The Effect of Access to AIDS Treatment on Employment Outcomes in South Africa

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Abstract

Antiretroviral (ARV) drug treatment for AIDS dramatically improves health status and increases life expectancy, but there is little evidence on whether it improves employment outcomes in developing countries. In this paper, I examine the labor market effects of the government provision of free ARV treatment in public health clinics in South Africa, which enrolled over 500,000 patients between 2004 and 2008. I use geographic and temporal variation in the program rollout to identify the causal impact of ARV treatment on labor force participation and employment. This study is the first evaluation of the largest AIDS treatment program in the world. When a clinic opens nearby, labor force participation and employment rise for Black men but there are no discernible effects for women. An increase in the fraction of the population of a neighborhood receiving treatment decreases participation and raises employment for both men and women. These results suggest that AIDS treatment is under-supplied in South Africa if these positive labor market effects are not taken into account.

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1 Introduction

Researchers have established a robust causal link between health status and economic outcomes. Poor physical health can negatively affect economic outcomes by diminishing physical strength and stamina, impairing mental health, reducing productivity and causing absenteeism. South Africa is at risk to suffer a severe negative economic impact due to HIV/AIDS because its high HIV prevalence rate adds another obstacle to reducing high unemployment and high inequality. HIV strikes individuals in their prime productive years and has the potential for devastating effects because the disease is chronic, severely incapacitating in late stages, and eventually fatal. The morbidity and mortality associated with HIV/AIDS have been shown to affect household employment outcomes, consumption, savings behavior, educational attainment and investment in children (Bachmann and Booysen, 2003; Collins and Leibbrandt, 2007; Cohen, 2002; Beegle, 2005).

The labor market effects of HIV/AIDS are of particular importance because income levels constrain many household decisions. Households with HIV-positive (HIV+) members face increased expenditures for medical treatment and the specter of funeral costs, but their income is reduced due to illness or the need to care for sick household members. The direct and indirect costs of HIV contribute to the socio-economic vulnerability of these households, potentially reinforcing existing inequalities.

This study examines the economic impact of the government provision of free antiretroviral (ARV) drug treatment for AIDS in South Africa. ARV treatment offers promise as an effective policy intervention to improve the lives of the nearly 6 million South Africans who are HIV+. AIDS treatment dramatically improves health and increases life expectancy by about seven years (Bachmann, 2006). South Africa's ARV treatment program is the largest in the world even though it has only treated a fraction of the HIV+ population in South Africa (UNAIDS, 2008). The government began providing free ARV drugs in July 2004 – much later than most developing countries – but scaled up rapidly, increasing patient enrollment to about 350,000 by September 2007.

South Africa has high unemployment rates compared to other middle-income countries, which may dampen any impact of ARVs on labor market outcomes. Unemployment peaked at 30.4 percent for ages 16 to 64 in September 2002 and still stood at 22.7 percent in September 2008 (Statistics South Africa). The unemployment rates for Black Africans, who constitute 80 percent of the population, are almost twice as high as those for Coloureds, Indians and Whites (the other three races in South Africa), which underscores the degree of racial inequality.[1]

A large literature focuses on the impact of health shocks on consumption and employment outcomes. However, many studies are plagued by reverse causality, selection bias and/or omitted variable bias.[2] These issues are particularly salient in the health literature because economic outcomes provide inputs for health status, and many unobserved factors that influence productivity also influence health. A few studies have overcome issues of endogeneity to obtain causal estimates. For example, Thomas et al. (2006) find that Indonesian adults randomly assigned to receive a weekly iron supplement were more likely to be working and appeared to have higher productivity. In another experimental study, Miguel and Kremer (2004) find that providing deworming drugs to Kenyan schoolchildren reduced absenteeism by one quarter. Mohanan (2008) uses exogenous variation in health due to bus accidents in India and finds that injuries lead to increased debt and reduced spending on festivals and education.

Despite the importance of determining the effect of HIV on labor market outcomes, our understanding of the nature of the causal relationship in Africa is limited to evidence from a few studies. Recent work has found a sizable negative impact on employment outcomes which likely accumulates as the disease progresses and may have especially devastating effects on the poorest households. Fox et al. (2004) find that tea plantation workers in Kenya who subsequently die of AIDS exhibit a 15 percent reduction in income compared to other workers. Murray et al. (2005) find a 30 percent higher rate of workplace injuries among recently-diagnosed HIV+ miners in South Africa compared to HIV- miners. Panel

[1] Coloureds are a mixed-race group descended from Whites, Malaysian slaves, and indigenous people who intermarried in the 1600s. Indians are descendents of immigrants from India.

[2] See Strauss and Thomas (1998) for further discussion.

data shows that these two groups had similar baseline levels of workplace injuries. In their study of mine workers in Botswana, Habyarimana et al. (2008) find that HIV+ workers experience a five-fold increase in absenteeism when they progress to AIDS. Using propensity score methods and nationally representative survey data, Levinsohn et al. (2010) find that being HIV+ leads to a 7 percentage point reduction in the likelihood of being employed in South Africa.[3]

