SOCIAL INTERACTIONS AND INDIVIDUAL REPRODUCTIVE DECISIONS

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Abstract. This paper presents a randomized field experiment to measure the social network effects of getting tested for HIV, carried out using a unique dataset with the nearly complete social networks individuals in 21 villages in Central Malawi. The experiment gave respondents the opportunity to take part in one of two lotteries for cash prizes with one lottery having no condition placed upon redemption of the cash prizes and the other having taking a HIV-test as a condition. With a nearly complete social network map of villages, this study overcomes significant biases inherent to many social network studies that sample network graphs.

I am able to exploit two sources of random variation in the incentives for social contacts to get tested. First, is random assignment to the "To Test" lottery. Being assigned to the "To Test" lottery increases the likelihood that a person will be tested by 50.71 percent. The second source of variation comes from the monetary incentive given to get tested. Everyone who visited the redemption center received a small bag of sugar. Each additional dollar that respondents randomly drew as a monetary incentive increased the likelihood of testing by 5.73 percent. Combining these two instruments gives me a random selection of peers with varying monetary incentives to get tested for HIV.

I find that while LATE identifies no significant overall effect of having additional contacts who get tested and are randomized into the test lottery -0.003 (s.e. 0.012), there are however, significant heterogeneous social network effects by payments to social contacts. Having an additional contact who gets tested with no monetary incentive to do so, decreases the likelihood that a person will get tested by 9.5 percent (s.e. 0.034). Each additional dollar that a social contact receives to get tested increases the likelihood that a person will get tested by 2.8 percent (s.e. 0.014).

1. Introduction

Since HIV was first recognized in 1983, the WHO estimates that the disease has killed 25 million people, with a third of these deaths occurring in Africa (Greener (2002)). Public

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health interventions have however struggled with motivating people to change risky behaviour around the world and particularly in Sub-Saharan Africa, the site of this study. For instance, long-term concurrent sexual partnerships that provide a superhighway for HIV infection in the population remain the norm in many parts of Southern and Eastern Africa (Halperin and Epstein (2004); Helleringer and Kohler (2007); Morris and Kretzschmar (1997)). Further, even with a multitude of of educational and marketing strategies, condom use in Africa remains markedly low (Green (2003)).

An active area of recent research in economics has been the study of the role of social interactions in economic behavior. Studies have found that social networks play critical roles in determining a variety of individual and aggregate economic outcomes ranging from transmitting information about job networks (Granovetter (1973); Granovetter (2005); Beaman and Magruder (2009)), to being the basis for trade in non-centralized markets, the provision of mutual insurance in developing countries (Fafchamps and Lund (2003)) to mention but a few. Social networks play an important role in individuals' reproductive behaviour as well. Individuals' immediate social groups have a strong impact on their subjective perception of risk and on subsequent risk-taking behaviour (Bandura (1986); Bauman and Ennett (1994); Cerwonka et al. (2000)). Further, persons' adoption of safer sex practices is related to their perceived level of social and normative support for risk reduction behaviour change (Catania et al. (1991); Kelly et al. (1992); McKusick et al. (1985)).

The objective of this paper is to identify the social interactions that matter for individuals' decision to get tested for HIV and their subsequent behavior in 21 villages in central Malawi. Given the importance of social networks in affecting individuals' decisions in a variety of areas including health, education and employment, a vital avenue practitioners could use in order to encourage greater risk reduction behaviour is social networks. It is thus important to identify which social interactions are most relevant to individuals' reproductive decision making.

An increasingly popular technique to identify social network effects has been using randomized experiments (for instance Duflo and Saez (2003); Angelucci and DeGiorgi (2009); Angelucci et al. (2009); Godlonton and Thornton (2010)) wherein a random subset of members of a social network are provided with some intervention to change their behaviour. The random variation in the behavior of some members of the social network thus induced is used to instrument for the average behaviour in the group. Under conditions presented in Imbens and Angrist (1994), an instrumental variables estimator identifies a Local Average Treatment Effect (LATE) which measures the impact of the intervention beyond the targeted group - the peer effect.

The peer effect thus identified however suffers from the usual critiques of local average treatment effects. LATE is uninformative about *who* is induced to change behaviour by the instrument (Heckman and Vytlacil (2001), Heckman and Vytlacil (2005), Heckman and Vytlacil (2007), Heckman (2010)). Moreover, social contacts induced to change their behaviour by different policies and may have markedly different effects on individuals' behaviour as is demonstrated in this paper.

I present a randomized field experiment to measure the social network effects of getting tested for HIV, carried out using a unique dataset with the nearly complete social networks of individuals in 21 villages in Central Malawi. The experiment gave respondents the opportunity to take part in one of two lotteries for cash prizes with one lottery having no condition placed upon redemption of the cash prizes and the other having taking an HIV-test as a condition. With a nearly complete social network map of villages, this study overcomes significant biases inherent to many social network studies that sample network graphs.

I am able to exploit to sources of random variation in the incentives for social contacts to get tested. First, is random assignment to the "To Test" lottery. Being assigned to the "To Test" lottery increases the likelihood that a person will be tested by 50.71 percent. The second source of variation comes from the monetary incentive given to get tested. Everyone who visited the redemption center received a small bag of sugar. Each additional dollar that respondents randomly drew as a monetary incentive increased the likelihood of testing by 5.73 percent. Combining these two instruments gives me a random selection of peers with varying monetary incentives to get tested for HIV.

I find that LATE identifies no significant overall effect of having additional contacts who get tested and are randomized into the test lottery -0.003 (s.e. 0.012). There are however, significant heterogeneous Marginal Treatment Effects in social network influence by payments to social contacts. Having an additional contact get tested with no monetary incentive to do so decreases the likelihood that a person will get tested by 9.5 percent (s.e. 0.034). Each additional dollar that a social contact receives to get tested increases the likelihood that a person will get tested by 2.8 percent (s.e. 0.014).

The rest of the paper proceeds as follows. Section 2 gives some background information on HIV in Malawi and some descriptive statistics of social networks in the study. Section 3 describes the setting and the experiment, Section 4 describes the data. Section 5 concludes.

2. Background on HIV prevalence in Malawi

2.1. **Setting.** Malawi has one of the highest national prevalence rates of HIV in the world at 12 percent. Like many Sub-Saharan African countries, heterosexual contact is the principal mode of transmission. Prevalence varies by age, gender and socio-economic status. HIV prevalence is higher for women than men (13 percent versus 10 percent). Prevalence is highest between ages 30-34 at 18 percent for women and 20 percent for men. Women however start getting infected earlier with a prevalence rate of 4 percent between 15-19 years compared to less than 1 percent for men at the same age, (Chipeta et al. (2004)).

Knowledge of the existence of HIV and modes of transmission is widespread. The 2010 Malawi DHS reports that 99 percent of women and men have heard of HIV or AIDS. Similarly, at the baseline of my study in 2009, 98 percent of respondents reported having heard of an illness called HIV or AIDS. Knowledge of the measures one can take to reduce their risk of getting infected with HIV is also fairly common. The Malawi 2010 DHS reports 72 percent of women and 73 percent of men aged 15-49 years know that consistent use of condoms is a means of preventing the spread of HIV. Likewise at the baseline of this study, 71 percent of men and 73 percent of women agreed that people can reduce their chances of getting the AIDS virus by using a condom every time they have sex. Further, 87 percent of men and women know that limiting sexual intercourse to one faithful and uninfected partner can reduce their chances of contracting HIV.

Nonetheless risky behaviour is prevalent. At the baseline, 13 percent of women and 28 percent of men reported having 2 or more sexual partners in the 12 months preceding the survey. 7 percent of all women and 18 percent of all men report having used a condom the most recent time they had sexual intercourse. Among those who'd had multiple partners preceding the baseline, only 7 percent of women and 23 percent of men had used a condom the most recent time they had sexual intercourse. There is near universal knowledge about the availability of anti-retroviral therapy (98 percent of men and 96 percent of women).

Stigmatizing attitudes are also common. For instance 18 percent of women and 14 percent of men agree that "People with the AIDS virus should be blamed or bringing the disease into the community". 58 percent of men and 65 percent of women would want it to remain a secret if a member of their family got infected with the AIDS virus.

[Table 1 about here.]

