HIV/AIDS Treatment Availability and the Decision to Test: Evidence from Malawi

Nicholas Stacey

June 2, 2014

Abstract

This paper examines whether the availability of an effective treatment influences the decision to test for HIV/AIDS. Testing is a critically important policy outcome as it links infected individuals to treatment and is associated with reductions in risky behavior. Given the improved health that treatment bestows if one is HIV positive, treatment availability increases the expected benefit of testing and learning one's status. Using variation in proximity to health facilities during the expansion of antiretroviral therapy (ART) provision in Malawi in the early 2000s, we identify empirically the effect of increased availability of HIV/AIDS treatment on reported HIV testing. We find that the increase in the likelihood of reporting having tested over this time period is negatively correlated with distance to facilities providing treatment even when distance to facilities providing testing is controlled for. Thus, the analysis in this paper provides empirical evidence supporting the hypothesis that the availability of treatment increases testing. The policy implications of this result are that if widespread testing is viewed as a desirable public health outcome, access to treatment, beyond its own merits, provides a means of achieving this goal. Additionally, reducing the transportation costs associated with accessing treatment may further incentivize individuals to test.

Keywords: HIV/AIDS, Treatment, Testing, Malawi

JEL Classification Codes: I10, I12, O12

1 Introduction

HIV/AIDS has caused more than 30 million deaths worldwide and as of 2012 has left 35.3 million people living with a disease for which at present there is no cure and for which a preventative vaccine is not available [UNAIDS, 2013]. As such, understanding the full range of consequences of any particular policy response is of the utmost importance. The largest change in HIV/AIDS policy in the last decade has been the scaling up of the availability of an effective treatment, antiretroviral therapy (ART). The availability of ART has significantly increased the life spans of HIV infected individuals. In Kwazulu-Natal, the province with the highest HIV/AIDS prevalence in South Africa, life expectancy increased 11.3 years as ART access was increased between 2003 and 2011 [UNAIDS, 2013]. Through concerted local and international efforts the number of individuals receiving ART in low- and middle-income countries has increased over the last decade from less than half a million individuals on treatment in 2003 to over 9.7 million individuals on treatment in 2012 [UNAIDS, 2013]. While this progress is significant, under 2013 WHO guidelines this represents a coverage rate of only 34% of in-need individuals receiving treatment.

Conventionally, policy aimed at tackling HIV/AIDS is done under the banners of either treatment or prevention [Canning, 2006]. However, recent clinical findings have shown that to describe the expansion of access to ART exclusively as a treatment intervention would be misinformed [Cohen et al., 2012, Anglemyer et al., 2013]. In particular, individuals on a well-managed ART regimen have much lower viral loads, and as such have been shown to be much less infectious to sexual partners. This has lead to the promotion of a strategy to reduce transmission known as "Treatment as Prevention" (TASP) [WHO, 2012]. However, this view of treatment ignores that treatment alters the incentives that individuals face and therefore interacts with choices over the adoption of preventative or risk behaviors. Treatment's relationship with prevention is in fact more nuanced. For example, the availability of HIV/AIDS treatment has been shown to have induced increases in risky sexual behavior in a variety of settings [Lakdawalla et al., 2006, Friedman, 2014]. This paper examines the effect of treatment availability on an additional behavior that is traditionally characterized as preventative: testing. This paper seeks to examine empirically whether or not individuals' decision to test is motivated by whether or not they have access to antiretroviral therapy.

Widespread testing is viewed as an important policy goal [UNAIDS, 2013, Mechoulan, 2004, Granich et al., 2009]. Testing is a gateway that introduces HIV positive individuals to the treatment cascade and leads sick individuals to access care that extends their lives. In doing so, treatment also reduces the infectiousness of HIV positive individuals and reduces transmission of the virus. Additionally, there is a widely held view that learning one's status will cause individuals to reduce risky sexual behavior. There is considerable empirical evidence in the public health literature supporting this assessment [Weinhardt et al., 1999, Crepaz et al., 2006]. However, the reductions in risky behavior generally occur only among individuals who learn that they are HIV positive ("secondary prevention") as opposed to individuals who learn that they are HIV negative ("primary prevention"). Consistent with this, Thornton [2008] demonstrates in a randomized trial offering differing incentives for individuals to learn their status that HIV positive individuals who learned their status were more likely to purchase condoms.

To answer the question of whether or not treatment induces testing, we examine the early expansion of ART availability in Malawi as a natural experiment. In particular, we exploit spatial heterogeneity in access to facilities beginning to provide ART in Malawi as the availability of ART was expanded in the early 2000s. While the government of Malawi aimed to expand the provision of ART to all public facilities, due to resource and administrative constraints, the timing of the rollout of ART to health facilities was staggered. We exploit this variation in the timing of ART provision at particular facilities, and variation in proximity to the initially selected facilities as plausibly exogenous variation in ART availability. Applying a differences-in-differences approach we document that distance to facilities providing antiretroviral therapy is correlated with a lower increase in the likelihood of reporting having tested over the period of study, controlling for a number of pertinent behavioral variables as well as distance to volunteer counseling and testing (VCT) facilities. The results suggest that treatment did induce individuals to test and as such the availability of an effective treatment did induce individuals to part-take in what is traditionally viewed as a preventative behavior.

This finding has some policy implications. First, if policymakers are interested in increasing testing rates, the availability of an effective treatment may be an option to induce testing. Second, there is a role for subsidizing the costs of accessing treatment as an additional means of inducing preventative behaviors like testing. The paper proceeds as follows; section two discusses antiretroviral therapy and why it may induce individuals to test, section three discusses Malawi and its policy approach to addressing HIV/AIDS and providing ART, section four presents the data and empirical approach employed, section five presents and discusses the results of our empirical analysis, and section six discusses policy implications and concludes.

2 ART availability and the decision to test

2.1 Antiretroviral Therapy

Antiretroviral therapy is a combination of antiretroviral medications that are taken that support the body's response to the HIV virus [UNAIDS, 2013, Simon et al., 2006]. ART decreases viral loads and decreases the incidence of opportunistic infections, leading to a prolonging of the asymptomatic infection stage and extended life expectancies for HIV infected individuals [Ivers et al., 2005, UNAIDS, 2013, Simon et al., 2006]. At present ART is the only effective treatment available for HIV/AIDS. While there are a number of antiretroviral medications which work through slightly different mechanisms, they generally all act to reduce replication of the HIV virions and in doing so reduce HIV-related immunosupression [Simon et al., 2006]. It is important to note that in most developing countries individuals who test positive are not put on treatment immediately but rather are put on treatment only once their CD-4 cell count[1] falls below a threshold. Present WHO guidelines regarding the provision of ART suggest that once an individual's CD-4 count falls below 500 cells/μL, the individual should begin treatment.

Prior to the development of antiretroviral therapy in 1996, there was no effective treatment available for individuals infected with HIV. Following the development of ART there was an initial period where ART was available but the medications were prohibitively expensive for most infected individuals, especially those in

[1]CD-4 cells are a type of white blood cell. They are a critical component of the body's immune system. As such, tracking the number of CD-4 cells in a unit of blood, provides a useful measure of the impact of the HIV virus on infected individuals' immune systems, and of the progression of the disease [Simon et al., 2006].

developing countries like Malawi. Following coordination with pharmaceutical manufacturers and agreements regarding the availability of generic medications, the costs of public provision of ART in low-income settings fell sharply. In addition, the formation of a number of international efforts to address HIV/AIDS including the President's Emergency Plan for AIDS Relief (PEPFAR), and the Global Fund to Fight AIDS, Tuberculosis and Malaria, assisted in the provision of ART in many of the sub-Saharan African countries experiencing generalized HIV/AIDS epidemics.