Though the medical literature has documented strong evidence that ARVs improve the health of HIV+ individuals in both developed and developing countries, our knowledge of whether and how these improvements in health translate into economic outcomes in Africa comes from only small-scale studies.[4] ARV treatment is associated with increases in labor force participation and productivity. Thirumurthy et al. (2008) compare a sample of HIV+ individuals who participated in an ARV treatment program in Kenya to a random sample from the surrounding area. They observe increases of 8.5 percentage points in labor force participation and 4.6 percentage points in weekly hours worked for individuals on ARV treatment, with the largest increases observed within the first six months of ARV treatment initiation. They find that men are more likely to exhibit statistically significant changes in hours worked whereas women are more likely to change their labor force participation rates. Using time since ARV initiation as an instrument for HIV-related health status, Habyarimana et al. (2008) show that mine workers in Botswana experience a large reduction in absenteeism as health status improves in the 6-12 months following treatment inception, and these gains persist for at least four years. Larson et al. (2008) conservatively estimate that one year after initiating ARV treatment, tea pluckers in Kenya work twice as many days per month as they would in the absence of treatment. Using nearest-neighbor matching with panel data, Larson et al. (2009) find that after one year on ARVs, HIV+ women worked 30 percent fewer days plucking tea than the HIV- comparison group. There was no significant difference for men. Each of these

[3] See Levinsohn et al. (2010) for a more detailed discussion of these and other related studies.

[4] See Hammer et al. (1997), Hogg et al. (1998), Palella et al. (1998), Floridia et al. (2002), Laurent et al.(2002), Marins et al. (2003), Koenig et al. (2004), Coetzee et al. (2004), Wools-Kaloustian et al. (2006). ARVs are effective at raising white blood cell levels and reversing extreme weight loss, thereby improving overall health and increasing life expectancy by about seven years from the initiation of treatment.

Table 1: Geographic units in South Africa Census

Unit	Number in SA	Number in sample	Min	Max	Mean	Median
PSU	80,787	2,996	0.0075	1,460	20	6.4
Main Place	2,674	1,376	.0075	22,023	264	15.6
Municipality	253	253	92	11,351	1,860	732
District	53	53	635	48,939	8,118	5,910
Province	9	9	6,568	139,703	54,884	47,842

Table shows areas measured in square miles.

studies found statistically significantly better economic outcomes for individuals who were on an ARV treatment regimen, however, the identification strategies used by Habyarimana et al.(2008) and Larson et al. (2009) produce the most convincing causal effects.

In 2004, the South African government began the rollout of free ARVs in public health clinics. It was an ambitious government program that aimed to have one ARV clinic in each of 53 districts within the first year and a clinic in each of 253 municipalities within five years (Mbewu and Simelela 2003).[5] For most South Africans, this represented the first time that ARV treatment was accessible because ARVs were not widely available in South Africa prior to this program.[6] In the first three years of the program, 339 clinics opened and approximately 350,000 patients were enrolled on ARVs. A rollout of this size and scope presents an unprecedented opportunity to examine the effect of access to AIDS treatment at the national level.

This study is the first evaluation of the largest AIDS treatment program in the world.[7] It is also the first study, to my knowledge, to use such rich, nationally representative microeconomic data to address the impact of HIV/AIDS at the national level. I provide new evidence on the impact of AIDS treatment induced improvements in health status on economic outcomes, including spillover

[5]Table 1 compares the Census geographic units that are relevant to this study.

[6]While some private treatment options existed, they were generally conditional on employment, costly, or both.

[7]No internal Department of Health evaluations have been undertaken and the data have not previously been released to outside researchers.

effects within households and neighborhoods. The centralized accreditation process used to determine the timing of clinic opening provides an exogenous source of geographic and temporal variation in ARV access. This allows me to identify a plausibly causal effect of improved access to treatment on employment outcomes.

I combine newly available data from ARV treatment clinics with detailed, nationally representative economic outcome data. I take advantage of geographic and temporal variation in the ARV program rollout to determine the effect of access to ARV treatment on labor force participation and employment. I use detailed geographic coordinates to link data from the semi-annual South African Labour Force Survey (LFS) to data on patient enrollment at public ARV clinics. Having seven consecutive waves of the LFS data spanning September 2004 through September 2007 enables me to perform fixed effects (FE) estimation at the neighborhood level.

I find that after a clinic opens between 3 and 15 miles away, labor force participation rises by 2 percentage points for Black African men and employment rises by 3.3 percentage points. There are no discernible effects of the distance to the nearest clinic for women. As clinics grow over time, I find that a one percentage point increase in the fraction of the neighborhood population receiving treatment decreases labor force participation by 0.5 percentage points and raises employment by 0.4 percentage points for men. Women exhibit similar patterns.

Considering that my estimates average over the entire Black African population, including HIV+ individuals in the latent stage of HIV infection and HIV- individuals, the labor market impact for households that obtain ARV treatment is substantial. If these positive labor market effects aren't taken into account when designing health policy in South Africa, ARV treatment may be under-supplied.

The rest of this paper is organized as follows: Section I lays out the context for the ARV treatment rollout, Section II describes the data used for the analysis, Section III presents methods and results and Section IV concludes.

2 Context

This study examines the impact on employment outcomes of an improvement in health at an advanced stage of HIV infection. In South Africa, as in most developing countries, HIV+ individuals do not start highly-active anti-retroviral treatment (HAART) until approximately 8 to 10 years after initial infection, when a patient progresses to full-blown AIDS. ARVs are prescribed once a patient's white blood cell count (i.e. CD4 count) drops below 200 cells/cubic millimeter or they exhibit opportunistic infections or cancers characteristic of a depleted immune system.[8] Once patients are deemed eligible for ARVs, they must complete a 2-to-4-week adherence trial to ensure they are able to follow the daily medication regimen; only then will ARVs be prescribed. Patients exhibit dramatic improvements in health once the treatment is initiated. For example, Coetzee et al. (2004) found that within three months of treatment initiation, the percent of patients with a viral load below 400 copies/ml had increased from zero percent to 88 percent, which is accompanied by improvements in overall health.