2.2. **Testing for HIV.** Practitioners argue that if HIV infection is diagnosed early, treatment with antiretroviral therapy (ART) can reduce morbidity from opportunistic infections and prolong life. Failure to undergo an HIV test can lead to delayed diagnosis and treatment and to a lack of awareness of infectious risk on the part of the infected individual with serious consequences for individuals and society, (Vermund and Wilson (2002)). Indeed, researchers recently suggested that universal testing followed by immediate treatment with ART could eliminate HIV transmission worldwide, (Granich et al. (2009)). Prompt HIV diagnosis is therefore argued, to be necessary for both individual and public health benefit and is strongly promoted as international policy. Antiretroviral therapy is available free-of-charge in Malawi for individuals who are HIV-seropositive and who meet certain criteria[1].

[1]The Malawian Ministry of Health guidelines (Government (2006)) to start an adult (over 15 years) on antiretroviral therapy are:

(1) Assessed to be in WHO Clinical Stage 3 or 4

The 2004 Malawi DHS found that 83 percent of women and men report that they have never been tested for HIV. At the baseline of my study in 2009, the number of people who've never tested for HIV has dropped significantly to 53 percent of men and 32 percent of women. Among those who had been tested many had been tested some time ago. On average the number of months since the last test was 14 for women and 24 for men. A higher testing rate for women can be attributed to routine opt-out HIV testing that has been implemented for all pregnant women who visit a health facility for prenatal care in Malawi.

Reluctance to get tested for HIV is frequently attributed to high psychological or social costs associated with testing. Thornton (2008) evaluates an experiment in which individuals in rural Malawi were randomly assigned monetary incentives to learn their HIV results. In Thornton's study, 39 percent of participants attended clinics to learn their HIV status without any incentive. However, even the smallest incentive increased the share learning their results by 50 percent.

Social networks may play an important role in individual's testing behaviour. Neighbours could promote testing behaviour by providing support to reduce the emotional costs of testing or by reducing some of the fixed costs of testing if there are economies of scale in travel. On the other hand social networks might hinder testing by being a source of social stigma. Practitioners report that fear of being identified with HIV keeps people from learning their HIV status because of the potential negative social consequences of disclosing a positive status. This fear also prevents those who get tested from recommending testing to others, since it might lead to assumptions that they are HIV-positive. Fear of stigma is held responsible for low disclosure rates of positive status. Social stigma is reported to have consequences far beyond hindering testing. Practitioners also ascribe the silence that surrounds issues to do with HIV and AIDS (for instance, limited discussion of safer sex with one's partner and changing behaviour to prevent infection) to stigma. Nyblade et al. (2003) report that respondents in their study were unwilling to suggest

(2) Have a CD4-lymphocyte count $< 250/mm3$

(3) Assessed to be in WHO Clinical Stage 2 with TLC $< 1200/mm3$

safer sexual practices to a partner for fear that they would be suspected of infidelity, or being HIV-positive.

3. Data and Experiment

The study was carried out in 21 villages in central Malawi between December of 2009 and June of 2010.

3.1. **Measuring Social Networks.** At the baseline, enumerators visited the study villages and collected basic information from all the households in the village. Each household was asked to provide a list of all household members 16 years and older, and some basic information about each household member. We then created a village roster of all the adult inhabitants of the village assigning each individual a unique ID number. Enumerators then returned to the villages to collect information about each person's social connections. Respondents were asked to list their friends, family members and people that they admire in the village. The names that the respondents gave were matched to IDs from the village roster. No restriction was made on the number of contacts that a respondent could list.

Figures 5.1 - 5.4 show how the social network maps were constructed. Nodes coded in black represent male respondents while white nodes represent female respondents. Figure 5.1 shows the links of friendship within one of the study villages. A notable feature about Figure 5.1, which is true of all the villages in this study is that there is a bias in friendship among individuals of the same gender. As can be seen in the figure, people in these villages appear somewhat segregated by gender. Table 2 indicates that 90.17% of men's friendships are with other men, and similarly 93.79% of women's friendships are with other women[2].

[Table 2 about here.]

Figure 5.2 shows the family links within the same study village. Figure 5.3 is a directed graph where each link shows the person a respondent named in the survey as someone they admire. Figure 5.4 is the union of the links in Figures 5.1, 5.2 and 5.3. Figure 5.4 is the unit of analysis in this study. It's a directed graph which means that edges aren't

[2]These links do not include spouses.

necessarily symmetric. One person may list the other as a friend or someone that they admire but not vice versa. The kinship component of figure 5.4 is undirected.

[Figure 1 about here.]

[Figure 2 about here.]

[Figure 3 about here.]

[Figure 4 about here.]

Table 3 compares baseline social characteristics across men and women. Men in my study on average have 0.425 greater links than women. The composition of links across men and women is starkly different as shown in the figures above. Men have 1.6 more males links than women and women have 1.3 more female links than men. Men also appear to have denser kinship networks than women on average. Men have 0.374 more relatives than women do. Men are also more likely to list some that they admire in the village.

[Table 3 about here.]

The social network data collected in this study is unique among studies of this kind since it consists a near complete social map of the adult population of 21 villages.A recently identified challenge to consistent identification of social network effects arises if social networks are measured incompletely. Even if nodes are sampled randomly, applying regression estimators to sampled subgraphs often yields misleading results. As the measurement error is non-classical, in regression contexts sampling may introduce expansion bias or sign-switching in addition to attenuation bias (Chandrasekhar and Lewis (2010)).

3.2. **Experiment.** In June 2010, enumerators returned to the study villages to recruit respondents for the study. From the original population of 3155 respondents, 21 had since passed away and 397 had permanently moved away[3]. These 418 respondents have been removed from the social networks used in subsequent analysis.

A further 664 respondents were not available during the days when enumerators visited the villages to recruit participants for the study. Enumerators were stationed at the villages for 2 or 3 days and not everyone in the village was available during this time. These

[3]Respondents had moved to villages not covered in the study

respondents were often away at work or had temporarily left the village to visit friends or other family members.

2073 respondents were available during the recruitment period. The study was restricted to healthy adults between 16 and 60 years. Thus, 323 respondents weren't eligible to participate. 87 eligible respondents declined to participate in the study.

The remaining 1667 respondents were given the opportunity to participate in one of two lotteries. The lotteries gave respondents the opportunity to collect a randomly determined lottery amount between zero and four dollars. Respondents would have to travel to a pre-determined centre to pick up their incentive. Respondents randomized into Lottery A had no conditions placed on their collection of the lottery amount while those in Lottery B will had to get an HIV test in order to collect their lottery amount.

The lotteries were presented to study participants in the following way. Enumerators asked participants to pick one lottery amount out of four from a bag. They then also picked whether or not they had to get tested in order to collect their lottery amount or not. Enumerators then took a photograph of the participants. The participant's picture, lottery amount pick and lottery were printed out on a card. Enumerators distributed the cards to participants a few days later. Respondents were informed that if they took their entry cards to one of the six partner VCT centres during a special promotional week, they would be able to redeem their entry coupon for the lottery amount they picked. The redemption centres were partner Voluntary Counseling and Testing Centres and are between two and eight kilometers away from the study villages.

During the promotional week, enumerators were stationed at the partner VCT centres. The enumerator verified that the bearer of the entry coupon was the one photographed and paid the lottery draw. Those assigned to the conditional lottery (Lottery B) received their lottery draw only after being tested for HIV.

Figure 5.5 illustrates the various stages of the study.

[Figure 5 about here.]

Tables 4 and 5 compare people randomized into the test and no-test lotteries on baseline characteristics. Table 4 compares the test and no test groups, and there are no individually significant predictors of treatment. Table 5 compares individuals randomized across groups and payment levels. A few variables (such as male, married, tested previously) are individually significant for some specifications, though there are no discernible patterns. All results presented in the paper include these variables as controls.

[Table 4 about here.]

[Table 5 about here.]

3.3. **Attrition.** Table 6 looks at the various levels of attrition from the study from respondents' unavailability during the experiment and refusal to participate. Being male and having more years of education are both associated with unavailability during the experiment. This might be due to the fact that enumerators recruited participants for the study during weekdays when better educated males might be away at work. Further men are slightly more likely to consent to the study (2% off a mean of 96.5%) and each additional year is associated with being 0.2% less likely to consent to the experiment.

The analysis that follows includes these covariates as controls.

[Table 6 about here.]

