12 months, were more likely to use a condom every time with at least one partner, were more likely to use a condom sometimes to every time with at least one of their three most recent partners, and were less likely to have never used a condom with their three most recent partners. The

[14] We investigate later the impact of learning own and spouse's HIV status simultaneously.

[15] Sherr et al. (2007) found that in rural Zimbabwe, testing negative for HIV was associated with increased risky behavior in terms of partner acquisition rates, although they could not address the selection issue of HIV testing.

Table 6 The causal impact of learning HIV status on sexual behavior (IV)

Dependent Variables	Number of Partners in the Last 12 Months	Had a New Partner in the Last 12 Months	Has Condom at Home	Use Condom Every Time With at Least One Partner in the Last 12 Months	Use Condom Sometimes to Every Time With at Least One Partner in the Last 12 Months	Never Used Condom With up to 3 Most Recent Partners
Mean Dependent Variable	1.05	0.07	0.13	0.08	0.27	0.66
Learn HIV–	0.006	–0.013	0.071*	–0.009	0.055	–0.05
	[0.061]	[0.028]	[0.033]	[0.024]	[0.043]	[0.044]
Learn HIV+	–0.350*	0.022	0.132	0.114*	0.403*	–0.350*
	[0.161]	[0.098]	[0.120]	[0.047]	[0.152]	[0.176]
HIV+ in 2004	0.182	–0.034	0.029	–0.115**	–0.105	0.048
	[0.151]	[0.074]	[0.087]	[0.028]	[0.131]	[0.142]
Inverse Mills Ratio	0.043	0.072†	–0.021	0.017	–0.021	0.038
	[0.058]	[0.039]	[0.034]	[0.035]	[0.044]	[0.046]
N	2,129	2,131	2,130	1,843	1,848	1,833
No Selection Rejected and SEs Corrected	No	Yes	No	No	No	No

Notes: Robust standard errors, shown in brackets, are clustered at the village level. All regressions include controls for female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV– and Learn HIV+ are instrumented by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004), and the controls.

†$p < .10$; *$p < .05$; **$p < .01$

effect on condom use is quite large. For example, only 8% of the respondents used a condom every time with at least one partner, and learning HIV-positive status is associated with an 11 percentage point increase in this type of condom use.

Among HIV-negative individuals, those who learned their status are more likely to have condoms at home. Although we do not find a statistically significant impact of learning one's status on actual condom use with recent partners, this may still indicate that they intend to use condoms with at-risk partners.

Attrition between 2004 and 2006 affects inferences only for the variable "having a new partner." The standard errors for this variable are corrected as described in the Econometric Specification section. Table S3 in the online supplement shows the OLS results corresponding to Table 4 to evaluate the impact of selection into testing. As do the IV results, the OLS results show that learning HIV-positive status is associated with a statistically significantly (at 10%) lower number of partners and has no effect on condom use.

Finally, we use pregnancy in the past two years among nonmarried individuals as a proxy for risky behavior, since pregnancies are most likely to be unintended in this group.[16] Table 7 shows that among HIV-positive individuals, learning one's status decreases

[16] We focus on respondents who had never been married as of 2006, or who were divorced and separated in both 2004 and 2006. A female respondent is counted as having experienced a pregnancy in the past two years if she reports a higher number of children in 2004 than in 2006, or if (s)he reports being currently pregnant or having a partner currently pregnant.

Table 7 The causal impact of learning HIV status on pregnancy in the past two years among nonmarried respondents (IV)

Dependent Variables	Any Pregnancy in the Past Two Years
Mean Dependent Variable	0.05
Learn HIV–	–0.028
	[0.027]
Learn HIV+	–0.402*
	[0.176]
HIV+ in 2004	0.234
	[0.152]
Inverse Mills Ratio	–0.010
	[0.023]
N	359
No Selection Rejected and SEs Corrected	No

Notes: Robust standard errors, shown in brackets, are clustered at the village level. All regressions include controls for female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV– and Learn HIV+ are instrumented by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004), and the controls.

*$p < .05$

the pregnancy rate of nonmarried respondents. This suggests again that learning one's status is associated with safer sexual behavior among HIV-positive individuals. Our results contrast with those of Gong (2010), who found that in Kenya and Tanzania, learning HIV-positive status (among those who expected to be negative) increases risky sex. Our results, however, are consistent with the results of De Paula et al. (2010), who found that in Malawi, upward revision of infection beliefs leads to fewer extramarital affairs.