2.1 Conceptual Framework

The dramatic improvement in health brought about by ARV treatment should raise the productivity of sick workers which would increase labor force participation, search activity, employment and wage income. Improved access to ARVs can also affect employment outcomes through changes in expectations for individuals who may require treatment in the future. ARV treatment extends life expectancy by approximately seven years: individuals are likely to survive about eight years after treatment initiation compared to one year or less without treatment (Coetzee et al. 2004). Because the increase in life expectancy comes within ten years for anyone who is already HIV+, it would have a larger impact on behavior than a similar change in life expectancy that is only realized in old age. The cost of losing twenty years of life is higher in youth than in old age and with discounting, even a similar cost would mean less further into the future.

[8] The list of diseases includes tuberculosis, Kaposi's sarcoma, fungal infections and some viral infections that a full-strength immune system would be able to fight. See World Health Organization (2005) for additional information.

Increased access to treatment will produce a temporal spillover effect as individuals who know or suspect they are HIV+ increase labor market attachment in response to improved access to treatment they will need in the future. On the other hand, intra-household effects could lead to the crowding out of the labor force participation of some members of the household. We might see no change in household-level employment rates, for example, if the primary breadwinner returning to the labor force after being ill allows a secondary earner to leave the workforce with no reduction of household income. Positive effects will spill over within the household if family or extended family members, usually women or young adults, are released from caretaking responsibilities and are therefore able to pursue employment outside the home. The size and direction of the impact observed depends on the relative magnitudes of these effects.

Because my data are nationally representative, I am able to examine the equilibrium effects of changes on the labor supply-side. A priori and without demand-side data, it is unclear whether more healthy workers in the local labor force would increase unemployment or put downward pressure on wages. I expect to see the largest effect on participation and search activity because these changes can happen virtually overnight. The effect on employment is likely to be smaller because of the lags involved in obtaining employment and the labor demand-side factors that may limit hiring.

There are two reasons there may be a lag between obtaining access to ARV treatment and any change in labor market outcomes. First, it takes 3 to 6 months after enrollment in a treatment program for a patient to realize the initial health improvements from ARVs and longer for the full health benefits to come to fruition. Second, though individuals can adjust their labor supply almost immediately, it generally takes time to obtain employment, especially in the South African labor market.[9]

[9]McLaren (2010) shows that in the South African labor market, it can take 6-12 months for an increase in individual labor force participation to result in a change in employment status.

2.2 Description of the Rollout

The South African government began providing ARVs in public health clinics in July 2004, after a long delay caused by lack of political support. ARV provision was a highly politicized issue because the President and Health Minister, despite ample scientific evidence to the contrary, had perpetuated myths that HIV did not cause AIDS and that ARVs were ineffective (Nattrass, 2007). Meanwhile, South Africa's northern neighbor, Botswana, launched its national ARV treatment program in December 2001, two and a half years before South Africa would begin enrolling patients (Chigwedere et al. 2008). The South African treatment program was initiated following a civil disobedience initiative by the Treatment Action Campaign, a non-governmental organization which demanded that the government provide life-saving ARV drugs to its citizens (Nattrass, 2007).

The government's stated goal was to provide "equitable" access to AIDS treatment within every locality so that every South African would have access to these services and historically under-served districts would receive the same standard of care as more advantaged districts (Mbewu and Simelela, 2003). The Department of Health (DOH) conducted a centralized accreditation process to ensure that the proposed ARV treatment facilities were equipped to provide a standard quality of care. The minimum requirements for accreditation included having an on-site team of clinicians, nurses and nutritionists, access to care 24 hours a day, access to lab services, access to a pharmacy with secure drug storage facilities, adequate on-site consultation space and a patient tracking and monitoring system.[10]

Provincial governments were tasked with heading up the implementation of the clinic rollout and were granted a fair amount of autonomy. Provincial departments of health identified facilities that would apply for accreditation and shepherded clinics through the process. Provinces selected facilities with the following goals in mind: establishing one clinic per district (and once that had been achieved, one clinic per sub-district); selecting facilities that could meet the re-

[10]Though this appears to be an extensive list, the requirements "largely coincide with current standard operating procedures and practices at public health care facilities in South Africa" and the government pledged that "additional financial and technical resources [would] be deployed to service points in resource-constrained or underserved areas" to help them meet the requirements (Mbewu and Simelela, 2003).

quirements for accreditation within one year; opening additional clinics in districts with large AIDS populations; and choosing geographic locations that would keep transportation costs low for patients in the service area.[11] The national DOH evaluated applications from these clinics, provided feedback and made on-site visits to determine whether the criteria for accreditation had been fulfilled. There was high demand for accreditation once the process began and the small DOH accreditation team struggled to keep up with the demand.[12] The accreditation process created the main bottleneck in delivering ARV treatment to a particular location. In most cases, proposed ARV treatment centers were already providing other HIV/AIDS care on-site so they were able to start enrolling patients from this pool in the ARV program immediately following accreditation.[13]

The pattern of clinic openings provides additional evidence that the accreditation process was the primary determinant of the pace of the rollout. Clinics opened around the country at a fairly constant rate over the period in question. There was variance across the nine provinces in the number of clinics opening each month with Kwa-Zulu Natal opening half of its clinics by early 2005 while the Free State had only opened half of its clinics by mid-2006. On-site accreditation visits were conducted individually and not in one particular geographic area at a time, however, some temporal clustering of clinic openings by province is evident from the data.[14] The nine provinces vary widely in their resource endowment, management competence and political efficacy, so it is not surprising that there was wide variation in effectiveness at the provincial level for this program. Gauteng, Western Cape and Northwest Province scaled up quite quickly in the early periods; in fact, the Western Cape had begun planning for clinics prior to the official commencement date of the program (Venter 2006). Venter (2006) suggests that poor management and lack of political resolve accounted for some provinces lagging behind in the rollout.