4. Estimation

4.1. **Empirical Strategy.** In identifying the role of the behaviour and characteristics of others in a group in determining an individuals' choices, Manski (1993) distinguishes three reasons that drive the correlation between outcomes of individuals who interact together. Agents may behave similarly due to the influence of exogenous peer characteristics (exogenous effects), the influence of peers outcomes (endogenous characteristics) and the fact that individuals in the same reference group tend to behave similarly because they are alike or face a common environment (correlated effects). A popular strategy to disentangle these effects has been using randomized experiments wherein a random subset of members of a social network are provided with some intervention to change their behaviour. The random variation in the behavior of some members of the social network thus induced is used to instrument for the average behaviour in the group. Under conditions presented in Imbens and Angrist (1994), an instrumental variables estimator identifies a Local Average Treatment Effect (LATE) which measures the impact of the intervention beyond the targeted group - the peer effect.

Specifically, let agents be represented by a finite countable set $\mathcal{I}$. The preferences of an agent $i \in \mathcal{I}$ are affected by the choices of his social contacts given by $\mathcal{N}(i) \subset \mathcal{I}$. All agents' actions are common knowledge. The outcome of interest, whether i got tested for HIV or not, is denoted by Y_i. For each person i, let (Y_{0i}, Y_{1i}) correspond to the potential outcomes in the untreated and treated states. Let $D_i = 1$ denote having a social contact get tested; $D_i = 0$ denotes having no social contacts who get tested. The observed outcome Y_i can be written in terms of potential outcomes as

$$Y_i = D_i Y_{1i} + (1 - D_i) Y_{0i}, \tag{4.1}$$

or in random coefficients notation,

$$Y_i = \alpha_0 + \rho_i D_i + \eta_i \tag{4.2}$$

where $\alpha_0 \equiv E[Y_{0i}]$ and $\rho_i \equiv Y_{1i} - Y_{0i}$.

A latent variable model generates the indicator variable D. Specifically, the decision rule for the indicator is generated by a latent variable D_i^*:

$$\begin{aligned} D_i^* &= \gamma_0 + \gamma_1 z_j > \nu_j \\ D_i &= 1 \text{ if } D_i^* \geq 0, D_i = 0 \text{ otherwise,} \end{aligned} \tag{4.3}$$

where $z_j \in Z$ is an observed random variable and ν_j is an unobserved random variable involving unobserved costs and benefits of getting tested for i's social contact $j \in N(i)$, which is independent of z_j. Let D_{1i} be i's treatment status when $z_j = 1$, while D_{0i} is i's treatment status when $z_j = 0$. Observed treatment status is therefore

$$D_i = D_{0i} + (D_{1i} - D_{0i}) z_j = \pi_0 + \pi_{1j} z_i + \epsilon_i. \tag{4.4}$$

Following Imbens and Angrist (1994), given

$$\begin{aligned} &1.\ [Y_i(d,z);\forall d,z,D_{1i},D_{0i}] \perp\!\!\!\perp z_i; \\ &2.\ Y_i(d,0) = Y_i(d,1) \text{ for } d = 0,1; \\ &3.\ E[D_{1i} - D_{0i}] \neq 0; \\ &4.\ D_{1i} - D_{0i} \geq\ 0\ \forall i, \text{or vice versa,} \end{aligned}$$

the instrumental variables estimator identifies a local average treatment effect (LATE). For two distinct values of Z, z^1 and z^2, IV applied to 4.2 identifies

$$\text{LATE}(z^1, z^2) = E(Y_1 - Y_0 | D(z^2) = 1, D(z^1) = 0) \tag{4.5}$$

if the change from z^1 to z^2 induces people into the program $(D(z^2) \geq D(z^1))$. This is the mean change in the probability in testing from the social influence of people induced into testing by a switch in treatment status from z^1 to z^2.

LATE however, does not identify *who* are induced to change their treatment status by the change in the instrument. Indeed, the people induced to get tested by a policy need not be the same as those induced to get tested by any other policy that isn't exactly the same as the first.

Following Heckman (2010), let $P(z)$ denote the probability of taking treatment, $P(z) \equiv Pr(D = 1|Z = z)$. From equation 4.5, $P(z) = Pr(\gamma_0 + \gamma_1 z_j > \nu_j) = F_\nu(\mu_D(z))$ where $\mu_D(z) = E[\gamma_0 + \gamma_1 z]$. Let $U_D = F_\nu(V)$ be distributed over the interval [0,1] and thus the p^{th} quantile of U_D is p. Equation 4.5 can be expressed as

$$D = \mathbf{1}(P(Z) > U_D) \tag{4.6}$$

Thus the LATE parameter can also be expressed as using the latent variable U_D and the values taken by $P(Z)$ when $Z = z^1$ and $Z = z^2$.

$$LATE(z^1, z^2) = E(Y_1 - Y_0 | P(z^1 \leq U_D \leq P(z^2))) \tag{4.7}$$

which is the mean peer effect of persons whose $U_D \in [P(z^1) \leq U_D \leq P(z^2)]$.

We can partition the support of U_D into M discrete intervals

$$[u_{D,0}, u_{D,1}), [u_{D,1}, u_{D,2}), \ldots, [u_{D,M-1}, u_{D,M})$$

and define

$$E(Y|U_D \leq u_{D,k}) = E(Y_0) + \sum_{j=1}^{k} \text{LATE}(u_{D,j}, u_{D,j-1})\eta_j$$

where $\eta_j - u_{D,j} - u_{D,j-1}$.

Thus,

$$E(Y) = E(Y_0) + \sum_{j=1}^{M} \text{LATE}(u_{D,j}, u_{D,j-1})\eta_j \tag{4.8}$$

4.2. **First Stage.** What is the likelihood that someone assigned to the "To Test" lottery went on to get tested? Figure 5.6 demonstrates that being assigned to the "To Test Lottery" increases the likelihood that a respondent gets tested by 50.71 percent. Each additional dollar increases the likelihood that a respondent will get tested by 5.73 percent.

[Figure 6 about here.]

Table 7 presents the first stage: what is the probability that a respondent's contact i in village v assigned to the HIV test lottery with a particular prize went on to get tested?

$$\begin{aligned}\#\text{ Contacts Tested X Incentive}_{iv} = \alpha + \beta \cdot \#\text{ Contacts in To Test Lottery X Incentive}_{iv} \\ + \gamma \cdot \#\text{ of Contacts}_{iv} + v_j\end{aligned}$$

Having contacts who are randomized into the "To Test" lottery at the various incentive amounts strongly predicts the number of contacts that a respondent has who get tested at various incentives.

[Table 7 about here.]

4.3. **Social Network Effects.** To measure the effect of social contacts getting an HIV-test on individual's decision to get tested, I estimate:

$$Tested_{iv} = \alpha + \beta_1 \cdot \#SocialContactsTested_{ij} + \beta_2 \cdot \#SocialContacts_{iv} + X'_{iv}\delta + \gamma v_j + \epsilon_{ij} \tag{4.9}$$

where $Tested_{iv}$ is an indicator of whether individual i in village v got an HIV test. $\#SocialContactsTested_{iv}$ is the number of social contacts who get an HIV test and $\#SocialContacts_{iv}$ is the number of social contacts the respondent has. $\#SocialContactsTested_{iv}$ will be instrumented by the number of people in that network who were randomized into the HIV-Test Lottery.

Without conditioning on the incentive amount that i's social contacts receive, β_1 gives the mean peer effect of all people induced to get tested at all incentive amounts.

$$Tested_{iv} = \alpha + \beta_1 \cdot \#SocialContactsTested\_IncentiveAmt_{ij} + \beta_2 \cdot \#SocialContacts_{iv} + X'_{iv}\delta + \gamma v_j + \epsilon_{ij} \tag{4.10}$$

Table 8 presents the results. In Panel A, regression (1) estimates the impact of having an additional social contact who gets an HIV test on a respondents' decision to get tested. The point estimate is negative but not statistically significant. Regressions 2 and 3 attempt to disaggregate this by looking at separately at men and women and similarly find a small, negative and imprecisely estimated impact of having an additional social contacts getting a HIV test.

Panel B of Table 8 compares the impact of having additional social contacts who get tested on married respondents likelihood of testing and finds a similar pattern of social impact to Panel A. Having a spouse who gets tested appears to have a slightly positive though imprecisely estimated impact on testing.

[Table 8 about here.]