2.2 ART and the take-up of testing

The notion that treatment availability and the decision to test are related has been proposed in prior work in the public health and economics literature [Musheke et al., 2013, Phakathi, 2011, Warwick, 2006, Wilson, 2010]. Phakathi [2011] examines willingness to test relative to access to ART in South Africa. Warwick [2006] shows that in a community in Botswana the number of tests performed increased five-fold once treatment became available. Wilson [2010] documents testing patterns by age before and after ART was introduced to Zambia and argues that the large observed increase in testing among elderly males arises due to preferential access to ART. These findings point to treatment availability influencing testing behavior.

There are a number of mechanisms through which treatment availability may alter decisions regarding testing. Testing by itself simply provides individuals with information regarding their HIV status. Thus if an individual tests, their belief regarding their HIV status should change from some probability of being HIV positive to being either HIV positive or negative with certainty. An expected utility maximizer will therefore choose to test by comparing expected lifetime utility where they continue to operate with their initial infection belief relative to their expected lifetime utility where they know their HIV status with certainty. If ART is available, when an HIV positive individual tests they will be linked to treatment. If an individual is HIV positive and ART is available and they choose to test, they will be healthier in future and as such will have greater future survival probabilities. This suggests that treatment availability increases the expected lifetime utility of testing and should therefore induce individuals to test. If ART is not available, there are some alternative options that HIV positive individuals may follow to treat their condition, including a careful diet and close monitoring of opportunistic infections. These, however, are limited in effectiveness as they treat only symptoms of the infection and not the infection itself.

Along with the improved survival probabilities that ART is associated with, individuals on treatment are able to supply greater amounts of labor. Thirumurthy et al. [2008] demonstrates that ART increases labor supply among HIV positive individuals in Western Kenya. The effects of ART on labor supply suggest treatment increases incomes of the HIV positive, and these increased incomes further act to increase the expected benefit of testing, learning one's status, and receiving treatment if HIV positive.

An additional explanation for the change in testing behavior that may be associated with the availability of treatment is a change in priors regarding one's own probability of infection. The existing literature suggests that the availability of treatment is associated with improvements in mental health status. If individuals under-estimate their probability of being infected as a means of coping with the absence of an effective treatment, an increase in the availability of treatment may cause individuals to update their infection prior upward, and in so increase the relative benefit of testing and receiving treatment. If the availability of treatment leads individuals to adjust their belief in the likelihood that they are HIV positive upward, this brings about a further increase in the expected benefit of testing. In a similar vein, Oster et al. [2013] examines the possibility of, and finds behavior consistent with, belief selection in the context of the decision to test for Huntington's Disease.

In the early 2000s in Malawi the government provided VCT and ART at no charge at the selected public facilities[2] [Makwiza et al., 2009]. Thus the direct cost of purchasing a test or treatment does not influence our analysis. However in the United States, where receiving treatment is costly, Sood and Wu [2013] find variation in testing across insured and uninsured individuals as ART became available in the 1990s, suggesting that out-of-pocket payments for treatment do in fact play a role in the decision to test. There are other costs besides the actual purchasing of medical care that may influence the effect of treatment availability on the

[2] The government also highly subsidized the provision of ART in the private sector. However, in 2006 only 4% of individuals on ART were accessing it through the private sector [Makwiza et al., 2009].

decision to test. In rural African settings, transportation to facilities providing health care can be a significant burden particularly with respect to ART [Lankowski et al., 2014]. Transportation costs are important as once on treatment an individual will need to make repeated trips to their providing facility for checkups with physicians and to receive additional medication. Thus, in this study we exploit proximity to facilities providing ART as plausibly exogenous variation in the costliness of accessing treatment.

There are also likely psychological costs associated with knowing that one is HIV positive that may act as barriers to testing. These may arise from fears of stigmatization, as well as fears of dying. The qualitative literature suggests that treatment availability should act to reduce these costs. Phakathi [2011] examines the question of whether or not the availability of treatment affects individuals' willingness to test in Kwazulu-Natal province, in South Africa, through interviews of potential testers. Respondents report that treatment reduces the hopelessness that individuals who believe themselves to be HIV positive may feel, and thus encourages them to test and learn their status. The availability of treatment is thought to reduce stigma, by improving the observed health of infected individuals, and reducing the prevalence of the notion that the disease is a death-sentence, which in turn increases individuals' willingness to learn their own HIV status [Musheke et al., 2013, Phakathi, 2011].

There are some health behaviors in developing settings, like the use of deworming tablets as in Kremer and Miguel [2007], where the magnitude of social externalities is sufficiently large relative to the private benefit to prevent adoption. With HIV testing and treatment, important epidemiological externalities arise from reduced transmission through decreased viral loads and changes in risky behavior. As such, it may be possible that individuals put-off testing under the belief that others will test and reduce risky behaviors or receive treatment. However with HIV testing, the private benefit when treatment is available is greater longevity and thus is of significant consequence and should outweigh the deterrent effect of externalities. The private benefit likely depends on the individual's perception of their risk of having contracted HIV, and thus on local HIV prevalence. If HIV prevalence were sufficiently low, this would imply a low likelihood of contracting HIV and thus a low private incentive to test. In areas with high HIV prevalence, as in Malawi, the private benefit of testing will be large.

3 The Rollout of ART in Malawi

Malawi is a poor landlocked country in southern central Africa, with a population, at present, of approximately 15.9 million. In 2010, adult prevalence was estimated to be 10%, with an estimated 910 000 individuals living with HIV/AIDS [UNAIDS, 2014]. Malawi's first HIV/AIDS case was detected in 1985. There was, however, initially only a limited and ineffective policy response and as such by 1999 there were an estimated 800 000 individuals infected with HIV/AIDS in Malawi. In 1999, Malawi's National AIDS Control Program devised the National Strategic Framework for HIV/AIDS Prevention. This plan was supported by Malawi's international development partners: DFID, USAID, the European Union, and others [Chimzizi et al., 2003]. By 2003 the number of HIV infected individuals was 900,000 with an estimated adult prevalence rate of 14.4% [Chimzizi et al., 2005a,b]. Of those an estimated 170,000 individuals were in immediate need of antiretroviral therapy [Chimzizi et al., 2005a]. In 2002 Malawi's application to the Global Fund to Fight AIDS, Tuberculosis and Malaria was successful and provided financial support for the implementation of the National Strategic Framework, including the public provision of treatment. Following the receipt of this financial support from the Global Fund in 2002, the scaling up of ART availability began in earnest. Additionally Malawi agreed to meet the goals set out by WHO's "3 by 5" plan to have 3 million HIV positive individuals on treatment in the developing world by 2005. The Malawi Ministry of Health realized that the targets of this ambitious plan would be unachievable in such a short period of time, however, adopting the required targets created the momentum to tackle the absence of treatment with urgency [Harries et al., 2011]. This commitment involved the widespread provision of antiretroviral therapy free of charge as well as increased access to voluntary counseling and testing. Initially, only a number of facilities were selected to provide ART. These were chosen based on their physical facilities and having the human resources to successfully administer the provision of ART [Libamba et al., 2006].