Overall, our results confirm the argument underlying the current expansion of HIV testing services in sub-Saharan Africa that providing individuals with knowledge about their HIV status results in behavioral changes among the HIV-positive individuals, reducing the HIV infection risk of others: they expose fewer people to the disease, both by reducing the total number of partners and by increasing condom use. Learning one's HIV-negative status has no effect on self-reported number of partners or condom use, but those who learn of their HIV-negative status are more likely to have condoms at home. This suggests that the channel through which testing may be more effective at preventing new infections is through behavioral changes of HIV-positive individuals.

Learning Own and Spouse's HIV Status

For many married respondents, their spouses had the opportunity to be tested as part of the same testing experiment.[17] To the extent that spouses share their HIV test results,

[17] The incentive amounts were allocated independently on separate occasions to husbands and wives. Not all spouses of respondents were offered a test: men who divorced or were widowed and spouses of the newly sampled adolescents were ineligible for testing.

learning one's own status may be positively associated with learning spouse's status as well. In our analytical sample, we know the HIV test results for the spouse of 63% of the 1,620 respondents who were married in 2004 and not widowed in 2006.[18] Seventy-four percent of those spouses went to pick up their test results. However, not all respondents were aware that their spouse had been tested and learned his/her test results. Among respondents whose spouses learned their test results in 2004, 76.0% reported in 2006 that their spouse had ever been tested, 23.5% reported that their spouse had never been tested, and 0.5% reported that they did not know whether their spouse had ever been tested. Of those who reported that their spouse had ever been tested, 98.8% stated that their spouse shared the test result with them. This response pattern indicates that individuals are socially expected to reveal their HIV test result to their spouse if the spouse is aware of the HIV test, but HIV test participation may be kept secret by some individuals to avoid revealing this information to the spouse.

Overall, for one-third of the respondents in our analytical sample who were married in 2004, the spouse learned his/her status in 2004 and the respondent reported in 2006 that the spouse shared the test results when (s)he got tested. Of these, 94% found out that both spouses were HIV negative, 3% found out that they were HIV negative and that their spouse was HIV positive, 2% found out that they were HIV positive and that their spouse was HIV negative, and 1% found out that both spouses were HIV positive.

Spouses who participated in the testing experiment also received a financial incentive, which was allocated independently from that of the respondent. We therefore have a valid instrument for whether a spouse learns his/her HIV status.[19] We use the spouse's financial incentive as an instrument for whether a respondent learns the HIV status of the spouse.

We therefore investigate the causal impact of learning own and spouse's results for respondents married at the time of testing using the following model:

$$y_1 = \begin{pmatrix} z_1\boldsymbol{\delta}_1 + \alpha_N LearnHIVneg + \alpha_P LearnHIVpos \\ +\alpha_{SN} LearnSpHIVneg + \alpha_{SP} LearnSpHIVpos \\ +\beta_{HIV} HIV + \beta_{SpHIV} SpHIV \\ +\beta_{SpHIV\_u} SpHIVunknown + \varepsilon_1 \end{pmatrix}$$

$$\begin{aligned} &LearnHIVneg = z_3\beta_2 + \varepsilon_2 \\ &LearnHIVpos = z_3\beta_3 + \varepsilon_3 \\ &LearnSpHIVneg = z_3\beta_4 + \varepsilon_4 \\ &LearnSpHIVpos = z_3\beta_5 + \varepsilon_5 \\ &y_3 = 1(z_3\boldsymbol{\delta}_4 + v_4), \end{aligned}$$

where, as before, y_1 is the outcome of interest (subjective beliefs or risky behavior), and y_3 is an indicator of attrition between 2004 and 2006. The variables

[18] We exclude from the couples' analysis 19 respondents who were married in 2004 but whose spouse had died by 2006 because behaviors of widowed individuals may be quite different from those of married or separated respondents. Men in polygamous marriages are matched to their first wife.

[19] Distance between respondents' home and the HCT clinic is the same for both spouses.

