HIV TESTING, INFORMATION SPILLOVERS, AND PEER BEHAVIOR

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Mykhailo Sitiuk

May, 2013

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Abstract

This dissertation consists of two chapters. In the first chapter, I study the effect of HIV testing the risky behaviors of peer groups. Empirical studies to date offer mixed evidence on whether HIV testing prevents the spread of the disease. While most studies have focused on the effect of testing on the individual's own behavior, I examine the effect of HIV testing on the peer network using a unique dataset of injecting drug users from the Ukraine. I find that individuals who update their beliefs about their HIV status—from negative to positive following testing—induce less risky behavior among peers. More specifically, the peers double their spending on needles in comparison to peers who do not experience a change in information. The more robust response documented here also points to needle sharing among drug users as a viable alternative to the more commonly studied condom use and risky sexual practices for gauging the effectiveness of HIV testing on changing beliefs and behaviors.

In the second chapter, I study the effect of HIV testing on sexual behavior among couples and singles. Previous studies examining the effects of HIV testing on sexual behaviour have showed limited behavioral response to the epidemic. I examine a possible explanation for this, namely, individuals can respond to HIV not only by engaging in safer sex, but may adjust the frequency of sexual contacts or stop having sex. I also study the effect of HIV testing on condom usage allowing for this possibility. Empirical results indicate that HIV testing increases condom usage among singles and it has no effect on condom usage among couples. At the same time there is no evidence that HIV testing affects the frequency of sexual acts among singles or couples.

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Chapter 1

HIV Testing, Information Spillovers, and Peer Behavior

1.1 Introduction

HIV is the worlds leading infectious killer. Thirty four million people were infected worldwide and 1.8 million died from the disease in 2010 (World Health Organization). In recent years the world community has launched a global campaign to fight the spread of HIV. While HIV treatment is clearly important, many of the strategies used to combat the spread of the disease are directed towards HIV prevention. These strategies include voluntary counseling and testing (VCT), HIV education (promoting condom use, abstinence, or a minimization in the number of partners etc.), mass media campaigns and condom distribution (for more information, see Bertozzi et al. 2006). Many of these interventions build on HIV test results to provide the affected communities with information on HIV risk.

The existing literature has studied the response in sexual behavior to HIV risk, and has generally found economically modest effects. For example, Oster (2011) finds that the change in sexual behavior in response to community HIV prevalence is limited. Thornton (2008) conducts a randomized trial and finds that respondents who were incentivized to learn their HIV results subsequently purchased more condoms at a subsidized price but the response was small. In sum, empirical studies to date offer only limited evidence that HIV testing is effective in preventing the spread of the disease.

In this paper, I investigate the link between HIV testing, information spillovers, and engagement in risky behavior using a data set collected from the Ukraine. The data set is based on a Respondent-Driven Sample (RDS) of Injecting Drug Users (IDU). RDS is a sampling methodology designed to collect data from hard to reach populations, meaning they are hard to reach from the point of view of traditional sampling. As I argue below, the sampling structure and the type of respondents surveyed allows me to address some major weaknesses of the studies conducted to date which may have led investigators to underestimate the effect of HIV testing on the population HIV transmission rate.

First, in order to estimate empirically the total effect of HIV testing on the population HIV transmission rate one should take into account information spillovers associated with the test. HIV testing can have two types of effects: the effect on the respondents own risky behavior and an effect on the risky behavior of his peers (network of family and friends). Surprisingly, there are no studies on the influence of ones HIV status on peers. One possible reason is that peer networks are hard to identify. The use of RDS gets around this problem since the respondents themselves recruit other respondents. In this dataset, I find a significant impact of HIV testing on peers. Among IDU's, HIV spreads mainly through the sharing of injection needles (UNAIDS, 2010). I use spending on needles (controlling for the number of injections per month) to measure the extent to which needles are shared. Higher spending indicates less sharing, i.e., less risky behavior. I regress peers spending on needles on the change in an individuals knowledge of his HIV status. The magnitude of the coefficient suggests that a change in beliefs from I am HIV-negative to I am HIV-positive doubles peers spending on needles.

Second, many studies have focused on purchase of condoms to gauge changes in sexual behavior. However, an individual can respond to HIV not only by engaging in safer sex (buying condoms) but may adjust the frequency of sexual acts or forego sexual activity altogether, which would bias us towards finding no effect of HIV testing on condom purchases. While sex is the most common way the virus is transmitted in much of the world, there are also less common ways to transmit HIV such as sharing contaminated injection equipment which is the focus of study here. I argue that sharing of injection equipment might be a better proxy for engagement in risky behavior than condom use since injecting drug users are most likely addicted to drugs and unlikely to forego drug use altogether. In other words, needle purchases may more completely capture the behavioral response to HIV risk. Notably, I find a substantial behavioral response in terms of spending on needles but not condoms.

After describing the related literature (Section II) and the dataset used in this paper (Section III), Section IV discusses the estimation strategy. Estimating the role of social interactions or peer influences on risky behavior is difficult due to the problem of correlated unobservables as discussed in Manski (1993). For instance, it might be that an HIV-positive recruiters ex-ante have more risk-averse peers. I use two additional pieces of information - test result awareness, and change in beliefs - to show that it is new information provided by testing, and resulting information spillovers, rather than selection, that leads to changes in behavior among peers. First, using the fact that some recruiters learned their test results and some didnt, I explore whether new information and learning is important by separating the two groups. Second, I ask whether individuals who were surprised by their test result relative to their prior beliefs had a larger impact on their peers. Third, I look for evidence that individuals receiving new and surprising information are more successful in recruiting their peers to get tested.

The results, presented in Sections V and VI, indicate that individuals whose recruiters are HIV-positive spend significantly more on needles, but not on condoms. The findings for needles are driven by recruiters who learned their test results, and those who were surprised relative to their prior beliefs. Individuals whose recruiter experienced a bad surprise - believing they were HIV-negative but testing HIV-positive - had the largest response. These individuals spend twice as much on needles, holding the frequency of injections constant. Interestingly, I find no offsetting effect for the peers of recruiters experiencing a good surprise. I also show direct evidence that HIV-positive recruiters, in particular those receiving new information, had a higher likelihood of sending their peers to get tested.

From a policy perspective these results suggest that VCT might serve as an effective HIV prevention strategy.

1.2 Related Literature

This paper contributes to a literature within economics on the HIV epidemic. A large part of this literature studies the effect of HIV on various aspects of human life, including fertility (Chinhui et al., 2009), savings (Thornton, 2012), abortions (Hussey et al., 2010), etc. Another part of the literature studies the ability of HIV prevention programs to stop the spread of the disease. Voluntary counseling and testing (VCT) is considered to be one of the of core HIV prevention strategies (Bertozzi et al., 2006). Its main purpose is to induce less risky behavior in the population. This paper evaluates the effectiveness of VCT as an HIV prevention strategy.

My paper relates to recent studies on the effect of VCT on risky behavior. Thornton (2008) conducts a randomized trial in Malawi to examine the impact of learning ones own HIV status on ones own sexual behavior. In the study, subjects are first offered a free HIV test, and afterwards a subset is randomly selected and offered financial incentives to learn their test results. A follow-up survey is administered and respondents are asked whether they had sex after they learned their test results. They are also given the opportunity to purchase condoms. Thornton makes the following assessment of the effectiveness of free HIV testing: The results in this paper suggest that, relative to other available prevention strategies or targeting high-risk populations, door-to-door HIV testing may not be the most effective HIV prevention strategy, as measured by condom purchases. (Thornton, 2008, p. 1830).

De Paula et al. (2011), analyze how HIV testing changes risky behavior as measured by extramarital affairs among men in Malawi. This paper notably pays attention to respondents change in beliefs about their own HIV status. Before being tested, respondents report their own beliefs about their own HIV status. HIV testing allows respondents to revise beliefs. The authors look at changes in extramarital affairs with respect to changes in beliefs. Results show that an upward revision in beliefs assigned to being HIV positive (that is, from believing one is HIV-negative to believing one is HIV-positive) induces less risky sexual behavior while a downward revision induces more risky behavior. The authors conclude that informing people about their HIV status has some potential to change behaviors and reduce the HIV transmission rate. Gong (2012), however, finds a somewhat opposite result. He uses data from two urban centers in East Africa where respondents were randomly assigned an offer to be tested for HIV. He examines the number of sexually transmitted infections (STI) contracted during the six month period following the HIV test. He also takes into account respondents beliefs about their own HIV status prior to testing. The results suggest that those respondents who were surprised by an HIV-positive result were more likely to contract other STIs relative to a control group, suggesting they engaged in more risky behavior. Individuals who had test results that confirmed their prior beliefs did not change their behavior. The author also builds a theoretical model to simulate the net effect of HIV testing on the population transmission rate and finds that under certain conditions, testing could actually increase the transmission rate.