Figure 1 is a map showing the locations of facilities that were providing ART in 2004 (the "post" period for our analysis) and all other health facilities. As can be seen, the facilities selected to initially provide ART were geographically dispersed. Access to ART was provided in the poorer and more sparsely populated North Region as well as in the wealthier more densely populated Southern and Central Regions. Table 1 presents numbers of facilities providing ART and VCT, as well as the number of individuals having tested and received treatment drawn from administrative reports. Between 2002 and 2004, the number of facilities providing ART more than doubled, increasing from 9 to 24. In 2002, there had only been 1202 patients who had started ART, however, by the end of 2004 this figure had jumped to 13 183. While access to treatment was still extremely low relative to need, this jump represents a ten-fold increase in patients on treatment over a relatively small time period. While the analysis in this paper is limited to the initial period of scale-up, after 2004 the scale-up effort continued.

4 Empirical Strategy

4.1 Data

A variety of data are employed in this research. Individual-level survey data are drawn from the 2000 and 2004 Malawi Demographic and Health Surveys (DHS). The timing of these surveys coincides with before and after the initiation of ART scale-up in 2002. Due to these being repeated cross-sections, the same individuals are not followed over time. The sample is limited to the female DHS respondents as only a subsample of households were selected to include male interviews. The locations of DHS cluster centroids are available in this data, allowing for distances from DHS clusters to health facilities to be calculated. The estimation strategy employed in this paper relies on the distances from DHS clusters to health facilities to generate variation in accessibility of ART.

Facility-level data are drawn from a number of sources. Using government reports published by the HIV Unit of the Ministry of Health, we are able to identify which facilities were providing antiretroviral therapy in the post scale up initiation period. The locations of the health facilities are drawn from a 2002 census of health facilities conducted by the Japanese International Cooperation Agency (JICA). The facilities identified as providing ART are matched to the JICA census[3]. Additionally, using Ministry of Health reports and the JICA health facility census, we are also able to identify which facilities were offering VCT. This allows for the calculation of distances to nearest VCT facilities, which as discussed above have been identified as an important determinant of the decision to take up VCT or not.

Summary statistics for the sample under study are presented by wave and distance to the nearest ART facility in Table 2. While there was an only 3 percentage point increase in the fraction of people reporting having tested for individuals living further than 30km from an ART facility providing treatment in 2004, there was an 8 percentage point increase in the fraction reporting having tested among individuals living less than 30km from an ART facility. A naive differences-in-differences comparison, thus suggests the scale-up of treatment availability induced testing more among those for whom it was accessible (i.e. where individuals were closer to ART facilities), than where treatment was less accessible. Given however that individuals living further from ART facilities are less wealthy (less likely to own assets) and less educated, this simple comparison is not sufficient to identify whether or not the increase in testing was driven by increased treatment availability or other factors that are associated with being further from treatment facilities. Thus, we conduct a regression analysis where we are able to control for a variety of the many characteristics recorded by the DHS.

4.2 Empirical Approach

The ideal experimental approach to answering the question under consideration in this paper would be to randomly assign access to ART and observe testing behavior. This would be neither ethical, nor feasible. As such, we evaluate the natural experiment of Malawi's scaling-up of ART availability combined with heterogeneity in proximity to facilities beginning to provide ART. This empirical approach employed here is essentially a difference-in-differences approach. However, instead of having discrete and mutually exclusive treatment assignments as in a standard differences-in-differences setting, we use a continuous measure of "treatment",

[3]We are able to match 20 of the 24 facilities providing ART in 2004. Three of the remaining four are either military or police hospitals and as such not accessible to the general public. The last does not appear in the JICA census, or elsewhere.

namely distance to the nearest facility that began providing ART prior to the collection of the second wave of data. The main regressions are linear probability models of the following form:

$$Tested_{ijt} = \beta_0 + \beta_1 Post_t \times Dist_j + \beta_2 Post_t + \beta_3 Dist_j + \beta_4' x_{ijt} + \epsilon_{ijt}$$

where i indexes individuals, j indexes cluster and t indexes wave. $Tested_{ijt}$ is an indicator for whether or not respondent i reports ever having tested. $Post_t$ is an indicator for the 2004 wave. $Dist_j$ is the straight-line geodetic distance from cluster j to the nearest facility that provided ART by 2004 in hundreds of kilometers. Due to the rich set of covariates available in the DHS, we are able to control for a number of variables that could bias the estimates through omission. Control variables included are: personal characteristics (age, years of education, relationship to household head, literacy, ever married, number of children born in the last 5 years and in the last year), household characteristics (asset indicators, household size), cluster characteristics (distance to a facility providing VCT in 2002, distance to a facility providing VCT in 2004, distance to any health facility). Importantly we are able to control for reported prior sexual behavior including indicators for the timing of recent sexual activity, age at first intercourse, contraction of STDs, as well as knowledge of HIV. Additionally, for some specifications we include nearest ART facility fixed effects, which allows for the elimination of unobserved regional and ART facility heterogeneity. Given that the distance variable varies only at the level of the DHS cluster, we also cluster standard errors at the DHS cluster level. This is also important since DHS cluster locations are randomly perturbed to protect anonymity, and therefore there is random error in the calculated facility distances at the cluster level.

This approach, the use of spatial proximity to facilities providing ART, to estimating the effect of the rollout of ART has been used in other settings and to answer other questions. Baranov and Kohler [2013] and Baranov et al. [2013] have employed a similar differences-in-differences strategy to identify the effect of ART rollout in Malawi on mental health and labor market outcomes as well as the effect of ART rollout on human capital accumulation and savings. Additionally, Friedman [2014] uses a similar approach using DHS data and distance to ART facilities to identify the effect of ART availability on risky sexual behavior in Kenya as ART provision was scaled up after 2008.

In addition to the above simple specification a differences-in-differences-in-differences model is also estimated. We are able to add an additional layer of treatment through the construction of a variable indicating the likelihood of being HIV positive, referred to below as "Predicted HIV status". An important question regarding the effect of ART availability on testing is whether or not it induces individuals who are more or less likely to be HIV positive to test. The triple difference models allow this question to be addressed. The models estimated are of the form:

$$Tested_{ijt} = \beta_0 + \beta_1 Post_t \times Dist_{ijt} \times HIV_{ijt} + \beta_2 Post_t \times HIV_{ijt} + \beta_3 Post_t \times Dist_j + \beta_4 Dist_j \times HIV_{ijt}$$
$$+\beta_5 Post_t + \beta_6 HIV_{ijt} + \beta_7 Dist_j + \beta_8' x_{ijt} + \epsilon_{ijt}$$

Due to data limitations we are not able to use actual HIV status as this was only collected for a sub-sample of 2004 respondents. Instead however, using all of the covariates employed here, we predict HIV prevalence using a logit regression. Then, the estimates are used to construct an out of sample prediction for wave 1 respondents and the remainder of wave 2 respondents. A predicted HIV-status indicator variable is then constructed, taking the value of one if the predicted HIV probability was greater than 0.5. This allows us to assess the differential effects of ART scale up on individuals who are more likely to be HIV positive based on observed characteristics.