[11]Mbewu and Simelela, (2003); Personal communication with Andronica Ratshefola, former Assistant Director for the Comprehensive HIV and AIDS Care, Management and Treatment Program, 29 July 2009.

[12]Ratshefola, personal communication, 29 July 2009.

[13]Other HIV/AIDS care included HIV testing, counseling and treatment of tuberculosis and opportunistic infections. It is important to note that adding ARV drugs to this treatment regimen considerably improved the effectiveness of care.

[14]This is partially due to provincial plans that set monthly or quarterly goals for accreditation.

During the period of study, the demand for ARV treatment far exceeded the supply and there was queueing for appointments at every clinic site.[15] Enrollment capacity was determined by the national DOH guidelines for the maximum allowable ratio of enrolled patients to health workers (Mbewu and Simelela, 2003). Staff numbers were set during the accreditation process and were therefore unlikely to change from month to month in response to any changes in demand.[16] Monthly enrollment rates at each clinic corroborate that: patients were enrolled at each clinic at a fairly constant rate over the period of study.

The best measure of access to ARV treatment is the distance from a neighborhood to the nearest open clinic since the cost of travel tends to be directly related to the distance travelled in South Africa. One legacy of the Apartheid era is that transportation costs are generally high because there are limited public transportation options.[17] A change in the distance to the nearest AIDS treatment clinic should affect the likelihood that an individual seeks treatment. Figure 1 shows that though there was substantial variation in the distance to the nearest clinic in September 2004 near the beginning of the rollout; by March 2006 half the neighborhoods in the sample were less than 8.5 miles from the nearest clinic. South Africans may obtain ARV treatment at any public clinic in the country, but most will attend the nearest clinic to keep travel costs down.[18] In fact, travel costs were cited as a primary obstacle to obtaining access.[19] Travel costs can add up since multiple visits are required to determine eligibility for ARV treatment and to monitor adherence and toxicity. ARV patients must return to the clinic about four times in the first two months, and then either monthly, or quarterly if there are no complications.[20]

[15]Personal communication with Francois Venter, President of the Southern African HIV Clinicians Society and Clinical Director of the University of Witwatersrand Reproductive Health and HIV Research Unit, 27 July 2009.

[16]For these same reasons, the supply of care at ARV treatment sites was also likely to be unresponsive to changes in demand for other HIV care, which could arise due to differential HIV testing behavior once ARVs were available, for example.

[17]The Apartheid government took measures to limit the mobility of non-Whites.

[18]Though concerns about stigma may lead some individuals to avoid seeking treatment at the closest clinic, Rebecca Thornton (2008) finds that a small cash incentive was enough to overcome these types of psychological costs.

[19]Ratshefola, personal communication, 29 July 2009.

[20]Personal communication with Matthew Fox, Assistant Professor of International Health,

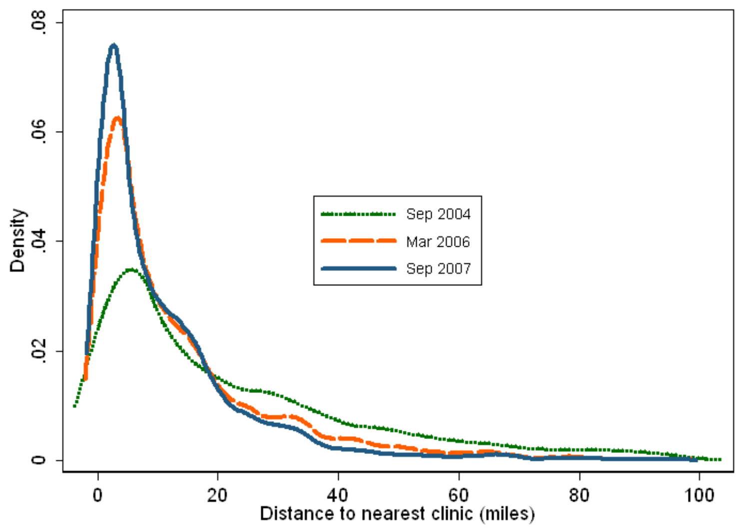

Figure 1: Density of distance to the nearest clinic over time

The number of patients receiving care through public clinics dwarfed the number of patients receiving care through private clinics. Private sector enrollment grew at a constant rate between 2004 and 2007. About 45,000 patients were in treatment in private clinics in October 2004, and the number of patients had only increased to 60,000 by mid-2005 and 67,600 by mid-2006 (Johnson, 2006; Johnson and McLeod, 2007). On the other hand, the public sector grew exponentially. It surpassed private enrollment in mid-2005 and by 2008 was almost six times as large. Because private insurance is costly and often tied to employment, public clinics serve a clientele that is more likely to be poor, unemployed and non-White.