In sum, the existing literature points to mixed evidence regarding the impact of HIV testing and updating of beliefs on sexual behavior with some studies even suggesting that informing people about their own HIV status might actually lead to an increase in the HIV transmission rate.

My paper differs from the above studies in several respects. First, these papers have focused exclusively on the effect of an individuals HIV status on his own risky behavior and have not examined the impact of testing on peers risky behavior.[1] Peer effects might help us make progress in understanding the effectiveness of HIV testing on changing beliefs

[1] Two previous papers have looked at peer effects in the decision to get an HIV test: Thornton (2012) and Ngatia (2011). These papers analyze the effect of next-door neighbors learning their HIV results on an individuals own learning. However, neither of these papers studies the effects on risky behavior.

and behaviors. I examine this important channel in this paper. A second difference is that previous studies exclusively used sexual behavior as a proxy for risky behavior. In this paper, I use two proxies for risky behavior: condom purchases and needle purchases. I argue that needle purchases are a better proxy than condoms for the change in risky behavior and my results support this interpretation.

1.3 Data

1.3.a Respondent Driven Sampling Methodology

Data gathering is a crucial part of the global fight against HIV. The main aim of HIV/AIDS data collection is to gain a deeper understanding of the factors causing the spread of the infection in order to create effective policies for HIV prevention and HIV treatment. Most often, data have come from the most easily accessible populations such as military recruits and pregnant women looking for care. Data are also collected by offering VCT to different communities. One problem with these approaches is that they miss many subgroups who are considered high risk such as injecting drug users, commercial sex workers, men who have sex with men, and mobile subgroups such as truck drivers. With limited public resources, reaching these high-risk populations is a priority.

A frequently used approach to reach these high-risk populations, where traditional methods are not appropriate, is snowball sampling, where seeds (initial respondents) are selected by survey organizers. Each seed receives uniquely identified coupons to distribute among others in the targeted group. After receiving a coupon a respondent may return it to survey organizers to participate in the study. These coupons generate the first wave of respondents. Members of the first wave also receive coupons to invite subsequent respondents. This process continues until a desired sample size is met. Respondent Driven Sampling (RDS) is a variation of snowball sampling where respondents are limited in the number of coupons they receive. This tends to increase the total number of waves which, in turn, reduces the influence of seeds on the composition of the final sample. In theory, RDS results in a more representative sample relative to snow ball sampling (for more information, see Gale, 2011).

1.3.b Ukrainian Context and Data

Africa has been a center of the HIV epidemic since its outburst. For this reason, most research on the HIV epidemic has been concentrated in Africa. However, there are other centers of infection in the world. In Europe and Central Asia the highest rates of HIV/AIDS infections are in the Russian Federation and Ukraine. In Ukraine 1.1 percent of the adult population was infected with HIV in 2010. The epidemic is mainly concentrated among commercial sex workers and injecting drug users (IDUs), and HIV prevention efforts are concentrated among these two groups. (UNAIDS, 2010).

The data I use in this paper is a unique RDS of drug users from Ukraine. It was collected in 2007 by the Center for Social and Political Studies. Surveys were conducted in twenty five cities and in six cities respondents were offered a free HIV test: Kyiv, Lutsk, Novovolynsk, Dnipropetrovsk, Krivoy Rog and Lugansk. In each surveyed city, HIV-service organizations helped to select initial respondents capable of contacting other drug users and invited them to participate in the survey. After the survey, individuals were offered a voluntary HIV test, and invited to recruit others to participate. Figure 1 shows the timeline of these interviews.

Each initial respondent received three invitation coupons to recruit new respondents who in turn took the survey, were offered an HIV test, and received three coupons to recruit subsequent respondents. Figure 2 illustrates this process. In the city of Lutsk, respondent number 4 tested HIV-negative, and invited three of his peers to participate in the survey, namely respondents number 41, number 42 and number 43. These individuals also tested HIV negative, and in turn invited others to participate. Each recruiter received a money reward one or two days after the interview of the person he recruited is completed. Participation in the survey and HIV testing was voluntary and each respondent was free to refuse to complete the questionnaire. Anonymity was guaranteed to the participants.

The survey includes general questions about education, occupation, and marital status. Two separate sections of the survey are dedicated to drug usage and sexual behavior. The section on drug usage includes questions on drug usage experience, type of drugs used, frequency of drug usage, and expenditures on needles. The section on sexual behavior covers information on condom usage, expenditures on condoms, existence of a regular sexual partner, and frequency of sex. The survey also includes a separate section on HIV/AIDS awareness. The respondent is asked to guess the probability of being HIV positive, and whether they were tested for HIV before and when this test took place. The respondent is also asked a series of questions about how HIV is transmitted. At the end of the section respondents are asked whether they want to reveal their own HIV status. After the completion of the survey, the respondent is offered a free HIV test. Test results are available immediately and respondents have the choice of learning the results of the test after waiting 20-30 minutes. In the sample, a sizable fraction of respondents chose not to learn their test results and left the facility. The data contain information on who waited to learn the results and who didnt.

1.3.c Descriptive Statistics

Table 1 shows summary statistics of the data. The main sample is 77 percent male with an average age of 29. About one fifth of the respondents report being married, while 46 percent report having a permanent sexual partner (either married or cohabitating with a partner). Seventy-four percent of the respondents had at least a high-school diploma at the time of the interview and 22 percent had a full time job. Based on the results of the HIV tests, 28 percent of the sample is HIV positive. Interestingly, a much larger fraction, seventy-nine percent, report having a prior belief that they are HIV positive. The average number of drug injections per month is 31.8 and the average respondent has an injecting drug experience of about 3.3 years. Average spending on needles is approximately 14.35 hryvnas (2.87 dollars) per month while average spending on condom is approximately 11.45 hryvnas (2.29 dollars) per month.[2] Each respondent was asked whether they were tested for HIV before and 49 percent report having been tested before. Among those who report the results of this previous test, 24 percent reveal they tested HIV-positive and 76 percent reveal that they tested HIV-negative.

[2]Average monthly salary in Ukraine in 2007 was approximately 1300 hryvnas or 260 dollars (The State Committee of Statistics of Ukraine, www.ukrstat.gov.ua).

1.4 The Effect of HIV Testing on Peer Behavior

In this paper I examine the effect of HIV testing not on the individual but rather on the individuals peers. The data I use is uniquely well-suited for answering this question for several reasons. First, the respondent driven sampling strategy reliably and properly identifies respondents relevant peer group, bypassing the common problem inherent in many data sets collected from traditional sampling methods. Second, the administration of the survey and elicitation of beliefs regarding HIV status before the individual is tested allows us to focus on the impact of new information and change in beliefs. While cross sectional correlations between the recruiters HIV status and the recruits behavior may be of some interest, it is difficult to attribute causality to this relationship due to the problem of correlated unobservables. The change in beliefs that results from HIV testing allows me to make a more credible argument that it is new information and assessment of risk that drives the recruits behavior.

I first estimate the baseline relationship between an individuals spending on needles or condoms and his recruiters HIV status as specified in equation (1) below. Denote i the indicator for an individual and denote S_i the spending on needles or condoms. These spending variables are proxies for risky behavior. Denoting the positive HIV status of recruiter by $RecHIVpos_i$, I estimate the following equation:

$$S_i = \beta_0 + \beta_1 RecHIVpos_i + \beta_3 X_i + \varepsilon_i \tag{1.1}$$

Here, X_i is a vector of individual controls including age, education, gender, dummy for having a job, city of residence, IDU experience, IDU frequency, and a dummy for having a permanent sexual partner. I also include the individuals own HIV status (based on his own test results) which he learns after the interview. The coefficient of interest is β_1. Estimates of this coefficient will measure the effect of the recruiters HIV status on the individuals spending on needles or condoms.