LearnHIVneg, *LearnHIVpos*, and *HIV* are defined as before. The variable *LearnSpHIVneg* is equal to 1 if the respondent's spouse tested negative in 2004 and the respondent reports that his or her spouse shared the test result, and 0 otherwise. The variable *LearnSpHIVpos* is equal to 1 if the respondent's spouse tested positive in 2004 and the respondent reports that his or her spouse shared the test results, and 0 otherwise. The variable *SpHIV* is equal to 1 if the respondent's spouse was HIV positive in 2004, and 0 otherwise. The variable *SpHIVunknown* is equal to 1 if the HIV status of the respondent's spouse is unknown to the research team, and 0 otherwise. Adding interaction terms for learning the various statuses would be interesting, but that would add even more endogenous variables to the estimation, so we focus here on the main effects.

The vector $\mathbf{z}_3$ is such that $\mathbf{z}_3 = [z_1,z_4]$, where z_1 includes respondents' characteristics and z_4 is a set of instruments. The vector z_4 includes the same instruments used earlier (being offered any incentive, the amount of the incentive, the amount of the incentive squared, the distance from the HCT clinic, and the distance squared—all interacted with the 2004 HIV status) along with the spouse's financial incentive (being offered any incentive, the amount of the incentive, the amount of the incentive squared—all interacted with the spouse's 2004 HIV status).

Table S4 in the online supplement shows the first stage of the IV when using HIV infection expectations as dependent variables in the second stage, and Table 8 shows the causal impact of learning own and spouse's HIV status on HIV/AIDS-related expectations. Because we do not allow for interaction terms, we test the impact of learning both own and spouse's status by taking the sum of the relevant coefficients. We find that among respondents in couples in which both individuals are HIV negative, learning both statuses has a smaller impact on own infection expectations ($\alpha_N + \alpha_{SN} = 0.18$; and is not statistically significantly different from 0) than learning an HIV-negative status without knowing a spouse's status ($\alpha_N = 0.63$). Similarly, learning both statuses has a smaller impact on spouse's infection expectations ($\alpha_N + \alpha_{SN} = 0.52$; not statistically significantly different from 0) than learning an HIV-negative status without knowing the spouse's status ($\alpha_N = 0.77$). Actually, those who learned both statuses do not hold beliefs that are statistically significantly different from those who did not learn their status. As one would expect, learning own and spouse's HIV status is associated with a smaller prediction error about their 2006 HIV status among HIV-negative couples ($\alpha_N + \alpha_{SN} = -0.01$) compared with those who did not learn the status of their spouse ($\alpha_N = 0.08$). This suggests that uncertainty about the status of the main partner may be driving the findings reported in the section investigating the causal impact of HIV testing on infection expectations. In particular, respondents who were tested but did not learn the test results of their main partner(s) may suspect that the main partner(s) tested positive and did not share their test results. In Table 8, we see that learning HIV-negative status is associated with a small decrease in the subjective probability of contracting HIV within the next 12 months if someone has several partners in addition to spouse.

Among respondents married to an HIV-positive spouse, learning their spouse's status is associated with a 43 to 48 percentage point decrease in own and spouse's expectations. One needs to be cautious when interpreting

Table 8 The causal impact of learning HIV status on AIDS-related expectations among respondents married at the time of testing (IV)