3 Data

I create a new data set by linking detailed economic data from the South Africa Labour Force Survey (LFS) with Department of Health data from clinics providing ARV treatment. I obtained geographic coordinates of the ARV clinics and LFS neighborhoods which enables me to calculate the distance from a neighborhood to the nearest clinic as new clinics opened.

3.1 Labour Force Survey data

The LFS is the most comprehensive source of national microeconomic data in South Africa and is therefore particularly suited to an analysis of the economic impact of the ARV rollout. The survey collects detailed information about the labor market situation of individuals aged 15-65 years, and basic information about children and seniors, in a nationally representative sample of approximately 30,000 households. The questionnaire includes questions about demographic characteristics; biographical information; activities related to work; unemployment and non-economic activities; agricultural activities and uncompensated activities. The LFS is equivalent to the U.S. Current Population Survey, but is conducted only twice-yearly, in March and September.

I use seven waves of data for my analysis, from September 2004 (LFS wave 10) through September 2007 (LFS wave 16).[21] I use sampling weights provided by Statistics South Africa (StatsSA) in generating all my results. These weights correct for dwelling-unit non-response and are benchmarked to population estimates.[22] Though the LFS data were designed as a rotating panel, with approximately 20 percent of the households refreshed every wave, it is not possible to link observations between survey waves to create a true panel of individuals or households. The survey was not designed to track individuals across waves. However, neighborhoods can be linked over time using geographic coordinates. Employment status is derived according to standard International Labour Organization (ILO) definitions using responses to a series of questions in the survey.[23]

[21]These waves use a master sample based on the 2001 Census that was drawn for LFS wave 10 (September 2004). The survey continued to be conducted after September 2007; however, it used a new sampling frame and altered a number of the components of the survey. I do not have detailed geographic data for waves beyond September 2007 so I cannot incorporate them into the analysis at this time.

[22]The overall dwelling unit non-response rate is approximately 10 percent. The author imputed instances of item non-response to zero.

[23]The only difference from U.S. Bureau of Labor Statistics (BLS) definitions is that seasonal workers in the off-season are also considered out of the labor force (also known as not economically active), rather than as unemployed.

I link the LFS data with proprietary geographic information at the primary sampling unit (PSU) level. There are 2,996 PSUs in my sample, of which 441 are within one of the seven metropolitan areas. The PSUs range in size from 0.0075 square miles in dense urban areas to 1,460 square miles in the Karoo desert, but most are small. The distribution has a median area of 0.15 square miles, which roughly corresponds to the sixteen city blocks in Manhattan, and an average area of 6.4 square miles.[24]

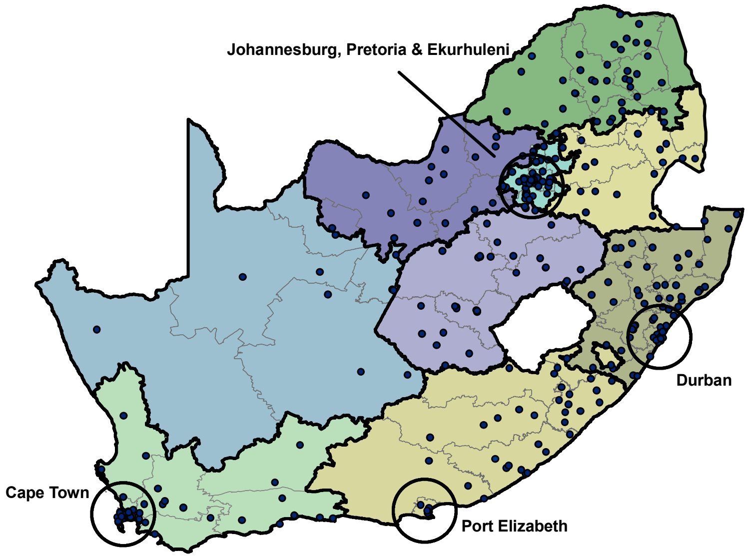

Figure 2: Geographic distribution of ARV clinics in September 2007
Map shows province boundaries (in black), district boundaries (in gray) and the six metropolitan areas (labeled).

3.2 Clinic enrollment data

The measures of access to treatment used in this analysis are derived from clinic-level reports of patient enrollment in ARV treatment. I use proprietary data collected by the South African Department of Health from all government-sponsored ARV clinics that opened between July 2004, when the rollout began, and September 2007. The data contain monthly reports of the cumulative number of patients

[24]The distribution is highly skewed: only ten neighborhoods are larger than 5,000 square miles.

Table 2: Type of ARV clinic by province for clinics open by September 2007.

Province	**% of Popn.**	**Health Center**	**Hospital**	**Total**
Eastern Cape	14	7	33	40
Free State	6	25	9	34
Gauteng	20	22	27	50
Kwa-Zulu Natal	21	13	57	70
Limpopo	12	1	35	36
Mpumalanga	7	0	19	19
Northern Cape	2	6	5	11
North West	8	2	21	23
Western Cape	10	27	30	58
Total	100	103	236	339
Percent		30.4	69.6	100

Column 2 shows percent of South African population residing in each province.

initiated on treatment at each clinic. Data on attrition due to death or loss to follow-up were not collected. However, because demand outstripped supply and supply was very inelastic over this period, the enrollment numbers are a good measure of the supply of treatment available at a particular time. I classified clinics as "open" once they had enrolled at least one patient.[25] The first fifty-three clinics opened in July 2004, and by September 2007 there were 339 clinics open in South Africa. Figure 3.1 shows that clinics were clustered in the main metropolitan areas, but otherwise were geographically widely dispersed. Approximately two-thirds of the clinics were in hospital facilities and one-third were in smaller health centers (see Table 2). Cumulative patient enrollment numbers increased from 5,574 in July 2004 to 357,292 in September 2007 .