Estimating the role of social interactions or peer influences on risky behavior is difficult due to the problem of correlated unobservables as discussed in Manski (1993). It might be the case that HIV-positive recruiters ex-ante have more risk-averse peers. It is also possible that an omitted variable is driving these results. Reverse causality is unlikely to be a concern since there is little reason to believe that risk-averse behavior among peers drives new HIV infections. However, the problems of correlated unobservables and omitted variable bias must be kept in mind while analyzing the results of peers behavioral response. I use three additional pieces of information–test result awareness, change in beliefs and post-test recruiting– to bolster my argument that it is new information provided by testing, and resulting information spillovers, rather than selection, that leads to changes in behavior among peers. I summarize my arguments in greater detail below.

To show that the results are driven by the new relative risk information, and not some other cause, I first use the fact that some recruiters learned their test results and some didnt. Nineteen percent of recruiters decided not to learn their HIV test result. Below I estimate a model that distinguishes between recruiters who learned their test results from those who didnt learn their results.

$$S_i = \beta_0 + \beta_1 RecHIVpos_i * Learn + \beta_2 RecHIVpos_i * NotLearn + \beta_3 X_i + \varepsilon_i \qquad (1.2)$$

where $Learn_i$ is an indicator variable equal to 1 if the recruiter learned his own HIV test result and $NotLearn_i$ is an indicator variable equal to 1 if the recruiter did not learn his own HIV test result. The omitted group consists of individuals whose recruiters tested HIV-negative. The coefficients of interest from regression (2) are β_1 and β_2. Here, $beta_1$ will tell us whether the behavioral change is related to the new information, while β_2 will tell us whether the recruiters HIV-positive status influences the respondent even when there is no information (which would indicate selection).

In addition to regression (2) I use information on recruiters prior beliefs about their own HIV status in order to show that it is new information that changes behavior and not some other factor. Previous studies have indicated that only those individuals who are surprised by their HIV results should be expected to change their risky behavior in response to the information (Boozer and Philipson (2000), Gong (2011)). Intuitively, it is only for these individuals that the HIV test results represent new information compared to their prior beliefs. Extending this argument, we expect that recruiters who are surprised by their HIV test results are more likely to provide peers with new information. Therefore I test whether the recruiters change in beliefs affects his peers risky behavior. I separate all recruiters who learned their HIV test results into the groups (depicted in Figure 3). The two groups along the diagonal, Groups 1 and 4, are those individuals whose test results confirmed their prior beliefs. The groups along the off-diagonal, Groups 2 and 3, are those individuals for whom the HIV test resulted in a surprise - a bad surprise in the case of Group 2, and a good surprise in the case of Group 3.

I create a dummy variable for each category and run the following regression:

$$S_i = \beta_0 + \beta_1 RecBadSurprise_i + \beta_2 RecGoodSurprise_i + \beta_3 RecConfirmHIVneg_i + \beta_4 RecConfirmHIVpos_i + \beta_5 X_i + \varepsilon_i \tag{1.3}$$

The coefficients of interest from equation (3) are β_1,β_2,β_3 and β_4. The coefficients β_1 and β_2 estimate the effect of recruiters being surprised and gaining new information regarding their status. The omitted category consists of observations where the recruiters did not learn their test results.

Equations (1)-(3) are constructed to demonstrate that changes in beliefs, in particular new information about the recruiter's HIV status, induce more cautious behavior among peers. While it was presumed that this new information was somehow relayed to the peers, no direct evidence has been presented in this regard. One possibility is that recruiters expend more effort to relay the new information among their peers. To address this, I count how many recruits each recruiter has, and estimate the effect of a recruiter's HIV status and change in beliefs on the number of peers recruited. I run a regression similar to regression in equation (3) but this time I have the number of recruits for each recruiter as a dependent variable.

$$INV_i = \beta_0 + \beta_1 RecBadSurprise_i + \beta_2 RecGoodSurprise_i + \beta_3 RecConfirmHIVneg_i + \beta_4 RecConfirmHIVpos_i + \beta_5 X_i + \varepsilon_i \tag{1.4}$$

here, INV_i is the number of people who showed up for an interview as a result of recruiter's invitation.

Equations (1)-(3) are designed to demonstrate the effect of direct exposure to an HIV-positive recruiter. I also investigate how quickly the effect of information spillovers diminish in the peer network. In particular, I examine whether twice-removed recruiters (the recruiter of an individual's recruiter) have any influence on the individual's risky behavior.

To do this, I run the following regression:

$$\begin{aligned} S_i = \beta_0 + \beta_1 RecHIVpos_i + \beta_2 TRRecHIVpos_i + \beta_3 RecHIVpos_i * TRRecHIVpos_i \\ + \beta_4 X_i + \varepsilon_i \end{aligned} \tag{1.5}$$

where $RecHIVpos_i$ is equal to one if individual i has an HIV-positive recruiter and $RecTRHIVpos_i$ is equal to one if the individual has an HIV-positive twice-removed recruiter.

1.5 Main Results

1.5.a Baseline Estimates

In this section I estimate the baseline relationship between an individuals spending on needles or condoms and his recruiters HIV status as specified in equation (1) above. Coefficients of interest will measure the effect of the recruiters HIV status on the individuals spending on needles or condoms. I present estimates of equation (1) in Table 2. The omitted category consists of individuals whose recruiters tested HIV-negative. Column 1 of Table 2 shows OLS estimate of the effect of the recruiters HIV test result on the recruits spending on needles. The coefficient is positive and significant at the 10 percent level. Having an HIV-positive recruiter increases monthly spending on needles by 4.52 hryvnas (approximately 1 USD). Given the average spending level, 14.35 hryvnas, reported in Table 1, this translates into about a 32 percent increase. As reported in column 2, I find no significant effect of the recruiters HIV status on condom purchases.

1.5.b Test Result Awareness

The effect of recruiters HIV status on the respondent can be examined separately for those recruiters who learned their test results and for those recruiters who did not learn their results. I explore whether new information and learning is important by separating the two groups. I present estimates of the regression as specified in (2). The estimates are reported in Table 3. The omitted group consists of individuals whose recruiters tested HIV negative. The first row of column 1 reports the coefficient for the first interaction where the recruiter both tested HIV positive and learned the results. The effect is positive and statistically significant at the 10 percent level. The second row reports the coefficient for the second interaction where the recruiter tested positive but did not learn the result. The coefficient is much smaller and is not significant. These results show evidence that the behavioral change is particularly related to new information and the recruiters HIV-positive status alone does not influence the respondent.

Column 2 reports the results for condom use. There is little evidence that the recruiters HIV status significantly influences the individuals condom purchases. One possible explanation is that spending on condoms does not adequately cover the full range of possible sexual behavioral responses to HIV risk. An individual can respond not only by engaging in safer sex (buying condoms) but may adjust the frequency of sexual acts or forego sexual activity altogether. Since our sample consists of intravenous drug users who are most likely addicted to drugs, this particular channel of response– that of foregoing drug use altogether– may not be an option for these individuals. This suggests that spending on needles may afford a better way to measure changes in risky behavior than spending on condoms.

1.5.c Change in Beliefs

My next step is to test whether the recruiters change in beliefs affects the respondents risky behavior as specified in equation (3). I present estimates of these equations in Table 4. Recruiters were separated into four groups - those who had a bad surprise, those who had a good surprise, and those whose test results confirmed their prior beliefs regarding HIV status. If new information is important in changing peer behavior, it is expected that those recruiters who had experienced surprises would have the largest effects on the behavior of their peers. Table 4 shows that individuals whose recruiters experienced a bad surprise - that is, they believed they were HIV negative prior to the test but actually tested HIV positive - had the largest response in terms of spending on needles. Relative to those individuals whose recruiters did not learn their test results, the spending was 15.3 hryvnas higher per month. Given that average spending was 14.35 hryvnas per month, this translates into about a 107 percent increase in spending. The direction of the surprise seems to matter. Table 4 shows that having a good surprise, from recruiters believing that they were HIV positive to actually testing HIV negative, does not have a significant impact on peers behavior. Likewise, there is no significant effect on peer behavior when the recruiters do not experience any change in their beliefs.

1.6 Further Results and Discussion

1.6.a Recruiting

If the transmission of new information is important in explaining the above findings, we should also find that recruiters who learn that they are HIV-positive are able to send more of their peers to get tested. To address this, I run regression (4), and Table 5 presents the results. Those recruiters who are tested HIV-positive invite more people (0.2 more recruits), especially if the test result is a surprise (0.347 more recruits). It might be that recruiter's HIV-positive test result is a good motivation for his peers to check their own HIV status. Another possibility is that HIV-positive recruiters expend more effort to relay the new information among their peers, especially if they were surprised by the test result. These findings provide further evidence supporting the interpretation of the above results as being driven by the transmission of new information between peers.