4.3 Was the scale-up of VCT correlated with distance to ART facilities?

An important threat to the validity of this empirical strategy is the expansion of access to voluntary counseling and testing simultaneous to the expansion in the provision ART. Proximity to VCT facilities has been empirically identified as an important determinant of the take-up of testing [Thornton, 2008]. Prior to 2002 the government had provided ELISA testing which could only be conducted in a small number of relatively large public facilities. In 2002 the government shifted to rapid testing, allowing tests to be conducted at many more isolated less-well resourced facilities. This facilitated the expansion of access to VCT in areas where it had previously not been available. If it were the case that the increase in access to VCT was greater in areas nearer to ART facilities, this would suggest an alternative explanation for any observed increase in testing closer to ART facilities. However, this is unlikely to be the case as the expansion in testing expanded VCT to many minor health facilities when it had initially only been available in a few major facilities. This suggests that the reduction in distance to the nearest facility providing VCT should in fact be positively correlated with distance to a 2004 ART facility. Figure 2 is a scatter plot of the change in distance to the nearest VCT facility by distance from ART facilities for only the 2004 DHS clusters[4]. As can be observed, there is a greater reduction in distance needed to travel to access VCT for individuals who were further from ART facilities. Thus, if anything the change in the provision of VCT would bias the magnitude of the estimated effect of ART facility proximity on testing downwards.

5 Results and Discussion

5.1 Did ART scale-up induce testing?

This section presents a discussion of the results of the regression estimates making up the empirical analysis of the paper. Figure 3 presents non-parametric estimates of reported testing on distance from facilities providing ART. As can be seen, there was a greater increase in reported testing from the first wave to the second wave among individuals residing closer to facilities providing ART in 2004. The results of the main differences-in-differences regressions are presented in Table 3. The coefficient of interest is on the interaction of the post indicator with distance to an ART facility. If it was observed that the increase in testing between the pre and post periods was lower for individuals who were further from a facility providing treatment in the post period, the sign of the coefficient on the interaction term should be negative. The sign of the estimated coefficient on the interaction term is negative in all specifications and is significantly different from zero at the one percent confidence level in 5 of the specifications. Distances are entered in this regression in 100s

[4]As the spatial distribution of DHS clusters is very similar in 2000 and 2004, it is irrelevant which year is chosen.

of kilometers, thus the magnitude of the coefficient lends itself to the following interpretation: for every 10 kilometers further from a facility providing ART in the post period the increase in the likelihood of reporting having tested decreases by 0.77 percentage points[5]. While this seems small, given that over this period the overall increase in reporting testing was only approximately 5 percentage points[6], the magnitude of the estimate suggests increased proximity to ART facilities was an important determinant of the increase in testing over this period. This result is robust to a variety of specifications and the inclusion of a number of important controls. In particular, we include controls regarding prior sexual behavior and riskiness of prior sexual behavior - a significant measure of individuals' risk of having contracted HIV and therefore individual's private incentive for learning HIV status. Another important set of controls included, is proximity to VCT facilities in the pre and post period. The point estimates are quantitatively and qualitatively similar across specifications and with the inclusion of nearest ART facility fixed effects.

It is possible that this differential testing response to ART availability is driven by the fact that the facilities chosen to initially provide ART were more likely to be in urban areas and as such that the individuals nearby these facilities may be systematically different to individuals residing further from these initial ART facilities, and thus may respond differently to the arrival of an effective HIV treatment. To address this concern, we stratify the sample by respondents reported as being urban or rural, and estimate the main regressions with ART facility fixed effects. The results are robust to the limiting of the sample to these urban and rural sub-samples.

5.2 Who did ART availability induce to test?

When examining policy aimed at HIV/AIDS, an important question is who responds to the particular policy intervention[7]. The desired outcomes of increased testing are the linkage of infected individuals to treatment and reductions in risky behavior, both of which hinge on HIV positive individuals testing and learning their

[5] This is the point estimate from Column 7 of Table 3 multiplied by 1/10.

[6] See Table 2.

[7] Kremer [1994] illustrates this point by showing that reductions in risky behavior may lead to increases in HIV prevalence if only low-risk individuals decrease risky behavior.

status. Therefore, an important question is whether or not the expansion of ART availability induced HIV positive individuals to test. To answer this question we construct a predicted HIV status and estimate a differences-in-differences-in-differences regression.

Since HIV testing was only conducted in the 2004 DHS, we cannot use actual HIV status to identify heterogeneity in the effect of the scale-up. Instead we estimate a logit model of HIV status on all of the observable characteristics used in this study using only the 2004 data. We then construct a predicted probability of being HIV positive for both waves using the estimates from the 2004 wave. Then we generate an indicator variable, predicted HIV status, identifying whether or not the predicted probability of being HIV positive is greater than 0.5. Using this predicted HIV status, we then estimate triple difference models. These regressions are estimated separately for each of the regions, as well as for the full sample. If it's the case that individuals who are more likely to be HIV positive, at least based on observable characteristics, are more likely to respond to the change in availability of ART, the sign of the coefficient on the triple interaction term should be positive.

The results of the triple difference regressions presented in Table 4 suggest that in general there was not a differential response to ART availability among individuals who are more likely to be HIV positive - that is, the estimated coefficient on the triple interaction term is not significantly different from zero. There is, however, some regional heterogeneity in this result - the coefficient on the triple interaction term is positive and statistically significant for the Northern region. The signs on the double interaction terms (i.e. post and ART distance interactions) are generally consistent with the results from the main regressions. These results for the Northern region suggest that although the increase in the likelihood of ever having tested is decreasing in distance from an ART facility, this negative effect is smaller in magnitude for individuals who were more likely to test positive. Additionally, the coefficient on the predicted HIV status term is negative, suggesting that in general HIV positive individuals were less likely to test.

5.3 Falsification checks

In order to confirm that the observed effects of ART availability on testing behaviors are in fact caused by the ART expansion and not by other unobserved factors, we conduct a number of falsification checks. It is possible that there is some unobserved increase in the demand for testing that is correlated with proximity to ART facilities that is driving the observed increase in ever tested being correlated with proximity to ART facilities. While it is not possible to directly observe or test this, we propose an indirect test. In particular, the DHS asks respondents whether or not they know where to get an HIV test. If there is some unobserved increase in demand, this should be correlated with individuals reporting knowing where to get a test. This unobserved demand could be associated with messaging campaigns or the localized diffusion of information. Thus, as a falsification test, we estimate the main regressions again, however, with the dependent variable being whether or not individuals report knowing where to get tested, as opposed to whether or not the individuals actually report ever testing. As can be seen in Table 5, the post interaction with ART distance is in fact significant and positive. This suggests there was a differential increase in knowing where to go to test further from ART facilities. Thus there was a greater increase in knowing where to get tested further from ART facilities, despite the increase in reported testing being lower further from ART facilities. This suggests that an increase in demand for testing driven by an unobserved factor correlated with ART distance is unlikely responsible for the greater increase reported testing closer to ART facilities.

As an additional falsification check, we construct a set of placebo ART facilities. These are a set of 20 facilities[8] randomly selected from the JICA health facility census that, importantly, were not providing ART. As these facilities were not providing ART, proximity to these facilities should not be affecting the decision to test over the time period under study if treatment is a salient determinant of the decision to test. As such, in a regression of ever tested, the coefficient on the post distance interaction should not be significantly different from zero. The results of these placebo regressions are presented in Table 5. As expected, there is no effect of distance to the placebo ART facilities on the change in testing. This provides additional support to the

[8]This is the same number of actual ART facilities used in this study.

hypothesis that it was the expansion in treatment that induced the increase in testing.