Table 9 compares the effects of different compliant sub-populations by the incentive amount that social contacts receive on respondent's likelihood of testing. In Panel A, regression (1) estimates the impact of having an additional social contact who gets an HIV test while receiving sugar and 0 Kwacha on a respondents' decision to get tested. Each additional contact that gets tested while receiving sugar and 0 Kwacha reduces the likelihood of testing by 9.5 percent (s.e. 0.034). This is a significant reduction of a mean of about 22 percent. In contrast, each additional dollar that social contacts receive increase the likelihood of testing by 2.8 percent (s.e. 0.014). Regressions 2 and 3 attempt to disaggregate this by looking at separately at men and women and find similar effects. Panel B of Table 9 compares the impact of having additional social contacts who get tested on married respondents likelihood of testing and finds a similar pattern of social impact to Panel A. Having a spouse who gets tested appears to have a slightly positive though imprecisely estimated impact on testing.

[Table 9 about here.]

LATE gives us very different peer effects depending on the incentive given to the social contact. Differences in compliant subpopulations might explain the difference in treatment effects from one instrument to another. Following Angrist and Pischke (2008), I calculate the relative likelihood a complier has a certain characteristic.

Let x_{1i} be a Bernoulli-distributed characteristic. The relative likelihood a complier has $x_{1i} = 1$ is given by the ratio of the first stage for x_{1i} to the overall first stage. Specifically,

$$\begin{aligned} \frac{P[x_{1i}=1|D_{1i}>D_{0i}]}{P[x_{1i}=1]} &= \frac{P[D_{1i}>D_{0i}|x_{1i}=1]}{P[D_{1i}>D_{0i}]} \\ &= \frac{E[D_i|z_i=1,x_{1i}=1]-E[D_i|z_i=0,x_{1i}=1]}{E[D_i|z_i=1]-E[D_i|z_i=0]}. \end{aligned} \tag{4.11}$$

Table 10 reports compliers' characteristics ratios for a variety of baseline characteristics using "low incentive to test" and "high incentive to test" instruments. Those who get tested while receiving a low incentive seem to be slightly better informed about HIV than those who get tested while receiving a high incentive to do so. For instance, they are less likely to believe that a person can get the AIDS virus by sharing food with a person who has AIDS and slightly less likely to think that a person can get the AIDS virus as a result of witchcraft or other supernatural means.

People who get tested while receiving a low incentive report being more concerned about getting infected with HIV and also believe the prevalence of HIV in the area to be higher than the average and higher than those who test while receiving a high incentive. Respondents who get tested while receiving a low incentive are much less likely to have used condoms that most recent time that they had sexual intercourse and are slightly more likely to have ever been tested for HIV before.

[Table 10 about here.]

LATE identifies starkly different peer effects from sets of social contacts who have different observables. Social contacts who seem to have a slightly higher awareness about HIV on average and are more worried about being infected with HIV have negative externalities on individuals' likelihood of testing than peers who aren't as worried about infection. I am currently working on a model to provide further insight into these results.

5. Conclusion

This study aims to contribute toward a better understanding of the role that networks play in motivating sexual behavioural change. Studies have shown that individuals' immediate social groups have a strong impact on their subjective perception of risk and on subsequent risk-taking behaviour. However measuring social network effects is complicated by the fact that social networks are endogenous. This study creates a unique dataset of the full social network map of 21 villages in Central Malawi and overcomes the difficult identification problems of detecting social network effects by varying the incentives of a subset of a social group to get tested for HIV and evaluating whether the intervention extends beyond the group targeted. This study is able to

This paper shows significant heterogeneities in social network influence. The separate identification of different social effects is important for policy evaluation because different channels of influence generally require different policies. An estimate of "aggregate" social interactions, despite being important, may be of limited use because without knowledge of the composition and/or source of the social effect, it is difficult to make policy recommendations (Cohen-Cole and Zanella (2008)).

Results from this study could guide policy about the best way to target interventions to induce greater risk prevention behaviour. Every year, there are a significant number of new infections and further still, research shows these occur in low risk populations who have made limited behavioural responses to the general population level risk of being infected with HIV/AIDS. Given the primacy of social networks, for a wide range of economic and social outcomes, this study hopes to identify which social interactions should be targeted by policy makers.

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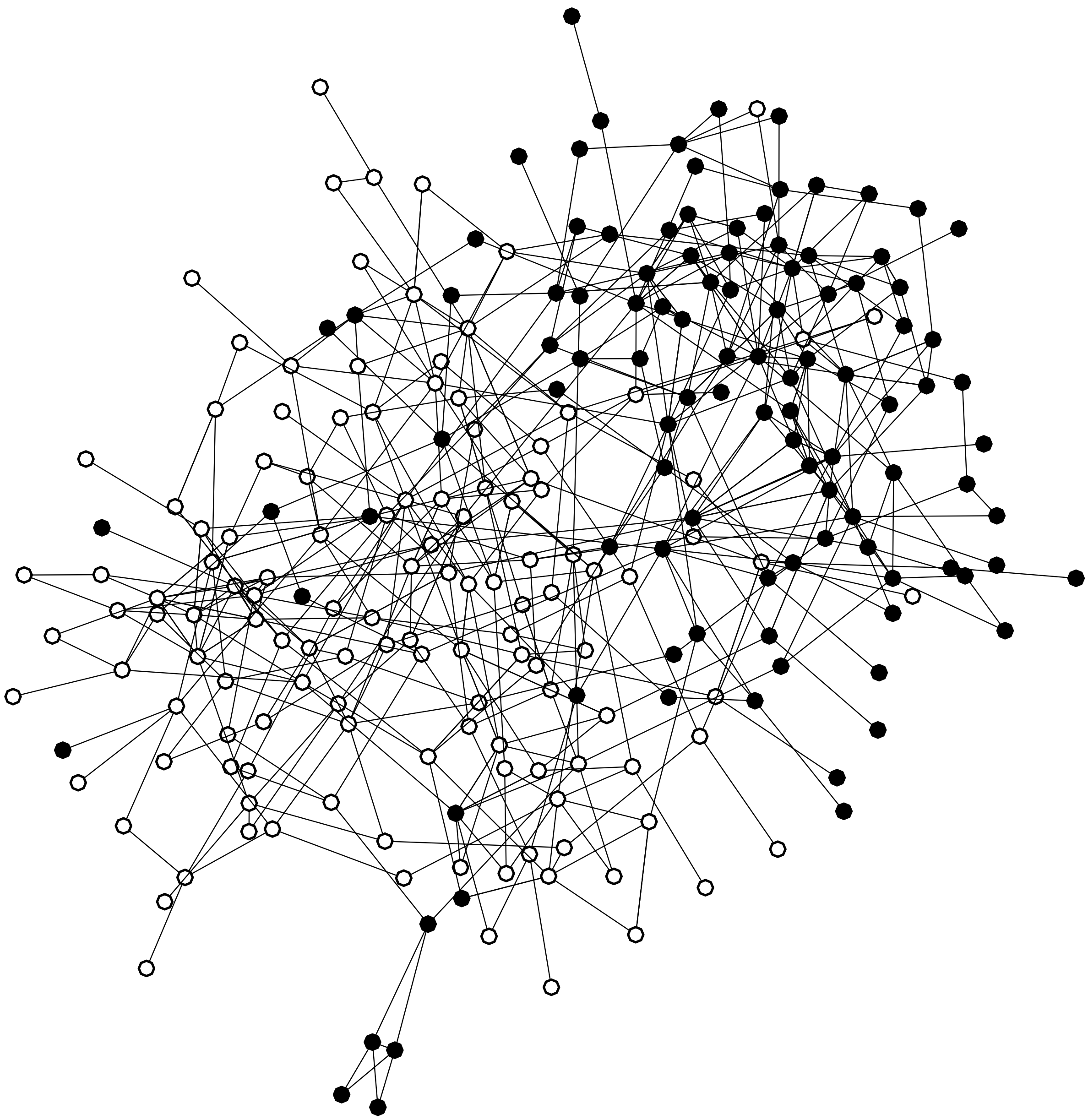

FIGURE 5.1. Link denotes that at least one of the two respondents named the other as a friend in the survey. Nodes coded by Gender: Black=Male, White=Female.