1.6.b The Effect of Twice-Removed Recruiter

In this section I estimate equation (5) and examine whether the HIV status of recruiters twice-removed impact an individuals spending on needles and condoms. Panel A of Table 6 shows the initial estimates of the impact of both a direct recruiter and a recruiter twice-removed on an individuals risky behavior with inclusion of basic controls. In Panel A I do not distinguish between those recruiters who learned HIV test results and those who didnt. The dummy, RecHIV, is equal to one if the direct recruiter tested HIV-positive, and TRRecHIV is equal to one if the twice-removed recruiter tested HIV-positive. An interaction term is set equal to one if both recruiters tested HIV-positive. Column 1 presents estimates for needles and Column 2 for condoms. The omitted category includes individuals who had both recruiters test HIV-negative. The coefficient on the direct recruiter is significant and positive for needles and insignificant for condoms. In both columns, the coefficients on TRRecHIV are positive but statistically insignificant. Finally, both coefficients on interaction terms are negative and insignificant. Panel A shows that the direct recruiter matters while the recruiter twice-removed doesnt.

Of course, results described in the previous paragraph are not complete without taking into account the recruiters knowledge about their own HIV test results. Panel B of Table 6 repeats the regressions in Panel A but this time I look only at those recruiters who learned their own HIV test results. The omitted category consists of individuals with recruiters who tested HIV-positive but did not learn results or tested HIV negative. While the coefficient is somewhat smaller and marginally significant, Panel B basically shows the same pattern as Panel A. Only the direct recruiter matters, and only in the case of spending on needles.

1.6.c Gender

It might be that women and men respond differently to new information about their peers HIV status (Thornton, 2012; Moore, 1990). For instance, men might buy condoms more often than women. To test this, I separate the respondents by gender female and male. I then interact the recruiters HIV status with the respondents gender; the rest of the regression stays the same as equation (1). Columns 1 and 2 of Table 7 present the OLS results. According to the point estimates, men are less likely than women to respond to their recruiters HIV status by adjusting their spending on needles or condoms, but these differences are not statistically significant due to the large standard errors.

1.6.d Singles and Couples

In addition to potential gender differences discussed above, there might be differences in the response between couples and single people. Thirty percent of respondents are females and forty six percent of respondents have a permanent sexual partner. Thus there could potentially be several couples in the dataset, with recruiters inviting their sexual partner to participate in the survey. In the case of a couple, a bad surprise might force them to forego sexual activity. To test this, I interact the recruiters HIV status and an indicator that the respondent has a permanent sexual partner; the rest of the regression is identical to equation (1). Table 8 presents these results. Columns 1 and 2 of Table 8 present the OLS results of whether having a permanent sexual partner changes the effect of the recruiters HIV status. This implies that there is a negative effect of the recruiters HIV-positive status among those respondents who have a permanent sexual partner. Among individuals with HIV-negative recruiters, having a permanent sexual partner leads to 6.46 hryvnas more being spent on condoms each month. By contrast, among individuals with an HIV-positive recruiter, having a permanent sexual partner leads to significantly lower spending, by -5.57 hryvnas. This is consistent with the above interpretations. Condom use in part reflects the frequency of sexual activity, and respondents whose sexual partner is more likely to be HIV-positive may choose to reduce exposure to risk by foregoing this activity altogether.

1.6.e Limitations and Contributions of This Paper

As discussed in the introduction, while this data set provides unique information on IDUs peers, this information is not complete. For each particular recruiter we observe only those peers who were invited to participate in the survey. We do not observe all his peers. Obviously the ideal would be to observe the risky behavior of all peers after the recruiter is tested HIV-positive. Intuitively there is no reason to believe that HIV-positive recruiters ex ante have risk averse peers relative to HIV-negative recruiters. However, an issue would arise if the composition of peers that recruiters choose to invite from among their peers varies between HIV-positive and HIV-negative recruiters. In particular, HIV-positive recruiters could choose to invite those peers who (ex ante) inclined to behave less risky.[3] This issue is difficult to address using the respondents driven sample. Who exactly recruiters choose to invite to participate in the survey is worth exploring in future research. Nevertheless, at this point the data at hand provides evidence that voluntary HIV testing induces less risky behavior among peers and this effect is economically significant. It implies that HIV testing might reduce risky behavior at least among peers. It also implies that in order to estimate the total effect of HIV testing on the population transmission rate one should probably take

[3]Note however that it is unclear why this would be different between HIV-positive and HIV-negative recruiters. For example, if risk-averse individuals are more likely to get tested, then both HIV-positive and HIV-negative recruiters gain by targeting this subgroup, since they are more likely to collect the reward. The incentive structure of the RDS implies that all recruiters should invite similar individuals from among their peers.

into account both: the effect of HIV testing on respondents own behavior and on his peers.

1.7 Conclusion

Previous studies examining the effects of HIV testing on learning and sexual behavior showed little evidence of risky behavior reduction in response to HIV. In this paper I point to two reasons why these previous studies may have understated the behavioral responses following testing. First, previous papers have focused on the effect of testing on a respondents own behaviorwhich is ambiguous even theoretically. In contrast, I focus on the effect of testing on the peer network and show that there are significant behavioral responses in the anticipated directionnew information about increased HIV risk induces less risky behavior. This is the first micro-level study I am aware of that directly examines the impact of HIV testing on peers risky behavior. Second, I employ a unique data set of injecting drug users and use needle purchases as a proxy for risky behavior. The use of needle purchases presents an alternative to the more often examined condom purchases as a proxy for safe sexual behavior. The more robust behavioral responses I document in the paper, compared to other studies, may be due to the fact that the full range of behavioral responses for injecting drug users, who are most likely addicted to drugs, is rather limited. Therefore the purchase of needles may more completely capture engagement in less risky behavior as compared to the purchase of condoms. Measuring risky behavior with spending on needles, I show that a change in persons beliefs about his HIV status from I am HIV-negative to I am HIV-positive doubles spending on needles among his friends. Results indicate a substantial behavioral response in terms of spending on needles but not condoms. From a public policy perspective, these results show evidence that voluntary counseling and testing might be an effective HIV prevention strategy.

Table 1.1: Summary Statistics

	(1) Mean	(2) St. Dev.
Male	0.77	0.41
Age	29.09	7.79
Married	0.18	0.39
At least high-school diploma	0.74	0.43
Full-time job	0.22	0.41
Permanent sexual partner	0.46	0.49
Number of successful invitations	0.97	1.28
HIV-positive	0.28	0.45
Beliefs HIV-positive	0.76	0.42
Learnt HIV results	0.70	0.49
Number of drug inj per month	31.77	31.01
IDU experience (years)	3.28	6.16
Spending on needles	14.35	4.13
Spending on condoms	11.45	4.53
Beliefs HIV-positive	0.79	0.49
Beliefs HIV-negative	0.21	0.43
Never tested before	0.51	0.50
Tested HIV-positive	0.08	0.41
Tested HIV-negative	0.26	0.49
Tested but didn't reveal results	0.15	0.49

Notes: Full sample has 1254 observations.

Table 1.2: The Impact of Recruiter's HIV Status

	(1) Needles	(2) Condoms
Recruiter is tested HIV-positive	4.524*	0.176
	(2.341)	(1.758)
Respondent is tested HIV-positive	0.185	-2.768*
	(1.770)	(1.630)
Number of drug inj per month	0.185***	-0.003
	(0.029)	(0.031)
Permanent sexual partner	0.781	5.016***
	(1.290)	(1.929)
Age	-1.021*	-1.193**
	(0.584)	(0.563)
IDU experience	-0.028	0.137
	(0.071)	(0.089)
Education	-0.487	-1.862
	(1.527)	(2.400)
Job	1.076	-0.928
	(1.716)	(1.830)
City Fixed Effects	Yes	Yes
Observations	987	987
R-Squared	0.117	0.0744
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days. OLS estimates are presented. The omitted category - recruiter is tested HIV-negative. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.3: The Impact of Recruiter's Learning HIV Status