[25] To my knowledge, clinics were never closed. However some failed to enroll a positive number of patients in a subsequent month (as reported in the DOH data), which is likely due to non-reporting.

4 Results

4.1 Empirical strategy 1

I use seven waves of the LFS to perform fixed effects (FE) estimation at the PSU level to control for bias due to time-invariant unobserved variables.[26] I estimate the following equation separately by gender for individual i in neighborhood j at time t:

$$Y_{ijt} = \beta_0 + \beta_1 nearest0to3mi_{ijt} + \beta_2 nearest3to15mi_{ijt} + \phi' X_{ijt} + \delta_t + \alpha_j + \epsilon_{ijt}, \quad (1)$$

where Y_{ijt} is an indicator variable for the outcome of interest, either labor force participation or employment, $nearest0to3mi_{ijt}$ is an indicator for the nearest open clinic being within 3 miles of the neighborhood centroid and $nearest3to15mi_{ijt}$ is an indicator for the nearest clinic being between 3 and 15 miles away.[27] The vector X includes the following covariates: age, age squared, years of primary education, years of secondary education, have completed a Matric (high school), have some post-Matric education, ever been married, spouse lives in household, number of adults in the household and number of children (aged 14 and under) in the household. I include a set of interactions between survey wave and district to control for district-specific time effects.[28] I restrict the sample to individuals between age 25 and 44 because the HIV prevalence rate peaks for men and women in this age group. Standard errors are clustered at the main place level, which is slightly larger than the neighborhood.

4.2 Empirical strategy 2

ARV treatment was highly rationed in South Africa because demand for treatment far exceeded the supply throughout the period of analysis (the first three years

[26] Fixed-effects estimation relies on the assumption that the mean of the outcome variable is stable over time. This is likely to hold in repeated cross sections and rotating panels (James J. Heckman and Richard Robb Jr., 1985). One exception is if there is selective attrition on unobservables, for example, due to differential AIDS death rates.

[27] These cut-off points correspond to the tertiles of the initial distribution of distance to the nearest clinic.

[28] Figure 3.1 shows the 53 districts outlined in grey.

of the rollout). Access to treatment can be measured by the ratio of treatment enrollment slots to the population at risk for needing treatment. South Africans may seek ARV treatment initiation at any clinic but are likely to use nearby clinics, though not necessarily the nearest clinic, to minimize transportation costs. I take into account the availability of treatment slots and the competition from other at-risk populations in the vicinity of each neighborhood. I use data on treatment enrollment by clinic to calculate the likelihood that an HIV+ individual in a particular neighborhood (PSU) is able to obtain a treatment enrollment slot.

Although only a fraction of HIV+ individuals have progressed beyond the latent stage of the disease and are in need of ARV treatment, I use the size of the HIV+ population as a good estimate of the relative size of the population at risk for needing ARV treatment. The vast majority of patients at public ARV clinics are Black African. I therefore calculate the size of the HIV+ population in a particular neighborhood by multiplying the Black African population in a neighborhood by the probability of being HIV+ in the municipality (m),

$$HIV^{+}Popn_j = BlackAfricanPopn_j * ProbHIV_m^{+}, \tag{2}$$

where the probability of being HIV+ is estimated by the HIV prevalence rate which is obtained from the 2005 SABSSMII survey.

I do not know which individuals in a neighborhood are obtaining ARV treatment nor do I know at which clinic individuals choose to obtain treatment. I therefore rely on the same assumption used in the first empirical strategy: that individuals are more likely to obtain treatment from a particular clinic the closer that clinic is. The demand for treatment is therefore inversely related to the distance to the nearest clinic,

$$DemandForTreatment_{jk} = \frac{HIV^{+}Popn_j}{Distance_{jk}} * 1(Distance_{jk} < radius). \tag{3}$$

I also assume that there is a maximum distance beyond which individuals will not travel to access a clinic. This enters the equation above as the $radius$, set to 50 miles in my analysis, which is the distance between a neighborhood and clinic beyond which demand is set to zero.[29] I use this estimated demand function as a weight in calculating the likelihood of an individual obtaining a treatment slot, where the denominator normalizes the weights to sum to one over all neighborhoods (J) for each clinic (k):

$$\frac{Demand_{jk}}{\sum_{j=1}^{J} Demand_{jk}}. \tag{4}$$

Recall that this $Demand_{jk}$ is zero for all neighborhood-clinic pairs that are beyond the distance specified by the radius.

Using the weight in Equation 4, I allocate patients enrolled at clinic k in time t to neighborhoods $j = 1, ..., J$ with probability proportional to the demand for treatment. The allocated patients are summed over all clinics to calculate the total number of treatment slots available to a particular neighborhood (PSU):

$$PSUTreatmentSlots_{jt} = \sum_{k=1}^{K} EnrolledPatients_{kt} * \left(\frac{Demand_{jk}}{\sum_{j=1}^{J} Demand_{jk}} \right). \tag{5}$$

I then calculate the likelihood of being treated in a particular neighborhood in time t as the number of treatment slots available to that neighborhood in Equation 5 scaled by the neighborhood population,

$$ProbabilityOfBeingTreated_{jt} = \frac{PSUTreatmentSlots_{jt}}{BlackAfricanPopn_j}, \tag{6}$$

where I use the PSU population from the 2001 South African Census so that changes in the probability of being treated come from changes in the availablility of treatment slots, and not from changes in the PSU population.