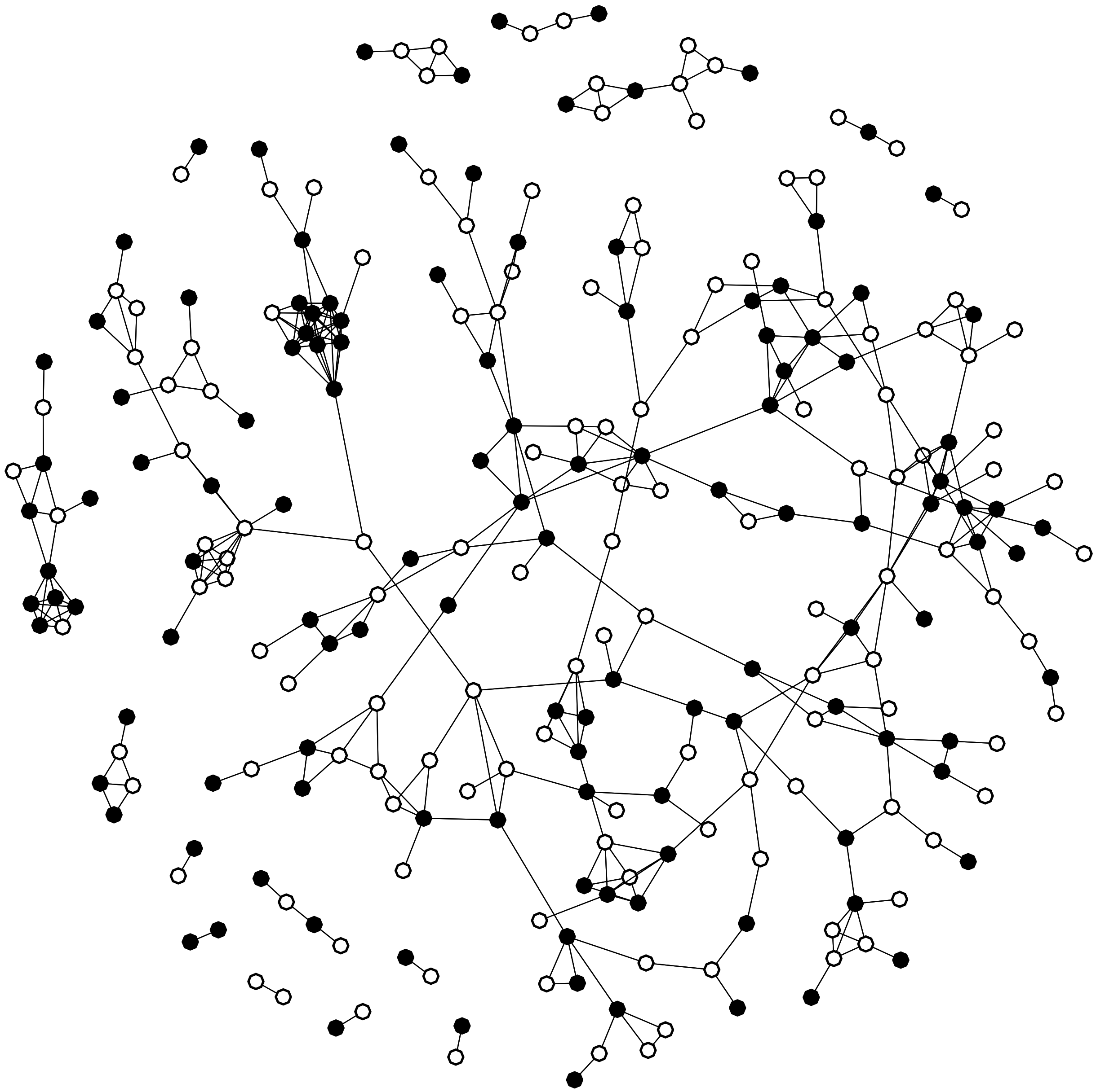

Figure 5.2. Link denotes denotes that at least one of the two respondents named the other as a blood relative in the survey.

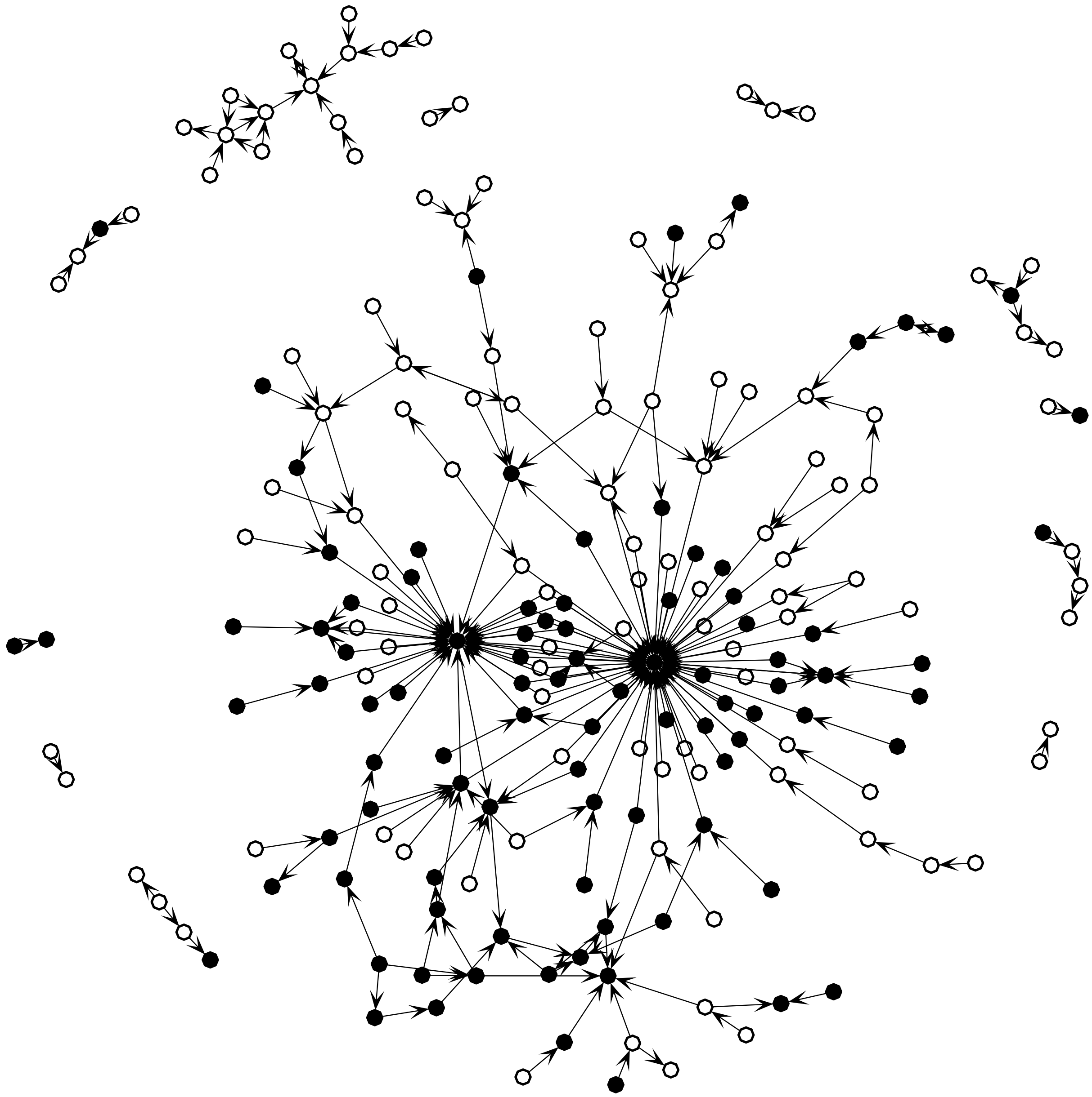

FIGURE 5.3. Directed graph with each link denoting someone the respondent named in the survey as someone that they admire.