	(1) Needles	(2) Condoms
(Test HIV-positive)*(Learn)	5.255*	1.093
	(2.878)	(2.159)
(Test HIV-positive)*(Not Learn)	1.852	0.011
	(2.332)	(2.629)
Respondent is tested HIV-positive	0.319	-2.851*
	(1.765)	(1.665)
Number of drug inj per month	0.184***	-0.003
	(0.029)	(0.031)
Permanent sexual partner	0.801	4.981**
	(1.297)	(1.920)
Age	-0.945*	-1.175**
	(0.577)	(0.562)
IDU experience	-0.044	0.130
	(0.077)	(0.090)
Education	-0.486	-1.841
	(1.521)	(2.397)
Job	1.020	-0.946
	(1.704)	(1.829)
City Fixed Effects	Yes	Yes
Observations	984	984
R-Squared	0.122	0.076
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days. OLS estimates are presented. The omitted category - recruiter is tested HIV-negative.
Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.4: The Impact of Recruiters Change in Beliefs

	(1) Needles	(2) Condoms
Group 2: "Bad Surprise"	15.330**	6.126
	(7.298)	(4.540)
Group 3: "Good Surprise"	0.713	0.448
	(1.636)	(2.374)
Group 1: Beliefs are confirmed (HIV-negative)	0.265	0.442
	(1.884)	(2.253)
Group 4: Beliefs are confirmed (HIV-positive)	1.843	-2.044
	(2.379)	(2.682)
Respondent is tested HIV-positive	0.272	-3.000*
	(1.783)	(1.681)
Number of drug inj per month	0.184***	-0.002
	(0.029)	(0.031)
Permanent sexual partner	0.747	5.057**
	(1.346)	(1.960)
Age	-0.961*	-1.190**
	(0.571)	(0.555)
IDU experience	-0.001	0.167*
	(0.073)	(0.092)
Education	-0.662	-1.982
	(1.583)	(2.393)
Job	1.227	-0.798
	(1.677)	(1.893)
City Fixed Effects	Yes	Yes
Observations	984	984
R-Squared	0.133	0.079
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days. OLS estimates are presented. The omitted category - recruiter is tested but didn't learn results. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.5: The Impact of Change in Beliefs on Recruiting

	(1)
Group 2: "Bad Surprise"	0.347**
	(0.167)
Group 3: "Good Surprise"	0.0567
	(0.0930)
Group 1: Beliefs are confirmed (HIV-negative)	-0.00157
	(0.111)
Group 4: Beliefs are confirmed (HIV-positive)	0.201*
	(0.117)
Number of drug inj per month	0.000611
	(0.00129)
Permanent sexual partner	0.109
	(0.0681)
Age	0.00458
	(0.0293)
IDU experience	0.0123
	(0.0322)
Education	0.0108
	(0.0764)
Job	-0.0897
	(0.0809)
City Fixed Effects	Yes
Observations	456
R-Squared	0.141
Mean of dependent variable	2.459

Notes: Dependent variable - number of people showed up for an interview after invitation.
OLS estimates are presented. The omitted category - recruiter is tested but didn't learn results.
Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.6: Impact of Two Times Removed Recruiter

	(1) Needles	(2) Condoms
RecHIV	7.282**	1.963
	(3.510)	(2.313)
TTRRecHIV	2.271	4.841
	(2.260)	(4.479)
Interaction Term	-5.758	-6.78
	(3.891)	(5.117)
Observations	833	833
R-Squared	0.12	0.09
Mean spending on Needles/Condoms	14.34	11.45
(RecHIV)*(Learn)	6.593*	0.181
	(3.634)	(2.289)
(TTRRecHIV)*(Learn)	1.038	3.483
	(1.951)	(4.190)
(Interaction Term)*(Learn)	-0.779	-6.382
	(7.05)	(5.365)
Observations	875	875
R-Squared	0.12	0.08
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days.
OLS estimates are presented. The omitted category - recruiter is tested HIV-negative.
Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.7: Gender Differences in Risky Behavior

	(1) Needles	(2) Condoms
RecHIV	8.884**	2.706
	(4.035)	(3.967)
ResMale	0.985	-1.467
	(1.589)	(2.634)
RecHIV*ResMale	-6.5	-2.815
	(4.035)	(4.201)
Observations	1026	834
R-Squared	0.121	0.077
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days.
OLS estimates are presented. The omitted category - recruiter is tested HIV-negative.
Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.8: Differences in Risky Behavior between Couples and Single People

	(1) Needles	(2) Condoms
RecHIV	8.435*	3.822
	(4.431)	(2.322)
ResPartner	0.528	6.469***
	(1.214)	(2.065)
RecHIV*ResPartner	1.163	-5.575*
	(3.144)	(3.230)
Observations	1026	834
R-Squared	0.117	0.079
Mean spending on Needles/Condoms	14.34	11.45

Notes: Dependent variable - respondent's spending on needles or condoms during Last 30 Days. OLS estimates are presented. The omitted category - recruiter is tested HIV-negative.
Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1.1: The Timing of the Interview

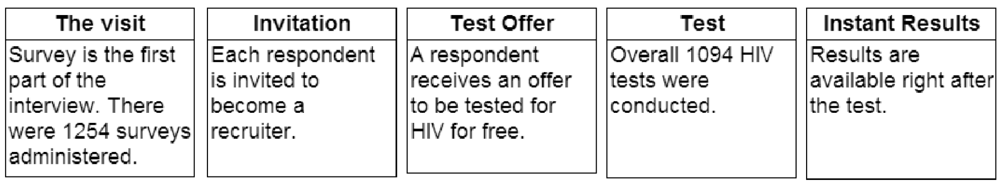

Figure 1.2: Social Network in the City of Lutsk for a Seed Number Four

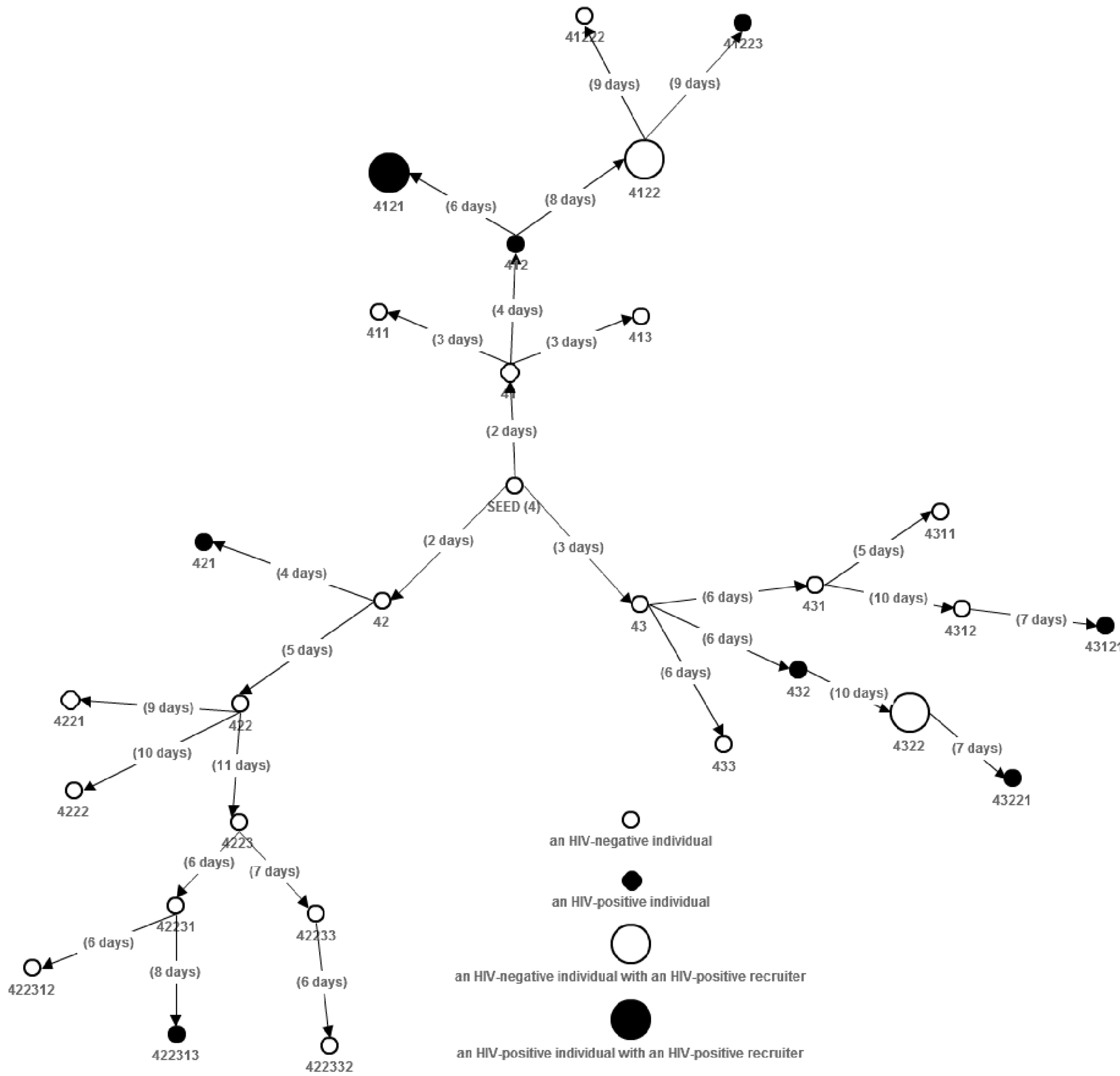

FIGURE 2. SOCIAL NETWORK IN THE CITY OF LUTSK FOR A SEED NUMBER FOUR.