I estimate a similar fixed-effects regression as in Equation 1, where the treatment variables of interest are replaced with $ProbabilityOfBeingTreated_{jt}$:

$$Y_{ijt} = \beta_0 + \beta_1 ProbabilityOfBeingTreated_{jt} + \phi' X_{ijt} + \delta_t + \alpha_j + \epsilon_{ijt}, \tag{7}$$

and the rest of the specification is identical.

[29] The results do not change if I use log distance in Equation 3. Results do not change when the radius varies between 10 miles and 50 miles.

Table 3: Comparing characteristics at baseline and over time for Black men.

Variable	Nearer baseline	Farther baseline	t-Stat on diff.	Nearer change	Farther change	F-stat (wave)	P-val
Age	33.06	32.86	1.18	-0.12	-0.12	0.24	0.96
Yrs. of primary educ.	5.75	6.38	-7.88	0.30	0.02	1.30	0.25
Yrs. of secondary educ.	2.19	2.93	-8.22	0.30	0.17	0.37	0.90
Completed Matric (H.S.)	0.25	0.38	-6.00	0.03	0.02	1.17	0.32
Some post-Matric educ.	0.02	0.03	-2.00	-0.01	0.00	1.09	0.37
Never held a job	0.26	0.22	2.00	-0.03	-0.06	1.25	0.28
Ever married	0.45	0.46	-0.50	-0.06	-0.02	0.92	0.48
Spouse resides in hhold	0.33	0.37	-2.00	-0.03	-0.03	0.90	0.49
Number of adults in hhold	3.17	2.81	4.00	-0.04	-0.01	1.22	0.29
Number of kids in hhold	1.51	1.09	7.17	-0.02	-0.05	0.70	0.65
Senior in hhold	0.23	0.11	12.00	0.01	0.00	0.43	0.86
Lived here 6 months ago	0.97	0.96	1.00	-0.01	-0.04	0.71	0.64

Notes: Nearer defined as closer than median (7.5 miles) from nearest clinic in first wave of sample. Change defined as change in value of variable between first wave (Sept 2004) and last wave (Sept 2007) of sample. F-stat for joint test of the null of zero coefficients on the full set of wave dummies interacted with treatment dummy. Distance calculated from centroid of neighborhood to clinic location. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Standard errors clustered at the main place level.

4.3 Specification tests

Because I am identifying off changes within a neighborhood over time we would be concerned if neighborhoods with better access in September 2004 have different changes over time in underlying characteristics compared to neighborhoods with less access in September 2004. I compare those with better access to AIDS treatment clinics in September 2004 with those who have less access, splitting the sample at the median distance to the nearest clinic. I perform fixed effect regressions similar to my estimation equation, but I regress each X covariate on the other covariates, time dummies, and the set of time dummies interacted with an indicator variable for having better access to ARV treatment:

$$X_{k\_ijt} = \beta_0 + Near * \gamma_t + \gamma_t + \phi' X_{-k\_ijt} + \alpha_j + \epsilon_{ijt}. \quad (8)$$

Table 3 reports some descriptive statistics for the sample of Black men used in my analysis and results from these diagnostic regressions. The first two columns contain raw sample means of individual covariates for individuals who were nearer to clinics at baseline with those who were farther, respectively, and the third column presents the t-statistic on the difference in means. The fourth and fifth columns contain the change in the value of each characteristic between the baseline wave (September 2004) and the final wave in the sample (September 2007). The sixth column contains the F-statistic for the joint test of the null of zero coefficients on the full set of time dummies interacted with the dummy for more access ($Near$), and the seventh column contains the p-value for this F-statistic. The t-statistic on the difference between these raw means indicates a statistically significant difference on most covariates. However, the results from the F-test show that there are no significant differences over time between neighborhoods with more access and those with less, providing additional evidence that the variation in the timing of clinic opening was exogenous. When the analysis is repeated in Table 4 for the sample of Black women, there are only statistically significant differences over time in the proportion of individuals who lived in the same residence six months ago. Considering the number of coefficients involved in these tests, there are no more statistically significant tests than we might expect by chance. Additionally, it is clear from the values in columns 4 and 5 that these

Table 4: Comparing characteristics at baseline and over time for Black women.

Variable	Nearer baseline	Farther baseline	t-Stat on diff.	Nearer change	Farther change	F-stat (wave)	P-val
Age	33.42	32.97	3.00	-0.02	-0.05	0.22	0.97
Yrs. of primary educ.	5.77	6.37	-10.00	0.30	0.12	0.83	0.54
Yrs. of secondary educ.	2.18	2.88	-10.00	0.30	0.29	0.32	0.93
Completed Matric (H.S.)	0.24	0.33	-10.00	0.03	0.06	0.51	0.80
Some post-Matric educ.	0.01	0.03	-1.00	0.00	0.00	1.91	0.08
Never held a job	0.43	0.39	1.50	-0.05	-0.10	0.94	0.47
Ever married	0.56	0.54	1.00	-0.08	-0.04	1.81	0.09
Spouse resides in hhold	0.33	0.42	-4.50	-0.05	-0.03	1.87	0.08
Number of adults in hhold	3.33	3.08	3.57	-0.09	0.05	1.60	0.14
Number of kids in hhold	2.44	1.88	8.14	-0.05	-0.09	0.55	0.77
Senior in hhold	0.22	0.13	9.00	0.02	0.01	0.22	0.97
Lived here 6 months ago	0.98	0.98	0.00	-0.02	-0.03	2.83	0.01