Dependent Variables	Chance of Being Currently Infected With HIV (in no. of beans)	Chance of Contracting HIV (in no. of beans): During a Single Intercourse Without Condom With Someone Who Has HIV/AIDS	Chance of Contracting HIV (in no. of beans): Within the Next 12 Months (with normal behavior)	Chance of Contracting HIV (in no. of beans): Within the Next 12 Months if Married to Someone Who Is Infected With HIV/AIDS	Chance of Contracting HIV (in no. of beans): Within the Next 12 Months if Several Sexual Partners in Addition to Spouse	Village Prevalence (from 0 to 10)	Chance That Spouse/Romantic Partner Is Infected (in no. of beans)	Error in Prediction
Mean Dependent Variables	1.08	8.66	2.16	9.27	7.72	2.91	1.12	0.14
Learn HIV–	0.627*	–0.029	–0.069	–0.176	–0.606*	0.244	0.767**	0.077*
	[0.236]	[0.203]	[0.262]	[0.140]	[0.243]	[0.214]	[0.227]	[0.027]
Learn HIV+	–0.246	–0.895*	–0.829	–0.537	–0.646	–0.244	–1.208	0.085
	[1.072]	[0.407]	[0.625]	[0.365]	[0.749]	[0.665]	[1.194]	[0.118]
Learn Spouse HIV–	–0.448	–0.131	0.290	–0.062	0.010	0.104	–0.250	–0.085
	[0.377]	[0.353]	[0.320]	[0.244]	[0.345]	[0.302]	[0.370]	[0.052]
Learn Spouse HIV+	–4.848*	–2.787*	–1.010	–0.192	6.340*	–1.932	–4.336*	–0.091
	[2.236]	[1.401]	[1.307]	[0.887]	[2.517]	[1.734]	[2.006]	[0.871]
HIV+ in 2004	2.094*	0.588*	0.715	0.158	0.190	1.201	2.368*	0.020
	[0.783]	[0.283]	[0.456]	[0.172]	[0.527]	[0.906]	[0.832]	[0.438]
Spouse HIV+ in 2004	2.271†	1.785*	0.894	0.308	–3.317*	0.531	2.586*	0.602**
	[1.276]	[0.769]	[0.793]	[0.498]	[1.477]	[0.440]	[1.141]	[0.086]
Spouse's Status Unknown	0.038	0.052	0.141	–0.021	–0.043	–0.050	0.145	–0.010
	[0.238]	[0.200]	[0.196]	[0.129]	[0.206]	[0.185]	[0.234]	[0.031]
Inverse Mills Ratio	–0.279	0.188	0.094	–0.046	–0.393†	0.445†	–0.288	–0.034
	[0.256]	[0.211]	[0.199]	[0.105]	[0.204]	[0.245]	[0.303]	[0.034]
N	1,592	1,595	1,594	1,594	1,595	1,587	1,549	1,426
Wald Test (p values)								
$\alpha_N + \alpha_{SN} = 0$	.615	.630	.506	.213	.072	.235	.119	.884
$\alpha_P + \alpha_{SN} = 0$	.533	.073	.409	.185	.445	.847	.228	.994

Table 8 (continued)

		Chance of Contracting HIV (in no. of beans)						
Dependent Variables	Chance of Being Currently Infected With HIV (in no. of beans)	During a Single Intercourse Without Condom With Someone Who Has HIV/AIDS	Within the Next 12 Months (with normal behavior)	Within the Next 12 Months if Married to Someone Who Is Infected With HIV/AIDS	Within the Next 12 Months if Several Sexual Partners in Addition to Spouse	Village Prevalence (from 0 to 10)	Chance That Spouse/Romantic Partner Is Infected (in no. of beans)	Error in Prediction
$\alpha_N + \alpha_{SP} = 0$	.053	.037	.397	.673	.020	.319	.073	.987
$\alpha_P + \alpha_{SP} = 0$	.056	.017	.267	.483	.040	.293	.049	.995
No Selection Rejected and SEs Corrected	No	No	No	No	No	Yes	No	Yes

Notes: Robust standard errors, shown in brackets, are clustered at the village level. All regressions include controls for female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV–, Learn HIV+, Learn Spouse HIV–, and Learn Spouse HIV+ are instrumented by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004); the spouse's incentive (any incentive, incentive amount, and incentive amount squared—all interacted with the spouse's HIV status in 2004); and the controls.

$^{\dagger}p < .10$; $^{*}p < .05$; $^{**}p < .01$

those results because only 25 respondents have a spouse who is HIV positive and report that their spouse shared their test results. One possibility is that some HIV-positive individuals lied to their spouse about their test results. However, we also find that learning about one's spouse's HIV status is associated with a 63 percentage point increase in the perceived probability of becoming infected if one has several sexual partners, which is consistent with some spouses telling the truth about their status.

Table 9 presents the causal impact of learning own and spouse's HIV status on risky behavior among respondents married at the time of testing. As found earlier, learning HIV-positive status is associated with a lower number of partners in the past 12 months, and an increase in condom use.