Figure 1.3: Change in Beliefs

	Test Result: HIV-Negative	Test Result: HIV-Positive
Prior Belief: HIV-Negative	Group 1	Group 2
Prior Belief: HIV-Positive	Group 3	Group 4

Chapter 2

HIV Testing and the Sexual Behaviour of Singles and Couples

2.1 Introduction

In this chapter I refine parts of my work in Chapter 1. In the first part of my dissertation I study the effect of testing on the peer network and show that new information about increased HIV risk induces less risky behavior. Results indicate a behavioral response in terms of spending on needles but not condoms. Previous studies examining the effects of HIV testing on sexual behavior have also showed rather limited behavioral response to the epidemic (De Paula et al., 2011; Thornton, 2008; Oster, 2012). Many studies have focused on purchase of condoms to study changes in sexual behavior. This literature is described in detail in Chapter 1. In this chapter I examine a possible explanations for the finding of limited behaviour response, namely, an individual can respond to HIV not only by engaging in safer sex (buying more condoms) but may adjust the frequency of sexual contacts or stop having sex, which would bias us towards finding no effect of HIV testing on condom purchases. To test it I use OLS and Multinomial Logit models where individuals have three choices after the test. They can stop having sex, have sex with a condom, or have sex without condom. I explore how individuals change their behaviour in response to the HIV test. I also want test this hypothesis separately for single people and couples. Intuitively, couples and singles might react differently to HIV because they have different levels of social pressure. If a single person is tested HIV-positive he or she does not have a partner to care about, meanwhile in a couple one person might feel responsible for the other person. As a result the effect of HIV testing on singles and couples might be different.

Empirical results indicate that HIV testing affects condom usage among singles and it has no effect on condom usage among couples. At the same time there is no evidence that HIV testing affects the frequency of sexual acts among singles and couples.

2.2 Data

2.2.a Singles

The data used in the analysis for this paper are part of the survey among Injecting Drug Users (IDU) in Ukraine in 2009 where respondents were offered Voluntary Counselling and Testing (VCT). The first round of data was collected using Respondent Driven Sample (RDS). RDS methodology is described in more detail in Chapter 1. Initial respondents received VCT and recruited other responders. Respondents were offered monetary incentives to recruit other people to participate in the survey. Participation in the survey and HIV testing was completely voluntary and anonymity was guaranteed to the participants. In four cities (Kiev, Dnepropetrovsk, Krivoy Rog, Nikolayev), a follow up survey was added to the original sample. At baseline respondents were asked about their sexual behaviour and subjective beliefs about their own HIV status. If the respondent was single, he came back for the follow-up, while if he had a partner, then his partner came back. At the follow-up survey respondents were asked about their sexual behaviour after VCT. The sample for the paper consists of all respondents who were recruiting new respondents after VCT or sent back their partners.

Table 1 presents summary statistics for singles. In all, this sample has 408 observations: 76 percent are male, with an average age of 33.6 years. Forty one percent of the respondents were tested HIV-positive, and forty five percent were never tested before. Respondents had completed, on average, 10.99 years of school at the time of the interview. Fifty one percent of respondents reported using a condom last time they had sex. On average respondents in the sample have sex 8.74 times per month and eighty seven percent reported having sex during last 30 days.[1]

Before measuring how learning HIV results affects sexual behaviour, I first present statistics on subjective beliefs at baseline. Thirty two percent of respondents believed that they are HIV-positive, 15 percent believed to have high likelihood of being HIV-positive, 19 percent of respondents believed to have fifty percent likelihood of being HIV-positive, 20 percent reported a low likelihood, and only 5 percent reported some likelihood. Finally, 8 percent reported they did not know.

[1]The maximum number of sexual contacts per month in this sample is 120. This number might look relatively high, but it is feasible given that some respondents are commercial sex workers, which is indicated in the survey.

Previous studies have indicated that only those individuals who are surprised by their HIV results should be expected to change their risky behavior in response to the information (Boozer and Philipson (2000), Gong (2011)). Intuitively, it is only for these individuals that the HIV test results represent new information compared to their prior beliefs. While learning HIV test results might affect sexual behaviour, it is expected that only those respondents who had experienced surprises would change their behaviour. I separate recruiters into four groups, those who had a good or a bad surprise, and those whose test results confirmed their prior beliefs either positive or negative. I define a bad surprise as a change in beliefs from some or low likelihood of being HIV-positive to be tested HIV-positive. I define a good surprise as a change in beliefs from 100, high or 50 percent chance of being HIV-positive to be tested HIV-negative. Ten percent of respondents had experienced a "bad surprise" after VCT, and 37 percent had experienced a "good surprise". For 24 percent of respondents the test results confirmed that they are HIV-positive, and for 21 percent the results confirmed that they are HIV-negative. After VCT all respondents learned their test results.

I next turn to the reports on sexual behaviour after the test in Table 2. Fifty two percent of respondents reported having sex after VCT, and seventy one percent reported using condom.

2.2.b Couples

Tables 3 and 4 present summary statistics for couples, before and after VCT respectively. Overall this sample has 599 observations. A noticeable difference between singles and couples is that singles have higher HIV prevalence rate. Forty one percent of singles are infected with HIV, while among couples thirty three percent of recruiters are infected with HIV and twenty five percent of their sexual partners are HIV-positive. In the data set on couples, among recruiters 79 percent, and among sexual partners only 24 percent are males. This indicates that most couples in this sample are heterosexual couples. The average number of days between interviews of recruiter and his partner is 6.65 days. This information is missing for the data set on singles.

2.3 Estimation Equations

2.3.a OLS Estimation

Previous studies have showed that only those individuals who are surprised by their HIV results should be expected to change their risky behavior (Boozer and Philipson (2000), Gong (2011)). If new information is important in changing behavior, then only those respondents who had experienced surprises would have changed their behavior. I use information on respondents prior beliefs about their own HIV status and previous HIV tests in order to show that it is new information that changes behavior and not some other factor. Therefore I want to model change in beliefs to estimate the effect of HIV testing on risky behavior. First, I estimate the relationship between an individuals HIV test result and his condom usage after VCT, among those individuals who had sex before and after the test, as specified in equation (1). I estimate the following equation:

$$CondomAfter_i = \beta_0 + \beta_1 HIVPositive_i + \beta_2 CondomBefore_i + \beta_3 X_i + \varepsilon_i \tag{2.1}$$

Here, $HIVPositive_i$ is equal to one if an individual is tested HIV-positive, X_i is a vector of individual controls including gender, age, education, sex frequency and a dummy for having a permanent sexual partner. I also control for condom usage before VCT. The coefficient of interest is β_1. Estimates of this coefficient will measure the difference in condom usage between those who are tested HIV-negative and those who are tested HIV-positive.

In my second specification I use an individual's change in beliefs to identify the effect of HIV testing. It is expected that recruiters who are surprised by their HIV test results change their behaviour. Therefore I test whether the respondent's change in beliefs affects his risky behavior. I run the following regression:

$$\begin{aligned} CondomAfter_i = \beta_0 + \beta_1 BadSurprisePositive_i + \beta_2 NoSurprisePositive_i \\ + \beta_3 CondomBefore_i + \beta_4 X_i + \varepsilon_i \end{aligned} \tag{2.2}$$

The coefficient of interest from equation (2) is β_1. This coefficient estimate the effect of being surprised and gaining new information on condom usage after VCT. The omitted category consists of observations where the respondents were tested negative.