5.4 Limitations

The empirical approach in this paper is limited in a number of ways; these limitations are discussed briefly in this section. First, due to the timing of the roll-out and the timing of the DHS data collection, it is not possible to identify whether or not there were parallel trends in reported testing by distance from ART facilities prior to the study period. Earlier DHS waves (1992 and 1996) did not ask for reports of HIV testing. That said however, HIV emerged as a significant issue in Malawi only in the late nineties, when policy aimed at addressing the epidemic was formed and access to VCT and ART was expanded. Thus it is possible there is little meaningful variation in testing patterns prior to the beginning of the study period in 2000. Second, this analysis is limited to women. By not considering men the impact on an important sub-population cannot be identified. However, given women's greater vulnerability to contracting HIV, they are a critically important sub-population for whom to know the effect of ART availability on testing. Third, the dependent variable is whether or not the respondent reports ever having tested for HIV. This may be under-reported and there could be changes in the extent of under-reporting over time that may affect the results. A priori it is not possible to assess how under-reporting may be related to proximity to ART facilities.

6 Conclusion

This paper has examined empirically the effect of the roll out of an effective HIV treatment on the decision to test. The availability of a suitable and effective treatment increases expected survival probabilities conditional on being HIV positive, and thus the expected benefit to learning one's HIV status. Thus, as treatment becomes available, individuals should be more likely to test. To identify an increase in availability we proxy access to treatment with distance to the nearest facility providing ART, noting that receiving treatment involves trips to providing facilities and that in developing regions transportation costs are not trivial. The estimates of the main regressions suggest that between 2000 and 2004, for every additional 10 km individuals were from a facility providing ART the increase in the likelihood of testing decreased by slightly under one percentage point, controlling for sexual behavior and distance to testing facilities. The results therefore suggest that increased availability of treatment increased testing. Additionally, to identify heterogeneity in this effect, triple difference regressions were estimated, where the additional layer of treatment comes from predicted HIV status. There is some regional variation in these triple difference results, where, in the Northern Region the findings suggest that individuals who were more likely to be HIV positive were more likely to be induced to test by the increase in the availability of treatment, but the same is not true in other regions.

The availability of treatment has emerged as a key component of any HIV prevention strategy. Conventionally, the effect of treatment in this regard is viewed through the lens of reduced viral loads and reduced infectiousness among infected individuals. However, this paper has provided empirical evidence on another pathway through which treatment may induce preventative behaviors, namely testing and its associated reductions in risky behavior. The triple difference results suggest that the availability of treatment induced people in the Northern Region of Malawi who were more likely to be HIV to test, thus suggesting that this policy may have induced reductions in risky behavior based on prior findings regarding reductions in risky behavior among individuals who learn they are HIV positive.

Based on the findings in this paper, we can make some suggestions for policy. The results suggest that the emphasis on expanding access to ART should be continued. The results reveal, based on the effect of distance to ART facilities on testing behavior, distance to ART facilities to be a salient measure of access to treatment. Thus, there is a role for reducing the burden of transportation costs in facilitating access to treatment. This could be achieved either through expanded geographic coverage of facilities providing ART or potentially through subsidizing the costs of traveling to ART facilities to receive care.

References

Andrew Anglemyer, Tara Horvath, and George Rutherford. Antiretroviral therapy for prevention of hiv transmission in hiv-discordant couples. *JAMA*, 310(15):1619–1620, 2013.

Victoria Baranov and Hans-Peter Kohler. The impact of aids treatment on savings and human capital investment in malawi. 2013.

Victoria Baranov, Daniel Bennett, and Hans-Peter Kohler. The indirect impact of antiretroviral therapy. 2013.

David Canning. The economics of hiv/aids in low-income countries: the case for prevention. *The Journal of Economic Perspectives*, 20(3):121–142, 2006.

Rhebab Chimzizi, Anthony Harries, Francis Gausi, Mwansambo, Felix Salaniponi, and Rex Mpazanje. Report of a country-wide survey of hiv/aids and joint hiv-tb services in malawi. Technical report, Ministry of Health, National AIDS Council, National Tuberculosis Control Programme, 2003.

Rhebab Chimzizi, Francis Gausi, John Aberle-Grasse, Perry Killam, Mindy Hochgesang, Felix Salaniponi, and Edwin Libamba. Report of a country-wide survey of HIV/AIDS services in malawi for the year 2004. Technical report, Ministry of Health, National AIDS Council, Centers for Disease Control and Prevention, 2005a.

Rhebab Chimzizi, Anthony Harries, Francis Gausi, C. Golombe, E. Manda, A. Khonyongwa, F. M. Salaniponi, E. Libamba, E. J. Schouten, A. Mwansambo, and R. Mpazanje. Scaling up HIV/AIDS and joint HIV-TB services in malawi [notes from the field]. *The International Journal of Tuberculosis and Lung Disease*, 9(5):582–584, May 2005b. URL `http://www.ingentaconnect.com/content/iuatld/ijtld/2005/00000009/00000005/art00020`.

Myron S Cohen, Marybeth McCauley, and Theresa R Gamble. Hiv treatment as prevention and hptn 052. *Current opinion in HIV and AIDS*, 7(2):99, 2012.

Nicole Crepaz, Cynthia M Lyles, Richard J Wolitski, Warren F Passin, Sima M Rama, Jeffrey H Herbst, David W Purcell, Robert M Malow, Ron Stall, HIV/AIDS Prevention Research Synthesis (PRS) Team, et al. Do prevention interventions reduce hiv risk behaviours among people living with hiv? a meta-analytic review of controlled trials. *Aids*, 20(2):143–157, 2006.

Willa Friedman. Antiretroviral drug access and behavior change. January 2014.

Reuben M Granich, Charles F Gilks, Christopher Dye, Kevin M De Cock, and Brian G Williams. Universal voluntary hiv testing with immediate antiretroviral therapy as a strategy for elimination of hiv transmission: a mathematical model. *The Lancet*, 373(9657):48–57, 2009.

Anthony D Harries, Simon Makombe, Edwin Libamba, and Erik J Schouten. Why did the scale-up of HIV treatment work?: A case example from malawi. *Journal of Acquired Immune Deficiency Syndromes*, 57 (Supplement 2), August 2011.

Louise C. Ivers, David Kendrick, and Karen Doucette. Efficacy of antiretroviral therapy programs in resource-poor settings: A meta-analysis of the published literature. *Clinical Infectious Diseases*, 41(2):217–224, 2005. doi: 10.1086/431199. URL `http://cid.oxfordjournals.org/content/41/2/217.abstract`.

Michael Kremer. Can having fewer partners increase prevalence of aids? Technical report, National Bureau of Economic Research, 1994.

Michael Kremer and Edward Miguel. The illusion of sustainability. *The Quarterly Journal of Economics*, 122 (3):1007–1065, 2007.

Darius Lakdawalla, Neeraj Sood, and Dana Goldman. Hiv breakthroughs and risky sexual behavior. *The Quarterly Journal of Economics*, 121(3):1063–1102, 2006. doi: 10.1162/qjec.121.3.1063. URL `http://qje.oxfordjournals.org/content/121/3/1063.abstract`.

Alexander J Lankowski, Mark J Siedner, David R Bangsberg, and Alexander C Tsai. Impact of geographic and transportation-related barriers on hiv outcomes in sub-saharan africa: A systematic review. *AIDS and behavior*, pages 1–25, 2014.

Edwin Libamba, Simon Makombe, Eustice Mhango, Olga de Ascurra Teck, Eddie Limbambala, Erik J Schouten, and Anthony D Harries. Supervision, monitoring and evaluation of nationwide scale-up of antiretroviral therapy in malawi. *Bulletin of the World Health Organization*, 84(4):320–326, 2006.

Ireen Makwiza, Lot Nyirenda, Grace Bongololo, Talumba Banda, Rhehab Chimzizi, and Sally Theobald. Who has access to counseling and testing and anti-retroviral therapy in malawi–an equity analysis. *International Journal for Equity in Health*, 8(1):13, 2009.