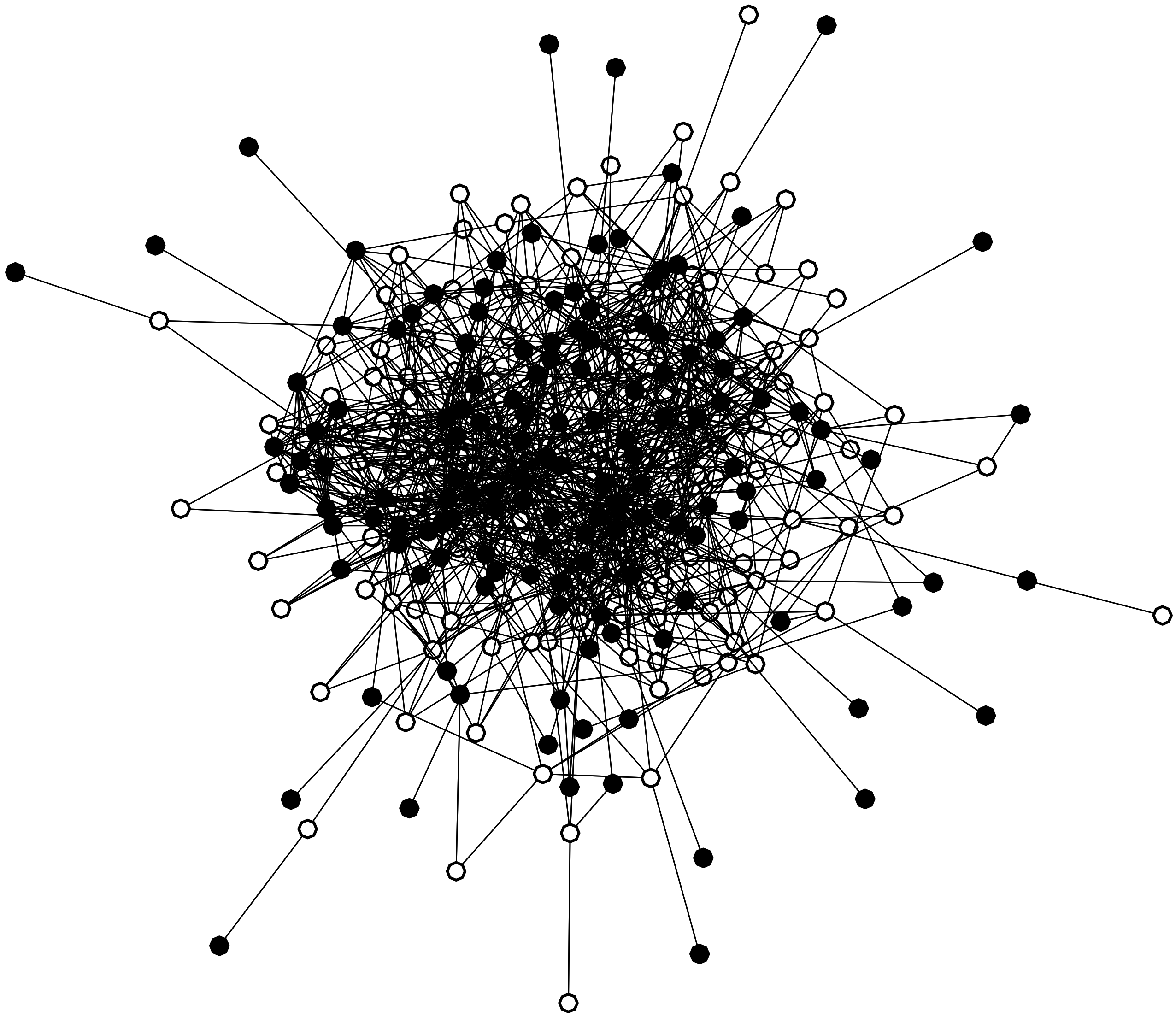

Figure 5.4. Village Social Network map with a union of all the links in Figures 5.1, 5.2 and 5.3.