However, an individual can respond to VCT not only by engaging in safer sex (buying condoms) but may adjust the frequency of sexual acts or forego sexual activity altogether. To address this, I run regressions (3) and (4). These regressions are identical to regressions

(1) and (2) but this time our dependent variable is $SexAfter_i$ - a dummy variable indicating whether or not an individual had sex after VCT.

$$SexAfter_i = \beta_0 + \beta_1 HIVPositive_i + \beta_2 CondomBefore_i + \beta_3 X_i + \varepsilon_i \tag{2.3}$$

$$\begin{aligned} SexAfter_i = \beta_0 + \beta_1 BadSurprisePositive_i + \beta_2 NoSurprisePositive_i \\ + \beta_3 CondomBefore_i + \beta_4 X_i + \varepsilon_i \end{aligned} \tag{2.4}$$

First, I run 4 regressions above for the data set on singles and then I run the same regressions for the data on couples.

2.3.b Multinomial Logit Estimation

In this section I describe an alternative approach to the equations above to model sexual behaviour. I model behaviour after the test using a Multinomial Logit model in which individuals face three choices: (1) no sex, (2) sex with condom, and (3) sex without condom, baseline category. I also control for individual specific characteristics, X, and condom usage before the test. Hence,

$$D_i^j = \beta_0^j + \beta_1^j HIVPositive_i + \beta_2^j CondomBefore_i + \beta_3^j X_i + \varepsilon_i \tag{2.5}$$

$$D_i^j = \beta_0^j + \beta_1^j BadSurprisePositive_i + \beta_2^j NoSurprisePositive_i + \beta_3^j CondomBefore_i + \beta_4^j X_i + \varepsilon_i \tag{2.6}$$

where $j = 1, 2, 3$ denotes the choice of an individual and i denotes the individual.

2.4 Empirical Results

2.4.a Singles

In this section I first estimate the difference between condom usage among HIV-positive and HIV-negative respondents as specified in equation (1) above. I present estimates of equation (1) and (2) in Table 5, Column 1. The coefficient on "HIV-Positive" is 0.0587, and it is statistically insignificant. It implies that there is no difference in condom usage among those who are tested HIV-positive and those who are tested HIV-negative.

My next step is to test the effect of change in beliefs on condom usage. The individuals who experienced a bad surprise - that is, they believed they were HIV-negative prior to the test but actually tested HIV-positive - had 22.7 percent higher probability of using condom after VCT, relative to respondents who were tested HIV-negative. These results suggest that having a bad surprise changes behaviour towards safer sex.

Table 6 presents the OLS estimates of equations (3) and (4), columns (1) and (2) respectively. The coefficient on "HIV-positive" is -0.00270 and it is statistically insignificant. The coefficient on a "bad surprise" in second specification is close to zero and statistically insignificant. Therefore Table 6 suggest that there is no evidence that HIV testing affects sexual activity.

Table 7 presents odds ratios for equation (5). There is no evidence that HIV-positive and HIV-negative respondents behave differently. Respondents do not choose no sex or sex with condom rather than sex without condom.

Table 8 presents odds rations for equation (6). Column 2 shows that the odds that a respondents chooses sex with a condom rather than sex without a condom are 4.411 times greater (increase about 341 percent) among respondents with a "bad surprise". There is no evidence that respondents stop having sex after VCT.

We may conclude that there is evidence that HIV testing induces singles to use condoms more often and there is no evidence that VCT affects sexual activity among singles.

2.4.b Couples

In this section I estimate equations (1) and (2) for couples. I present the results in Table 9, Column 1 and 2. The coefficient on "HIV-positive" in Column 1 and the coefficient on "bad surprise" in Column 2 are close to zero and statistically insignificant. This indicates that, in contrast to the data set on singles, couples do not change condom usage after VCT.

Table 10 presents the OLS estimates of the effect of VCT of the likelihood of having sex. Both coefficients of interest are statistically and economically insignificant. There is no connection between VCT and the frequency of sexual activity after the test among couples.

Table 11 presents odds ratios for equation (5) among couples. Column 1 and 2 indicate that, odds that a respondent chooses sex with condom or no sex rather than sex without condom are not statistically significant.

Finally, Table 12 presents odds ratios for equation (6). Column 2 shows that the odds that a respondent chooses no sex rather than sex without condom are multiplied by 0.487 (decrease about 51 percent) for individuals with a "bad surprise". However, this result does not hold in other specifications.

The difference in condom usage between singles and couples after the test might be due to the difference in information sharing. It might be that in a couple, those partners who are infected with HIV do not want to reveal their HIV status and as a result do not want to change condom use habits after the test. Change in condom usage after the test might be an indication that a person was tested HIV-positive. At the same time, singles might change partners and they might be able use condoms without revealing more information about their HIV status. To explore this possibility I present statistics on HIV status awareness among couples, Figure 1. Each partner was asked a series of questions about the HIV status of his recruiter. This allows me to compare partners' knowledge with the actual HIV status of the recruiter.

I present statistics on HIV status awareness separately for partners with HIV-positive and HIV-negative recruiters. Table 13, Panel A presents this for partners with HIV-positive recruiters. Among partners with recruiter who had prior HIV test 64.6 percent reported knowing the HIV status of their recruiter, 81 percent agreed to reveal the HIV status of their recruiter, and 79.4 percent gave the right answer. Column 3 presents the difference between those who had a prior test and those who did not. This differs from the reports of partners with recruiters with no prior test of whom 50 percent gave the right answer. Among partners with HIV-positive recruiter, those with a prior test were 29.4 percentage points more likely to report the right answer. Panel B presents the same statistics among partners with an HIV-negative recruiter. The difference between those with and without previous test is much smaller. The majority of partners with HIV-negative recruiters showed relatively accurate awareness about their recruiter's HIV status. All of this indicates that recruiters who are surprised with an HIV-positive test result (no prior test) do not reveal their own HIV status sincerely. This might explain why we find no effect of VCT on condom usage among couples.

Oster (2012) indicates that reverse causality might be a concern in studies on the effect of HIV testing on sexual behaviour, which will bias the estimates. Clearly HIV status might be a function of condom usage before the test. However in this data set all respondents are injecting drug users. The probability of HIV transmission through the sharing of needles is much higher than through unsafe sex. In this particular sample most HIV injections come from sharing of needles rather than unsafe sex. Therefore reverse causality unlikely to be a big concern.

2.5 Conclusion

We may conclude that across all specifications there is evidence that HIV testing induces singles to use condoms more often. At the same time couples do not adjust condom usage after HIV test. This might be explained by the fact that only fifty percent of partners with an HIV-positive recruiter with no prior test knew the actual HIV status of their recruiter. There is no consistent evidence that singles or couples adjust the frequency sexual activities after VCT. There is not support for the hypothesis that HIV testing lowers the frequency of sex and the effect of HIV testing on condom usage holds only for singles. Therefore, in line with the existing literature, this paper points to limited behavioral response to HIV but substantial difference in response between couples and singles.

Table 2.1: Summary Statistics (Singles, Before VCT)

	mean	sd	min	max	count
Male	0.76	0.43	0	1	408
Age	33.60	8.76	14	67	408
HIVPositive	0.41	0.49	0	1	408
NoTestBefore	0.45	0.50	0	1	408
Education	10.99	2.20	7	16	407
ConBefore	0.51	0.50	0	1	376
SexFreq	8.47	12.69	0	120	381
SexLast30Days	0.87	0.33	0	1	382
Beliefs100	0.32	0.47	0	1	408
Beliefs75	0.15	0.36	0	1	408
Beliefs50	0.19	0.40	0	1	408
Beliefs25	0.20	0.40	0	1	408
Beliefs0	0.05	0.22	0	1	408
HardtoAnswer	0.08	0.28	0	1	408
NoSurprisePositive	0.24	0.43	0	1	408
BadSurprisePositive	0.10	0.30	0	1	408
NoSurpriseNegative	0.21	0.40	0	1	408
GoodSurpriseNegative	0.37	0.48	0	1	408

Table 2.2: Summary Statistics (Singles, After VCT)

	mean	sd	min	max	count
SexAfter	0.52	0.50	0	1	383
ConAfter	0.71	0.45	0	1	200

Table 2.3: Summary Statistics (Couples, before VCT)

	mean	sd	min	max	count
Male	0.79	0.41	0	1	599
Age	34.72	8.47	16	67	599
HIVPositive	0.33	0.47	0	1	599
NoTestBefore	0.47	0.50	0	1	599
Education	11.07	1.89	7	16	598
ConBefore	0.55	0.50	0	1	580
SexFreq	12.07	15.21	0	120	581
SexLast30Days	0.94	0.24	0	1	586
Beliefs100	0.30	0.46	0	1	599
Beliefs75	0.13	0.34	0	1	599
Beliefs50	0.23	0.42	0	1	599
Beliefs25	0.19	0.40	0	1	599
Beliefs0	0.03	0.18	0	1	599
HardtoAnswer	0.11	0.31	0	1	599
NoSurprisePositive	0.19	0.39	0	1	599
BadSurprisePositive	0.09	0.28	0	1	599
NoSurpriseNegative	0.19	0.40	0	1	599
GoodSurpriseNegative	0.42	0.49	0	1	599