Stephane Mechoulan. Hiv testing: A trojan horse? *Topics in Economic Analysis & Policy*, 4(1), 2004.

Maurice Musheke, Harriet Ntalasha, Sara Gari, Oran Mckenzie, Virginia Bond, Adriane Martin-Hilber, Sonja Merten, et al. A systematic review of qualitative findings on factors enabling and deterring uptake of hiv testing in sub-saharan africa. *BMC public health*, 13(1):220, 2013.

Emily Oster, Ira Shoulson, and E Dorsey. Optimal expectations and limited medical testing: Evidence from huntington disease. *The American Economic Review*, 103(2):804–830, 2013.

Zipho Phakathi. The influence of antiretroviral treatment on willingness to test: a qualitative study in rural kwazulu-natal, south africa. *African Journal of AIDS Research*, 10(2):173–180, 2011.

Viviana Simon, David D Ho, and Quarraisha Abdool Karim. Hiv/aids epidemiology, pathogenesis, prevention, and treatment. *The Lancet*, 368(9534):489 – 504, 2006. ISSN 0140-6736. doi: http://dx.doi.org/10.1016/S0140-6736(06)69157-5. URL http://www.sciencedirect.com/science/article/pii/S0140673606691575.

Neeraj Sood and Yanyu Wu. The impact of insurance and hiv treatment technology on hiv testing. Working Paper 19397, National Bureau of Economic Research, September 2013. URL http://www.nber.org/papers/w19397.

Harsha Thirumurthy, Joshua Graff Zivin, and Markus Goldstein. The economic impact of aids treatment: Labor supply in western kenya. *Journal of Human Resources*, 43(3):511–552, 2008. doi: 10.3368/jhr.43.3.511. URL http://jhr.uwpress.org/content/43/3/511.abstract.

Rebecca L. Thornton. The demand for, and impact of, learning hiv status. *American Economic Review*, 98(5):1829–63, 2008. doi: 10.1257/aer.98.5.1829. URL http://www.aeaweb.org/articles.php?doi=10.1257/aer.98.5.1829.

UNAIDS. Global report: Unaids report on the global aids epidemic 2013, 2013.

UNAIDS. Aidsinfo, 05 2014. URL http://www.unaids.org/en/dataanalysis/datatools/aidsinfo/.

Zoe Warwick. The influence of antiretroviral therapy on the uptake of hiv testing in tutume, botswana. *International journal of STD & AIDS*, 17(7):479–481, 2006.

Lance S Weinhardt, Michael P Carey, Blair T Johnson, and Nicole L Bickham. Effects of hiv counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985-1997. *American journal of public health*, 89(9):1397–1405, 1999.

WHO. Programmatic update: Antiretroviral treatment as prevention (tasp) of hiv and tb. Technical report, World Health Organization, 2012.

Nicholas Wilson. Antiretroviral therapy and demand for hiv testing: Evidence from zambia. Department of Economics Working Papers 2010-23, Department of Economics, Williams College, October 2010. URL http://ideas.repec.org/p/wil/wileco/2010-23.html.

Table 1: ART Scale-up

	2002	2003	2004
ART scale-up:			
Number of facilities providing ART	3	9	24
Number of patients started on ART	1202	3703	6769
Cumulative number of patients started on ART	1202	6414	13183
VCT scale-up:			
Number of VCT sites	70	118	146
Total number of HIV tests done	149540	215269	283467

Source: Chimzizi et al., [2005]

Table 2: Summary Statistics

	Distance<30km				Distance >30km				Any Distance			
	Wave 1		Wave 2		Wave 1		Wave 2		Wave 1		Wave 2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Testing:												
Ever tested	0.107	0.309	0.186	0.389	0.073	0.260	0.104	0.306	0.091	0.288	0.147	0.354
Know where to test	0.762	0.426	0.873	0.333	0.653	0.476	0.778	0.416	0.711	0.453	0.828	0.378
Personal Characteristics:												
Age (yrs)	27.580	9.258	27.711	9.150	27.886	9.417	27.767	9.147	27.724	9.334	27.738	9.148
Educate (yrs)	4.571	3.700	5.032	3.927	3.870	3.456	4.099	3.606	4.241	3.604	4.583	3.805
Literate	0.620	0.485	0.667	0.472	0.537	0.499	0.554	0.497	0.581	0.493	0.612	0.487
Household Characteristics:												
Own radio	0.852	1.195	0.803	0.925	0.724	1.116	0.759	0.957	0.792	1.160	0.782	0.941
Own television	0.270	1.225	0.201	0.926	0.190	1.095	0.157	0.931	0.233	1.167	0.180	0.929
Own bicycle	0.656	1.236	0.560	1.036	0.660	1.126	0.631	1.028	0.658	1.186	0.594	1.033
Own car or truck	0.232	1.217	0.149	0.995	0.187	1.095	0.147	0.981	0.211	1.161	0.148	0.988
Electricity	0.324	1.234	0.228	0.959	0.216	1.102	0.185	1.025	0.273	1.175	0.207	0.992
Number of members	5.530	2.741	5.225	2.367	5.515	2.721	5.543	2.492	5.523	2.731	5.378	2.433
Urban	0.295	0.456	0.206	0.404	0.129	0.335	0.069	0.254	0.217	0.412	0.140	0.347
Fertility and Marriage:												
Ever married	0.815	0.388	0.828	0.378	0.840	0.367	0.848	0.359	0.827	0.378	0.837	0.369
Age at first marriage	17.425	3.213	17.462	3.233	17.384	3.271	17.326	3.291	17.405	3.241	17.396	3.262
Number of births in last five years	0.857	0.870	0.872	0.840	0.953	0.879	0.998	0.885	0.902	0.875	0.932	0.865
Number of births in last year	0.213	0.420	0.211	0.416	0.231	0.434	0.243	0.437	0.222	0.427	0.226	0.427
Sexual Behavior:												
Never had sex	0.103	0.304	0.104	0.305	0.104	0.306	0.107	0.309	0.104	0.305	0.105	0.307
Age at first intercourse	16.226	2.786	16.186	2.486	16.286	2.624	16.502	2.665	16.254	2.712	16.336	2.578
Condom used at last sex	0.054	0.226	0.052	0.222	0.047	0.212	0.043	0.204	0.051	0.220	0.048	0.214
STD contracted in last 12 months	0.016	0.189	0.070	0.701	0.020	0.257	0.062	0.681	0.018	0.223	0.066	0.691
HIV/AIDS:												
Prevalence			0.175	0.380			0.119	0.324			0.147	0.354
Predicted prevalence	0.217	0.412	0.198	0.398	0.189	0.392	0.174	0.379	0.204	0.403	0.186	0.389
Distances:												
To any health facility (km)	3.793	2.345	3.739	2.173	4.983	3.513	5.261	3.314	4.352	3.012	4.471	2.883
To 2002 VCT facility (km)	10.792	7.499	11.396	7.404	19.225	12.710	21.400	13.887	14.757	11.112	16.209	12.091
To 2004 VCT facility (km)	7.902	6.128	8.015	6.094	13.190	9.782	14.511	10.664	10.389	8.476	11.140	9.193

Notes: Distance refers to distance from cluster centroid to nearest facility providing ART in 2004.