Among respondents in couples in which both individuals are HIV negative, learning one's HIV status without learning spouse's status is associated with a decrease in consistent condom use with at least one partner ($\alpha_N = -0.039$) compared with those who did not learn their own status; learning both statuses is associated with a small increase in consistent condom use with at least one partner ($\alpha_N + \alpha_{SN} = 0.014$), although the effect is not statistically significantly different from 0. However, learning both HIV-negative statuses is associated with a statistically significant increase in the propensity to use a condom sometimes to every time with at least one partner ($\alpha_N + \alpha_{SN} = 0.167$). This suggests the existence of altruism toward the spouse in couples who share test results: married individuals are more likely to protect themselves when there are two HIV-negative statuses to preserve. This type of condom use refers mostly to extramarital partners (only 10 respondents report using a condom every time with their current or previous spouse). The observed decrease in consistent condom use potentially explains the larger beliefs in own and spouse's infection expectations among married respondents who learned their own negative status but did not learn the status of their spouse. Among HIV-negative couples, the only margin of adjustment appears to be condom use because there is no statistically significant effect of learning one's status on the number of partners. Our results therefore suggest that for those couples, learning one's status without learning that of the spouse slightly increases risky behavior, while learning both statuses decreases risky behavior. Our results do not allow us to decipher which of these two effects would dominate in terms of HIV incidence. However, given that HIV testing decreases risky behavior among HIV-positive individuals and that almost three-quarters of the married respondents whose spouse was tested reported that their spouse shared his/her test results, we may speculate that HIV testing would overall contribute to reducing the number of new infections.

For sero-discordant couples, Table 9 shows that learning both statuses reduces the probability of never using a condom ($\alpha_N + \alpha_{SP} = -0.540$ and $\alpha_P + \alpha_{SN} = -0.263$) and increases the probability of using a condom every time with at least one partner ($\alpha_P + \alpha_{SN} = 0.153$). These findings suggest that these couples are taking some measures to avoid infecting the HIV-negative spouse.[20]

[20] A natural explanation for this behavior is altruism. However, given that the vast majority of people who previously tested positive actually report a low probability of being HIV positive, other motives may be responsible.

Table 9 The causal impact of learning HIV status on sexual behavior among respondents married at the time of testing (IV)

Dependent Variables	Number of Partners in the Last 12 Months	Had a New Partner in the Last 12 Months	Has Condom at Home	Use Condom Every Time With at Least One Partner in the Last 12 Months	Use Condom Sometimes to Every Time With at Least One Partner in the Last 12 Months	Never Used Condom With up to 3 Most Recent Partners
Mean Dependent Variable	1.10	0.06	0.12	0.04	0.23	0.70
Learn HIV–	0.025	–0.005	0.091*	–0.039†	0.051	–0.076
	[0.058]	[0.026]	[0.041]	[0.020]	[0.054]	[0.056]
Learn HIV+	–0.296*	–0.060	0.102	0.090†	0.441*	–0.263†
	[0.138]	[0.127]	[0.142]	[0.046]	[0.151]	[0.140]
Learn Spouse HIV–	–0.048	0.015	0.012	0.053*	0.116	0.000
	[0.075]	[0.042]	[0.060]	[0.021]	[0.076]	[0.077]
Learn Spouse HIV+	–0.162	–0.363	0.044	0.080	0.280	–0.464
	[0.446]	[0.357]	[0.387]	[0.120]	[0.304]	[0.324]
HIV+ in 2004	0.173	0.188	0.068	–0.097**	–0.075	–0.031
	[0.125]	[0.217]	[0.100]	[0.027]	[0.128]	[0.112]
Spouse HIV+ in 2004	0.052	0.049	0.035	–0.025	–0.077	0.206
	[0.272]	[0.089]	[0.206]	[0.057]	[0.156]	[0.187]
Spouse's Status Unknown	0.140**	0.057*	0.033	0.062**	0.080	0.002
	[0.042]	[0.026]	[0.037]	[0.013]	[0.049]	[0.048]
Inverse Mills Ratio	0.083	0.110	–0.057	0.014	–0.010	–0.007
	[0.061]	[0.074]	[0.042]	[0.028]	[0.052]	[0.056]
N	1,599	1,601	1,601	1,521	1,521	1,518
Wald Test (p values)						
$\alpha_N + \alpha_{SN} = 0$	.733	.797	.090	.435	.014	.273
$\alpha_P + \alpha_{SN} = 0$	.030	.721	.468	.005	.001	.105
$\alpha_N + \alpha_{SP} = 0$	.754	.303	.721	.729	.268	.081
$\alpha_P + \alpha_{SP} = 0$	.394	.271	.732	.174	.030	.062