Table 2.4: Summary Statistics (Couples, After VCT)

	mean	sd	min	max	count
PartnerMale	0.24	0.43	0	1	599
PartnerAge	32.83	8.54	16	63	599
PartnerHIVPositive	0.25	0.43	0	1	599
PartnerEducation	11.48	1.94	7	16	598
ConAfter	0.53	0.50	0	1	581
PartnerSexFreq	9.90	9.18	0	75	581
DaysBetweenInterviews	6.65	10.41	0	70	578
SexAfter	0.45	0.50	0	1	599

Table 2.5: Change in Condom Usage (Singles)

	(1)	(2)
	ConAfter	ConAfter
ConBefore	0.224***	0.213***
	(0.0686)	(0.0686)
Male	0.0823	0.0607
	(0.0905)	(0.0940)
Age	-0.00813*	-0.00865**
	(0.00416)	(0.00401)
Education	0.0170	0.0213
	(0.0161)	(0.0159)
SexFreq	-0.00428**	-0.00427**
	(0.00179)	(0.00169)
HIVPositive	0.0587	
	(0.0682)	
NoSurprisePositive		0.120
		(0.0779)
BadSurprisePositive		0.227**
		(0.0940)
_cons	0.630***	0.597***
	(0.207)	(0.202)
N	180	180
r2	0.132	0.154

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6: Change in the Likelihood of Having Sex (Singles)

	(1)	(2)
	SexAfter	SexAfter
ConBefore	0.00591	0.00896
	(0.0539)	(0.0542)
Male	0.0938	0.0925
	(0.0633)	(0.0634)
Age	-0.000557	-0.000547
	(0.00343)	(0.00343)
Education	-0.0158	-0.0153
	(0.0125)	(0.0125)
SexFreq	0.00605***	0.00600***
	(0.00168)	(0.00167)
HIVPositive	-0.00270	
	(0.0546)	
NoSurprisePositive		-0.0198
		(0.0637)
BadSurprisePositive		0.0355
		(0.0914)
_cons	0.607***	0.601***
	(0.168)	(0.169)
N	356	356
r2	0.0388	0.0396

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.7: MLogit: 1-NoSex 2-SexCondom 3-SexNoCondom (Singles, HIV testing)

	(1) NoSex	(2) SexCondom
ConBefore	2.787^{***}	4.109^{***}
	(1.040)	(1.525)
Male	0.813	1.295
	(0.320)	(0.542)
Age	0.972	0.957^{**}
	(0.019)	(0.021)
Education	1.188^{*}	1.141
	(0.111)	(0.113)
SexFreq	0.951^{***}	0.978^{***}
	(0.016)	(0.007)
HIVPositive	1.463	1.069
	(0.586)	(0.428)
N	356	356
Pseudo r2	0.089	0.089

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.8: MLogit: 1-NoSex 2-SexCondom 3-SexNoCondom (Singles, Change in Beliefs)

	(1) NoSex	(2) SexCondom
ConBefore	2.516^{***}	3.655^{***}
	(0.892)	(1.305)
Male	0.865	1.399
	(0.338)	(0.590)
Age	0.964^{*}	0.948
	(0.018)	(0.019)
Education	1.164	1.126
	(0.108)	(0.108)
SexFreq	0.948^{***}	0.974^{***}
	(0.016)	(0.008)
NoSurprisePositive	2.13^{*}	2.535^{**}
	(0.975)	(1.173)
BadSurprisePositive	2.693	4.411^{**}
	(2.018)	(3.205)
N	356	356
Pseudo r2	0.072	0.072

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.9: Change in Condom Usage (Couples)

	(1)	(2)
	ConAfter	ConAfter
ConBefore	0.249***	0.255***
	(0.0669)	(0.0668)
Male	0.0671	0.0748
	(0.0821)	(0.0830)
Age	0.00235	0.00207
	(0.00478)	(0.00484)
PartnerAge	-0.00658	-0.00593
	(0.00470)	(0.00466)
SexFreq	-0.000822	-0.00108
	(0.00179)	(0.00177)
Education	0.00566	-0.000631
	(0.0187)	(0.0196)
PartnerEducation	-0.0226	-0.0216
	(0.0188)	(0.0190)
DaysBetweenInterviews	0.00520**	0.00480**
	(0.00242)	(0.00234)
HIVPositive	0.0932	
	(0.0820)	
NoSurprisePositive		0.0138
		(0.116)
BadSurprisePositive		-0.0882
		(0.124)
_cons	0.629*	0.705**
	(0.319)	(0.324)
N	215	215
r2	0.0978	0.0943

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.10: Change in the Likelihood of Having Sex (Couples)

	(1)	(2)
	SexAfter	SexAfter
ConBefore	-0.0234	-0.0235
	(0.0367)	(0.0365)
Male	-0.105**	-0.104**
	(0.0484)	(0.0486)
Age	-0.00293	-0.00282
	(0.00257)	(0.00257)
PartnerAge	0.00489*	0.00500**
	(0.00254)	(0.00254)
SexFreq	-0.000434	-0.000452
	(0.00113)	(0.00112)
Education	0.0104	0.0114
	(0.0102)	(0.0101)
PartnerEducation	-0.00259	-0.00305
	(0.00869)	(0.00868)
DaysBetweenInterviews	0.0242***	0.0242***
	(0.00246)	(0.00246)
HIVPositive	-0.0427	
	(0.0392)	
NoSurprisePositive		-0.0652
		(0.0466)
BadSurprisePositive		0.0184
		(0.0651)
_cons	0.239	0.221
	(0.181)	(0.182)
N	553	553
r2	0.311	0.312

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.11: MLogit: 1-NoSex 2-SexCondom 3-SexNoCondom (Couples, HIV testing)

	(1) NoSex	(2) SexCondom
ConBefore	1.954**	2.693***
	(0.578)	(0.761)
Male	2.035**	1.330
	(0.661)	(0.433)
Age	1.028	1.000
	(0.023)	(0.019)
PartnerAge	0.967*	0.980
	(0.019)	(0.018)
SexFreq	0.998	0.998
	(0.009)	(0.007)
Education	1.02656	1.089
	(0.079)	(0.087)
PartnerEducation	0.973	0.927
	(0.069)	(0.068)
DaysBetweenInterviews	0.643***	1.018*
	(0.037)	(0.011)
HIVPositive	1.165	1.171
	(0.528)	(0.523)
N	545	545
Pseudo r2	0.341	0.341

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.12: MLogit: 1-NoSex 2-SexCondom 3-SexNoCondom (Couples, Change in Beliefs)

	(1) NoSex	(2) SexCondom
ConBefore	2.031**	2.770***
	0.595	0.779
Male	2.009**	1.272
	0.671	0.407
Age	1.028*	1.000
	0.023	0.019
PartnerAge	0.965	0.980
	0.020	0.018
SexFreq	0.999	0.998
	0.009	0.007
Education	1.00	1.070
	0.078	0.086
PartnerEducation	0.979	0.925
	0.067	0.068
DaysBetweenInterviews	0.643***	1.018*
	0.037	0.010
NoSurprisePositive	1.065	1.094
	0.453	0.479
BadSurprisePositive	0.487*	0.855
	0.188	0.417
N	545	545
Pseudo r2	0.342	0.342

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.13: HIV Status Awareness among Couples

Panel A: HIV-positive recruiters	Prior Test	No Prior Test	Difference: Prior Test - No Prior Test
	(1)	(2)	(3)
Partner knew HIV status of his recruiter	0.646	0.544	0.102
Partner agreed to reveal this information	0.81	0.756	0.054
Partner gave the right answer	0.794	0.5	0.294***
Observations	130	68	

Panel B: HIV-negative recruiters	Prior Test	No Prior Test	Difference: Prior Test - No Prior Test
	(4)	(5)	(6)
Partner knew HIV status of his recruiter	0.516	0.445	0.071
Partner agreed to reveal this information	0.899	0.894	0.005
Partner gave the right answer	0.988	0.924	0.064**
Observations	192	209	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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