Table 3: Regression Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ever tested	Ever tested	Ever tested	Ever tested	Ever tested	Ever tested	Ever tested
Post × Distance to ART facility	-0.0426*	-0.0590***	-0.0775***	-0.0648**	-0.113**	-0.0787***	-0.0770***
	(0.0222)	(0.0223)	(0.0248)	(0.0300)	(0.0527)	(0.0232)	(0.0230)
Post	0.0676***	0.0770***	0.0736***	0.0668***	0.0933***	0.0763***	0.0752***
	(0.0114)	(0.0112)	(0.0126)	(0.0156)	(0.0200)	(0.0117)	(0.0116)
Distance to ART facility	-0.0425***	-0.0317***	-0.0138	-0.0101	-0.0255	0.00983	0.0117
	(0.0107)	(0.0109)	(0.0112)	(0.0119)	(0.0280)	(0.0156)	(0.0153)
Distance to any facility	0.223**	0.234**	0.224**	0.181	0.495	0.176*	0.217**
	(0.0983)	(0.0984)	(0.105)	(0.111)	(0.404)	(0.103)	(0.103)
Distance to 2002 VCT facilities	-0.0612**	-0.0326	-0.0430	-0.0489	0.0482	-0.0880**	-0.0910**
	(0.0287)	(0.0291)	(0.0305)	(0.0313)	(0.138)	(0.0366)	(0.0371)
Distance to 2004 VCT facilities	0.0704*	0.0448	0.0620	0.0658	-0.180	0.102**	0.0873*
	(0.0403)	(0.0404)	(0.0422)	(0.0440)	(0.204)	(0.0481)	(0.0475)
Age	-0.000544**	-0.000631**	-0.000776**	-0.000477	-0.00281***	-0.000701**	-0.000688**
	(0.000244)	(0.000259)	(0.000319)	(0.000324)	(0.000992)	(0.000322)	(0.000320)
Education	0.0125***	0.0106***	0.00790***	0.00801***	0.00606*	0.00843***	0.00848***
	(0.00145)	(0.00139)	(0.00154)	(0.00150)	(0.00338)	(0.00160)	(0.00161)
Constant	0.130***	0.111***	0.833***	0.871***	0.813***	0.825***	0.848***
	(0.0167)	(0.0167)	(0.0488)	(0.0324)	(0.0714)	(0.0522)	(0.0672)
Additional controls:							
Personal characteristics	Y	Y	Y	Y	Y	Y	Y
Household characteristics	N	Y	Y	Y	Y	Y	Y
Fertility	N	N	Y	Y	Y	Y	Y
Sexual Behavior	N	N	Y	Y	Y	Y	Y
HIV/AIDS Knowledge	N	N	N	Y	Y	Y	Y
Region	N	N	N	N	N	N	Y
Urban only	N	N	N	N	Y	N	N
Rural only	N	N	N	Y	N	N	N
Nearest ART Facility FEs	N	N	N	N	N	Y	Y
Observations	24,463	24,405	19,171	15,857	3,314	19,171	19,171
R-squared	0.038	0.042	0.070	0.058	0.079	0.079	0.080

Personal characteristics includes relationship to household head, literacy, and religion. Household characteristics include asset indicators, whether or not the house has electricity, the number of household members, and whether or not the household is in an urban area. Fertility includes the number of births in the last year and in the last five years. Sexual behavior includes indicators for the timing of recent sexual activity. HIV/AIDS knowledge includes whether or not the individual reports knowing about HIV or AIDS. Robust standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Triple Difference Estimates

	(1) Ever tested	(2) Ever tested	(3) Ever tested	(4) Ever tested	(5) Ever tested
Post × Distance to ART facility × Predicted HIV status	-0.0145	0.0104	-0.0184	0.00536	0.218**
	(0.0191)	(0.0688)	(0.121)	(0.151)	(0.106)
Post × Predicted HIV status	-0.00779	0.00601	0.0288	0.0120	-0.174***
	(0.0136)	(0.0308)	(0.0401)	(0.0711)	(0.0636)
Post × Distance to ART facility	0.0511***	-0.0788***	-0.0719*	-0.0881**	-0.125**
	(0.0170)	(0.0240)	(0.0374)	(0.0422)	(0.0558)
Distance to ART facility × Predicted HIV status	0.0173	0.0382	0.0646	0.0251	-0.0571
	(0.0182)	(0.0459)	(0.0767)	(0.0913)	(0.0865)
Post	0.0408***	0.0757***	0.0782***	0.0574***	0.131***
	(0.0106)	(0.0121)	(0.0163)	(0.0219)	(0.0353)
Distance to ART facility	-0.0618***	0.00676	0.0534*	-0.00776	-0.00323
	(0.0135)	(0.0155)	(0.0300)	(0.0263)	(0.0251)
Predicted HIV status	-0.0323***	-0.100***	-0.127***	-0.0715	-0.0323
	(0.0101)	(0.0216)	(0.0272)	(0.0478)	(0.0556)
Constant	0.120***	0.905***	0.892***	0.938***	-0.00553
	(0.00675)	(0.0533)	(0.103)	(0.0850)	(0.0637)
Additional controls:					
Facility distances	Y	Y	Y	Y	Y
Personal characteristics	Y	Y	Y	Y	Y
Household characteristics	Y	Y	Y	Y	Y
Fertility	Y	Y	Y	Y	Y
Sexual Behavior	Y	Y	Y	Y	Y
HIV/AIDS Knowledge	Y	Y	Y	Y	Y
Nearest ART facility FEs	N	Y	Y	Y	Y
Region	All	All	Southern	Central	Northern
Observations	24,488	19,171	9,866	6,704	2,601
R-squared	0.012	0.081	0.090	0.073	0.094

Personal characteristics includes relationship to household head, literacy, and religion. Household characteristics include asset indicators, whether or not the house has electricity, the number of household members, and whether or not the household is in an urban area. Fertility includes the number of births in the last year and in the last five years. Sexual behavior includes indicators for the timing of recent sexual activity. HIV/AIDS knowledge includes whether or not the individual reports knowing about HIV or AIDS. Robust standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Falsification Checks

	(1) Ever tested	(2) Ever tested	(3) Know where to test	(4) Know where to test
Post × Distance to placebo ART facility	-0.0119	-0.0280		
	(0.0341)	(0.0332)		
Distance to placebo ART facility	-0.0220	0.0176		
	(0.0158)	(0.0220)		
Post × Distance to ART facility			0.0818***	0.0769***
			(0.0312)	(0.0295)
Distance to ART facility			-0.151***	-0.118***
			(0.0262)	(0.0277)
Post	0.0505***	0.0577***	0.0874***	0.0875***
	(0.0128)	(0.0128)	(0.0136)	(0.0126)
Constant	0.838***	0.827***	0.816***	0.825***
	(0.0390)	(0.0440)	(0.0845)	(0.0634)
Additional controls:				
Facility distances	Y	Y	Y	Y
Personal characteristics	Y	Y	Y	Y
Household characteristics	Y	Y	Y	Y
Fertility	Y	Y	Y	Y
Sexual Behavior	Y	Y	Y	Y
HIV/AIDS Knowledge	Y	Y	Y	Y
Nearest ART facility FEs	N	Y	N	Y
Observations	19,171	19,171	19,173	19,173
R-squared	0.068	0.078	0.100	0.111

Facility distances includes distance from cluster to any nearest health facility, and distances to VCT facilities. Personal characteristics includes age, education, relationship to household head, literacy, and religion. Household characteristics include asset indicators, whether or not the house has electricity, the number of household members, and whether or not the household is in an urban area. Fertility includes the number of births in the last year and in the last five years. Sexual behavior includes indicators for the timing of recent sexual activity. HIV/AIDS knowledge includes whether or not the individual reports knowing about HIV or AIDS. Robust standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