Table 9 (continued)

Dependent Variables	Number of Partners in the Last 12 Months	Had a New Partner in the Last 12 Months	Has Condom at Home	Use Condom Every Time With at Least One Partner in the Last 12 Months	Use Condom Sometimes to Every Time With at Least One Partner in the Last 12 Months	Never Used Condom With up to 3 Most Recent Partners
No Selection Rejected and SEs Corrected	No	Yes	No	No	No	No

Notes: Robust standard errors, shown in brackets, are clustered at the village level. All regressions include controls for female, marital status, age category, primary school level or less, size of the land owned, and region dummy variables. Learn HIV–, Learn HIV+, Learn Spouse HIV–, and Learn Spouse HIV+ are instrumented by any incentive, incentive amount, incentive amount squared, distance, distance squared (all interacted with HIV status in 2004); the spouse's incentive (any incentive, incentive amount, and incentive amount squared—all interacted with the spouse's HIV status in 2004); and the controls.

$^{\dagger}p < .10$; $^{*}p < .05$; $^{**}p < .01$

Conclusion

Improving access to HIV counseling and testing (HCT) services in sub-Saharan Africa is potentially an important practice for facilitating long-term behavior change if individuals who get tested for HIV revise their subjective beliefs about being infected with HIV and change their behavior upon learning their status. However, despite the widespread expansion of HCT services in sub-Saharan Africa, little is known about how providing information on an individual's HIV status causally affects his/her medium-term behavior and HIV/AIDS-related subjective expectations. In this article, we investigate the impact of learning HIV status on subsequent HIV/AIDS-related expectations and sexual behavior, using a randomized experiment that provided varying incentives for individuals to learn their HIV status. From a methodological perspective, our results show that selection into learning HIV status is important and that inference based on nonrandomized knowledge of HIV status might be misleading. From a substantive perspective, we find that receiving an HIV-negative test result implies (a) *higher subsequent subjective probabilities* about being infected with HIV, although the effect is small in magnitude, and (b) *larger prediction errors* about one's HIV status. However, the effect disappears among individuals in HIV-negative couples who also learned the status of their spouse. We also find that learning an HIV-positive status has no effect on the reported probability of being infected in the medium run but decreases the subjective probabilities about transmission rates associated with various behaviors. The latter results may be driven by the fact that some respondents who tested positive found out that their main partner was HIV negative.

Finally, we show that providing HIV-positive individuals with knowledge about their HIV status results in behavioral changes that reduce the HIV infection risk to others: HIV-positive individuals who learned their status had fewer partners and used condoms more often than those who did not learn their status in the medium run. Nonmarried HIV-positive respondents who learned their status were also less likely to experience a pregnancy than those who did not learn their status. This confirms the argument underlying the current expansion of HIV testing services in sub-Saharan Africa that upon learning their status, HIV-positive individuals change their behavior to reduce the HIV infection risk of others.

Among married respondents in couples in which both members are HIV negative, learning only one's own status is associated with a decrease in consistent condom use with at least one partner, while learning both statuses is associated with an increase in condom use. Because consistent condom use within marriage is rare (Chimbiri 2007) this consistent condom use likely refers to extramarital relationships for most of the respondents, implying that respondents who tested negative without learning the status of their partners are now at greater risk of becoming infected. This difference in behavior may explain our results on beliefs about infection. In addition, we find that individuals in sero-discordant couples who learned both statuses were more likely to report some condom use.

Overall, our analyses suggest that ensuring that both spouses learn the HIV status of each spouse may be beneficial in high-prevalence environments. This could be achieved by encouraging spousal communication in post-testing counseling sessions or by organizing couples' testing. In our data, three-quarters of the married respondents whose spouse was tested reported that their spouse shared his/her test result. This proportion may be increased by making the sharing of results to sexual partners a specific component of the counseling session. A complementary option is to offer to both spouses the opportunity to learn their status jointly. Although this is the most effective way to ensure that couples share their results, acceptability may be low, especially because of fear of conflicts or domestic violence in case of sero-discordant results. However, recent studies (e.g., Allen et al. 2003, 2007; Desgrées-du-Loû and Orne-Gliemann 2008) have shown that couples' testing is a viable option.

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