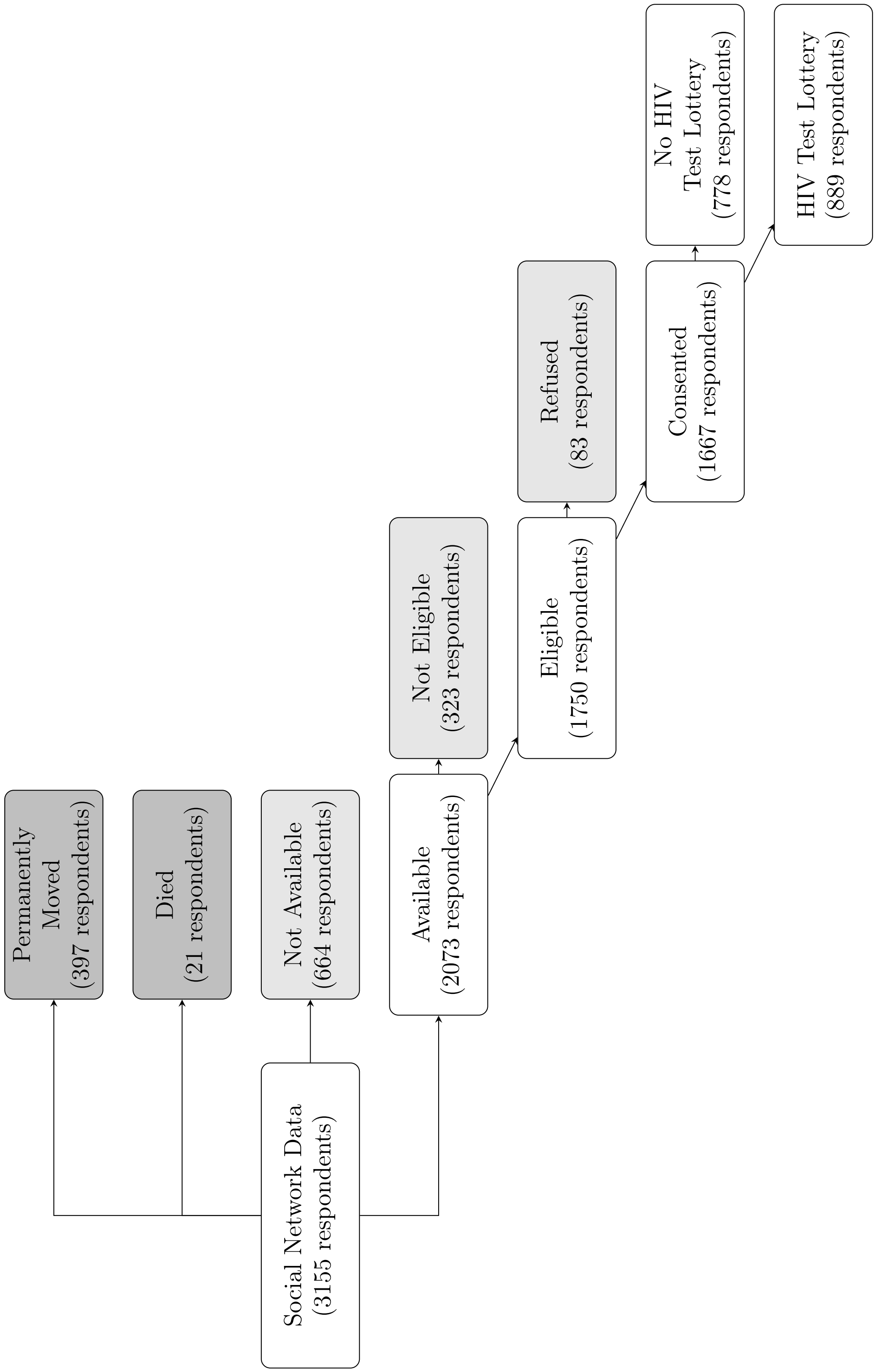

Figure 5.5. Study Timeline

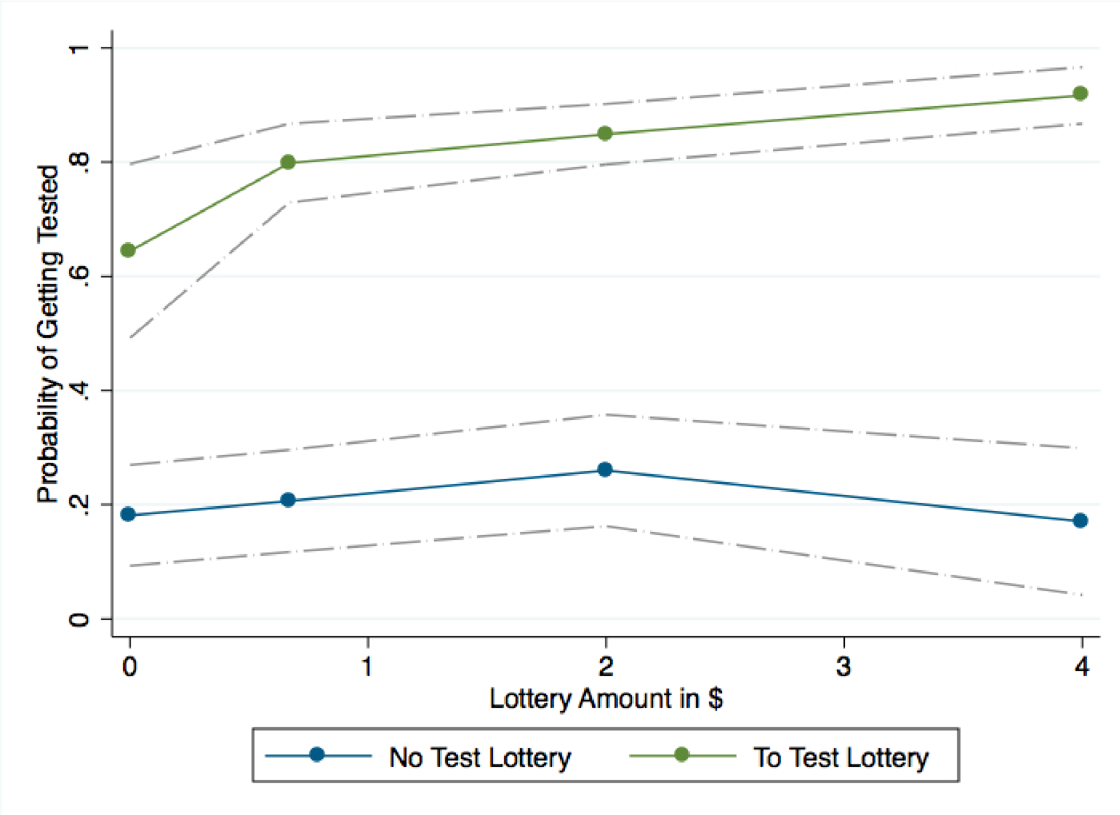

FIGURE 5.6. Lottery Amount Drawn on Probability of Testing

Table 1. **Baseline Differences between Men and Women**

	Males	Females	Diff (M-F)	N
Age	34.071	33.665	0.406	163
			(0.678)	
Years of Education	5.432	3.925	1.507***	158
			(0.156)	
Knowledge and Attitudes				
Have you heard of an illness called HIV?	0.991	0.985	0.007	151
			(0.004)	
Can people reduce their chance of getting the AIDS virus by:				
having just one faithful uninfected sex partner?	0.87	0.866	0.004	146
			(0.013)	
using a condom every time they have sex?	0.71	0.731	-0.021	146
			(0.027)	
not having sexual intercourse at all?	0.86	0.839	0.021	148
			(0.018)	
Is there a cure for HIV or AIDS?	0.058	0.093	-0.035**	147
			(0.013)	
Have you heard about anti-retroviral therapy?	0.979	0.955	0.024**	148
			(0.009)	
Can a person get the AIDS virus:				
from a mosquito bite?	0.283	0.261	0.023	144
			(0.014)	
as a result of witchcraft or other supernatural means?	0.135	0.179	-0.044*	141
			(0.021)	
Would you buy fresh vegetables from a shopkeeper with HIV?	0.925	0.834	0.091***	147
			(0.016)	
If a member of your family got infected with the AIDS virus, would you want it to remain a secret or not?	0.581	0.648	-0.067**	147
			(0.032)	
People with the AIDS virus should be blamed for bringing the disease into the community.	0.137	0.184	-0.047**	147
			(0.018)	
Recent History				
Had more than 2 sexual partners in the last 12 months	0.283	0.134	0.148***	153
			(0.024)	
Used condoms last time had sexual intercourse	0.168	0.068	0.1***	153
			(0.019)	
Used condoms conditional on having more than 2 partners in the last 12 months	0.234	0.071	0.163***	29
			(0.038)	

TABLE 2. **Frequency of friendships across gender**

	Men	Women
% of the population	42.69%	57.31%
% of friendships by gender: Men	90.17%	9.83%
Women	6.21%	93.79%
Observations	996	1337

Table 3. **Baseline Differences between Types of Links across Males and Females.**

	Males	Females	Difference (Std Error)
# All Links	4.814	4.388	0.425***
			(0.129)
# Male Links	3.862	2.279	1.583***
			(0.158)
# Female Links	2.399	3.711	−1.311***
			(0.097)
# All Peers	2.255	2.241	0.014
			(0.067)
# Male Peers	2.07	0.806	1.264***
			(0.097)
# Female Peers	0.7	2.088	−1.388***
			(0.064)
# All Relatives	2.386	2.012	0.374***
			(0.111)
# Male Relatives	1.664	1.376	0.288**
			(0.117)
# Female Relatives	1.609	1.545	0.064
			(0.071)
# All Admired	0.937	0.771	0.166***
			(0.035)
# Male Admired	0.867	0.503	0.364***
			(0.041)
# Female Admired	0.311	0.512	−0.201***
			(0.024)

* significant with 90% confidence, ** 95%, *** 99%.

Table 4. **Baseline Differences between "To Test" and "No Test" Lottery**

	To Test	No Test	Diff	N
Age	33.702	33.965	-0.262	1636
			(0.547)	
Years of Education	4.524	4.515	0.008	1589
			(0.157)	
Male	0.391	0.395	-0.003	1667
			(0.023)	
Knowledge and Attitudes				
Have you heard of an illness called HIV?	0.989	0.986	0.003	1514
			(0.005)	
Can people reduce their chance of getting the AIDS virus by:				
having just one faithful uninfected sex partner?	0.852	0.885	-0.033	1463
			(0.023)	
using a condom every time they have sex?	0.696	0.753	-0.056	1464
			(0.021)	
not having sexual intercourse at all?	0.847	0.846	0.001	1482
			(0.023)	
Is there a cure for HIV or AIDS?	0.067	0.093	-0.026	1474
			(0.012)	
Have you heard about anti-retroviral therapy?	0.962	0.967	-0.005	1483
			(0.012)	
Can a person get the AIDS virus:				
from a mosquito bite?	0.275	0.264	0.011	1447
			(0.021)	
as a result of witchcraft or other supernatural means?	0.15	0.175	-0.025	1419
			(0.021)	
Would you buy fresh vegetables from a shopkeeper with HIV?	0.877	0.859	0.018	1479
			(0.014)	
If a member of your family got infected with the AIDS virus, would you want it to remain a secret or not?	0.624	0.620	0.004	1470
			(0.022)	
People with the AIDS virus should be blamed for bringing the disease into the community.	0.161	0.171	-0.01	1478
			(0.014)	
Recent History				
Had more than 2 sexual partners in the last 12 months?	0.184	0.199	-0.015	1537
			(0.019)	
Used condoms the last time had sexual intercourse	0.100	0.113	-0.013	1537
			(0.016)	
Used condoms conditional on having more than 2 partners in the last 12 months	0.141	0.186	-0.045	294
			(0.045)	

Table 5. **Relationship between Treatment and Individual Characteristics**

	To Test				No Test			
	K600	K300	K100	K0	K600	K300	K100	K0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Male	−0.016	0.025	−0.035**	−0.000	0.028	−0.061**	0.045*	0.014
	(0.027)	(0.025)	(0.016)	(0.020)	(0.021)	(0.024)	(0.022)	(0.018)
Never Tested	0.046**	0.024	0.009	−0.001	−0.004	−0.025	−0.040**	−0.009
	(0.019)	(0.021)	(0.016)	(0.011)	(0.018)	(0.016)	(0.019)	(0.017)
Married	−0.032	0.051**	−0.062**	−0.013	−0.027	−0.005	0.044*	0.044**
	(0.024)	(0.022)	(0.028)	(0.029)	(0.034)	(0.026)	(0.023)	(0.019)
Age	0.001	−0.000	−0.001	−0.000	−0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Years of Education	0.002	−0.004	0.004	−0.002	0.000	−0.001	0.001	−0.000
	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
# Male Social Contacts	−0.002	0.003	−0.007**	0.002	0.001	0.006*	−0.002	−0.001
	(0.005)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)
# Female Social Contacts	−0.005	0.002	−0.003	−0.003	0.001	−0.004	0.009**	0.003
	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)
Observations	1667	1667	1667	1667	1667	1667	1667	1667
R-squared	0.032	0.015	0.034	0.013	0.019	0.029	0.032	0.021

Notes: OLS Regressions including village fixed effects.
Robust standard errors clustered at the village level, in parentheses.
* significant with 90% confidence, ** 95%, *** 99%.