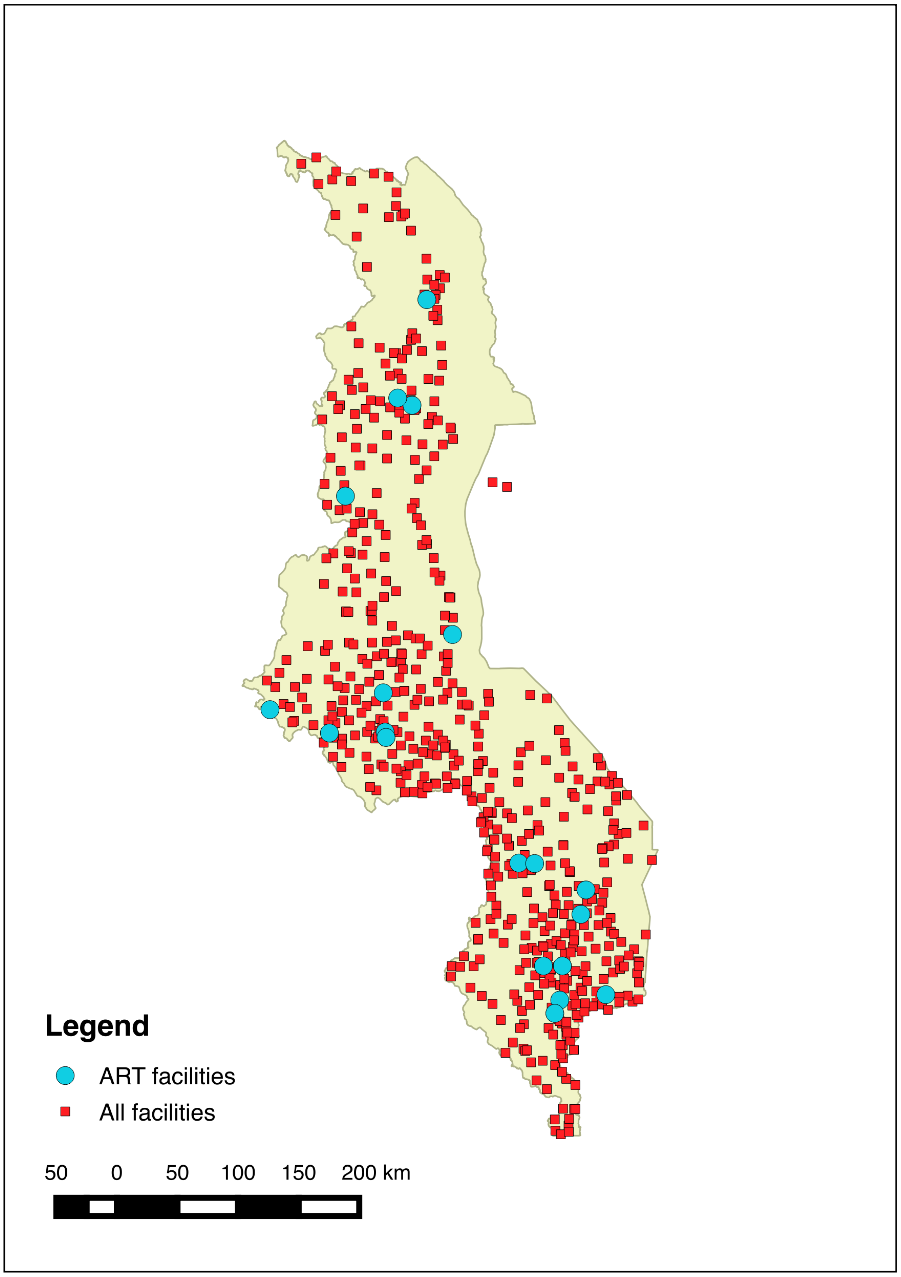

Figure 1: Facilities providing ART in 2004

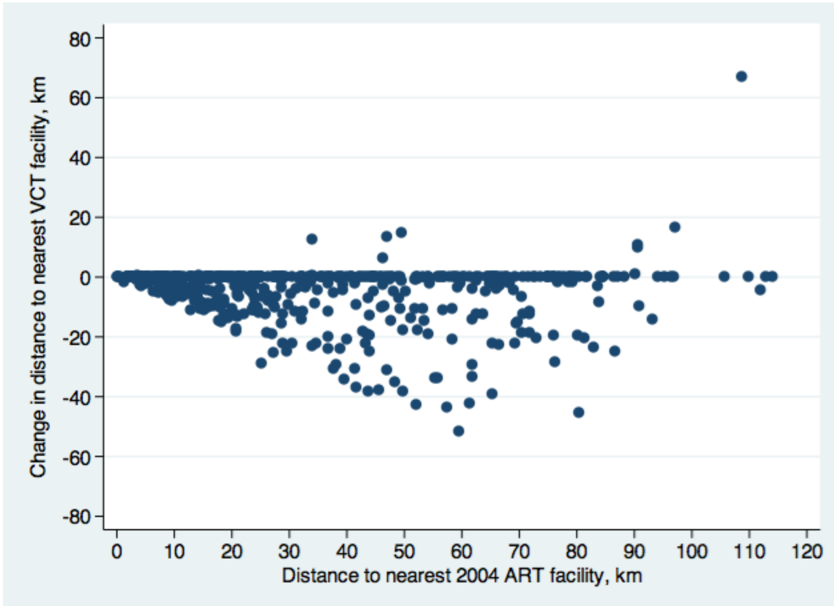

Figure 2: Change in distance to nearest VCT facility by distance to nearest 2004 ART facility for 2004 DHS Clusters

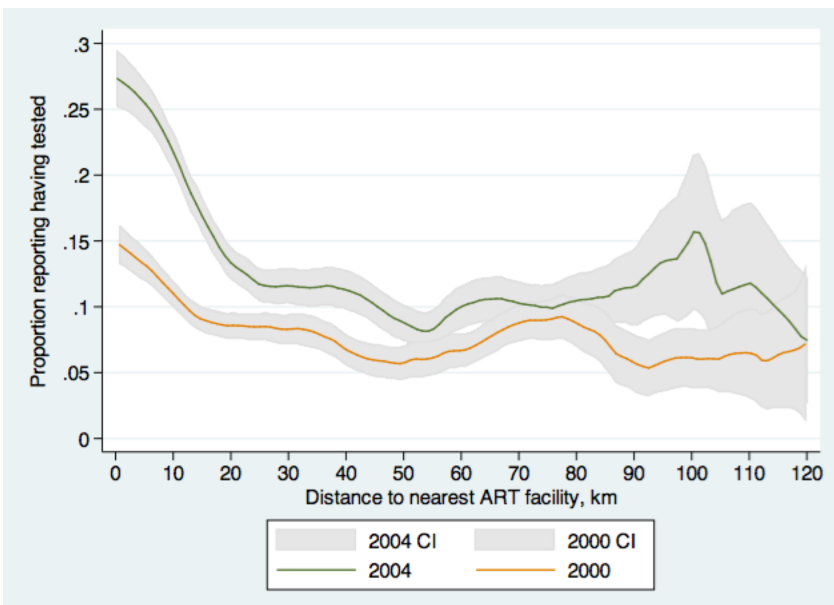

Figure 3: Proportion reporting having tested by distance to 2004 ART facility