TABLE 6. **Attrition**

Dependent Variable: Respondent	(1) Available	(2) Consented
Male	-0.071^{***}	0.021^{*}
	(0.017)	(0.011)
Married	0.002	0.033
	(0.015)	(0.028)
Age	0.001	-0.002^{**}
	(0.001)	(0.001)
Years of Education	-0.009^{**}	-0.000
	(0.004)	(0.002)
Ever Tested Before for HIV	0.014	0.015
	(0.015)	(0.010)
Constant	0.870^{***}	0.965^{***}
	(0.041)	(0.018)
Observations	2,737	1,750
R-squared	0.355	0.192

Notes: Robust standard errors clustered at the village level, in parentheses.
* significant with 90% confidence, ** 95%, *** 99%.

Table 7. **First Stage**

Dependent Variable	# Contacts Tested at ... Kwacha Incentive 600 (1)	300 (2)	100 (3)	0 (4)
# Contacts in To Test Lottery with 600 Kwacha Incentive	0.817***	−0.049*	0.002	−0.032**
	(0.061)	(0.027)	(0.027)	(0.014)
# Contacts in To Test Lottery with 300 Kwacha Incentive	-0.019	0.667***	-0.004	0.039**
	(0.030)	(0.067)	(0.029)	(0.016)
# Contacts in To Test Lottery with 100 Kwacha Incentive	0.033	0.022	0.667***	0.023
	(0.033)	(0.026)	(0.067)	(0.026)
# Contacts in To Test Lottery with 0 Kwacha Incentive	-0.015	-0.031	0.026	0.557***
	(0.029)	(0.046)	(0.042)	(0.107)
Mean among Controls	0.042	0.046	0.042	0.029
	(0.206)	(0.229)	(0.200)	(0.171)
Observations	1,667	1,667	1,667	1,667
R-squared	0.849	0.804	0.758	0.664
F-test statistic	157.18	76.72	147.55	21.95

Notes: Robust standard errors clustered at the village level, in parentheses. Additional controls not presented here but included in the regressions include the total number of contacts and village fixed effects.
* significant with 90% confidence, ** 95%, *** 99%.

Table 8. **IV Regressions of whether respondents got tested during the testing week**

	(1)	(2)	(3)
Panel A: All Respondents	**All**	**Men**	**Women**
Dependent Var: Tested			
# All Contacts Tested	−0.003	−0.005	−0.009
	(0.012)	(0.020)	(0.015)
Male	−0.047*		
	(0.024)		
To Test Lottery	0.507***	0.433***	0.541***
	(0.049)	(0.063)	(0.050)
Incentive Amount	−0.005	0.001	−0.011
	(0.013)	(0.014)	(0.017)
To Test Lottery X Incentive Amount	0.059***	0.070***	0.054**
	(0.020)	(0.021)	(0.022)
Mean Among Controls	0.219	0.172	0.248
	(0.414)	(0.379)	(0.433)
Observations	1,667	655	1,012
R-squared	0.453	0.433	0.489
Panel B: Married Respondents	**All**	**Men**	**Women**
Dependent Var: Tested			
# All Contacts Tested	−0.002	−0.006	−0.010
	(0.014)	(0.021)	(0.017)
Spouse Tested	0.039	0.060	0.053
	(0.039)	(0.053)	(0.073)
Male	−0.055**		
	(0.026)		
To Test Lottery	0.506***	0.463***	0.524***
	(0.055)	(0.070)	(0.051)
Incentive Amount	−0.008	0.006	−0.018
	(0.012)	(0.016)	(0.014)
To Test Lottery X Incentive Amount	0.058***	0.053**	0.061**
	(0.020)	(0.021)	(0.022)
Mean Among Controls	0.201	0.145	0.231
	(0.402)	(0.356)	(0.423)
Observations	1,284	501	783
R-squared	0.456	0.446	0.490

Notes: Robust standard errors clustered at the village level, in parentheses. Instruments used are whether contacts were randomized into the lottery where they had to get tested for HIV in order to collect their lottery draw. Additional controls not presented here but included in the regressions are age, lottery amount, whether the person has been previously tested for HIV, education level and village fixed effects.
* significant with 90% confidence, ** 95%, *** 99%.

Table 9. **IV Regressions of whether respondents got tested during the testing week**

	(1)	(2)	(3)
Panel A: All Respondents	**All**	**Men**	**Women**
Dependent Var: Tested			
# All Tested X All Lottery Amount	0.028*	0.019	0.034**
	(0.014)	(0.026)	(0.012)
# All Contacts Tested	−0.095**	−0.089	−0.110***
	(0.034)	(0.072)	(0.027)
Male	−0.047*		
	(0.024)		
To Test Lottery	0.505***	0.425***	0.535***
	(0.052)	(0.067)	(0.049)
Incentive Amount	−0.005	0.000	−0.012
	(0.013)	(0.014)	(0.016)
To Test Lottery X Incentive Amount	0.059***	0.071***	0.056**
	(0.021)	(0.022)	(0.022)
Mean Among Controls	0.219	0.172	0.248
	(0.414)	(0.379)	(0.433)
Observations	1,667	655	1,012
R-squared	0.453	0.441	0.489
Panel B: Married Respondents	**All**	**Men**	**Women**
Dependent Var: Tested			
# All Contacts Tested X All Lottery Amount	0.024	0.014	0.030**
	(0.014)	(0.023)	(0.013)
# All Contacts Tested	−0.084**	−0.077	−0.105***
	(0.034)	(0.062)	(0.027)
Spouse Tested X Spouse Incentive Amount	0.001	0.000	−0.006
	(0.015)	(0.024)	(0.025)
Spouse Tested	0.058	0.074	0.095
	(0.049)	(0.074)	(0.085)
Male	−0.049*		
	(0.026)		
To Test Lottery	0.502***	0.449***	0.515***
	(0.055)	(0.074)	(0.048)
Incentive Amount	−0.008	0.003	−0.020
	(0.012)	(0.015)	(0.013)
To Test Lottery X Incentive Amount	0.057**	0.057**	0.063***
	(0.020)	(0.021)	(0.022)
Mean Among Controls	0.201	0.145	0.231
	(0.402)	(0.356)	(0.423)
Observations	1,284	501	783
R-squared	0.455	0.453	0.489

Notes: Robust standard errors clustered at the village level, in parentheses. Instruments used are whether contacts were randomized into the lottery where they had to get tested for HIV in order to collect their lottery draw. Additional controls not presented here but included in the regressions are age, lottery amount, whether the person has been previously tested for HIV, education level and village fixed effects.
* significant with 90% confidence, ** 95%, *** 99%.

Table 10. **Complier Characteristics for "Low Incentive To Test" and "High Incentive To Test" Instruments**

Variable	$P[x_{1i}=1]$	Low Incentive To Test		High Incentive To Test	
		$P[x_{1i}=1 \mid D_{1i}>D_{0i}]$	$P[x_{1i}=1 \mid D_{1i}>D_{0i}]/P[x_{1i}=1]$	$P[x_{1i}=1 \mid D_{1i}>D_{0i}]$	$P[x_{1i}=1 \mid D_{1i}>D_{0i}]/P[x_{1i}=1]$
Knowledge and Attitudes	(1)	(2)	(3)	(4)	(5)
Have you heard of an illness called HIV or AIDS?	0.987	0.987	1.000	0.992	1.005
Can a person get the AIDS virus by sharing food with a person who has AIDS?	0.088	0.042	0.473	0.084	0.950
Can a person get the AIDS virus as a result of witchcraft or other supernatural means?	0.162	0.130	0.805	0.137	0.845
Worry about AIDS					
On a scale of 0 to 1, how concerned are you about getting infected with HIV?	0.477	0.539	1.131	0.427	0.895
What do you think, is the prevalence of HIV: among men in this area?	0.286	0.355	1.241	0.280	0.980
among women in this area?	0.300	0.342	1.140	0.282	0.942
Do you agree or disagree with the following: People with the AIDS virus should be blamed for bringing the disease into the community	0.166	0.158	0.953	0.196	1.182
Recent History					
Did you use condoms the most recent time you had sexual intercourse?	0.098	0.057	0.588	0.130	1.334
Have you ever been tested for HIV before?	0.598	0.644	1.077	0.518	0.867

This table reports an analysis of complier characteristics for "low incentive to test" and "high incentive to test" instruments. The ratios in columns 3 and 5 give the relative likelihood that compliers have the characteristic indicated on the left.