Notes: Nearer defined as closer than median (7.5 miles) from nearest clinic in first wave of sample. Change defined as change in value of variable between first wave (Sept 2004) and last wave (Sept 2007) of sample. F-stat for joint test of the null of zero coefficients on the full set of wave dummies interacted with treatment dummy. Distance calculated from centroid of neighborhood to clinic location. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Standard errors clustered at the main place level.

differences are generally small.[30]

4.4 Results

Table 5 presents results for the likelihood of labor force participation in the first two columns and results for the likelihood of employment in the second two columns. All specifications include a set of individual characteristics and district-wave interactions. Fixed effects are included where indicated. Black men are 2 percentage points more likely to be labor force participants after a clinic opens between 3 and 15 miles of their residence compared to those who are between 15 and 75 miles from a clinic.[31] This effect is significant at the 90 percent confi-

[30]Results are nearly identical if the predicted proportion of the neighborhood being treated is used as the measure of access (not shown).

[31]Neighborhoods that are still more than 75 miles from the nearest clinic in September 2007 are excluded from the analysis in all waves because they are particularly remote and may differ systematically from other neighborhoods. Only 0.8 percent of the sample is dropped due to this

Table 5: The effect of the distance to the nearest clinic on the likelihood of labor force participation and employment for Black African men.

Dependent variable:	Participation		Employment	
Variable	(1)	(2)	(3)	(4)
Distance to nearest clinic < 3 miles	0.033***	0.007	0.012	0.018
	(0.011)	(0.013)	(0.012)	(0.014)
Distance to nearest clinic 3-15 miles	0.009	0.020*	0.009	0.033**
	(0.009)	(0.012)	(0.011)	(0.011)
Completed the Matric (High school)	0.025***	0.024***	0.060***	0.047***
	(0.009)	(0.008)	(0.010)	(0.010)
Completed some post-Matric education	0.049***	0.073***	0.125***	0.115***
	(0.014)	(0.011)	(0.018)	(0.020)
Spouse resides in household	0.033***	0.051***	0.057***	0.090***
	(0.007)	(0.008)	(0.010)	(0.011)
Number of adults in household	-0.030***	-0.025***	-0.057***	-0.049***
	(0.002)	(0.002)	(0.002)	(0.002)
PSU Fixed Effects	No	Yes	No	Yes
Number of obs.	61,593	61,593	61,593	61,593
R^2	0.15	0.25	0.23	0.34

Notes: Standard errors in parentheses are clustered at the main place level. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Omitted category is individuals who are 15-75 miles from the nearest clinic. *** - Significant at the 99% confidence level, ** - 95% level, * - 90% level.

dence level. Surprisingly, I do not find a significant impact when a clinic opens less than 3 miles away. The point estimate is smaller – 0.7 percentage points – but not statistically significantly smaller (F=1.06, p=0.30). For Black men, the impact of distance to the nearest clinic is similar for employment and labor force participation. There is a positive, but not significant, increase in employment of 1.8 percentage points when the distance to the nearest clinic is less than 3 miles. However, the likelihood of employment rises by 3.3 percentage points when the distance to the nearest clinic is between 3 and 15 miles. This result is significant at the 95 percent confidence level. There is a bigger impact of schooling on the likelihood of employment than on the likelihood of participation, as we would expect, and we observe similar patterns for the household composition characteristics for both participation and employment.

restriction. Health workers are also excluded from the sample.

The signs and magnitudes of the coefficients on the individual characteristics are what we would expect in the context of the South African labor market. The impact of having completed high school (the Matric examination) is statistically significant and about one third to one-half of the magnitude of the impact of having completed some post-Matric schooling. Individuals who have completed at least one year of schooling beyond the Matric (either a technical or university degree, or higher) have substantially higher labor force participation. Having a spouse in the household, conditional on marital status, is associated with increased labor force participation for men, but additional household members decreases the likelihood of participation.

For Black women, labor force participation and employment appear to be unaffected when the distance to the nearest clinic is below 15 miles; the point estimates are small and not statistically significant (see Table 6). Though the point estimates are positive and significant in the specification in column 1, when the fixed effects are added in column 2 the magnitude falls dramatically and the point estimates are no longer significant. Women exhibit a similar pattern in terms of employment. It appears that the likelihood of employment actually decreases by about 1 percentage point when the distance to the nearest clinic is between 3 and 15 miles, however, this point estimate is not significant. The returns to schooling in terms of participation and employment are larger for women than for men, especially for the impact of having some post-Matric education on the likelihood of employment. Women are less likely to participate or be employed if their spouse resides in the household. Having an additional adult in the household reduces the likelihood of participation and employment for women, but to a lesser degree than for men.

Table 7 presents results for the impact of the fraction of the neighborhood receiving treatment on participation and employment. The preferred specification in columns 2 and 4 shows an estimated reduction in the likelihood of participation of 0.5 percentage points when one percentage point more of the neighborhood population obtains access to treatment and 0.4 percentage points more likely to be employed. Women exhibit a similar pattern (see Table 8). They are slightly, though not statistically significantly, less likely to participate as the frac-

Table 6: The effect of the distance to the nearest clinic on the likelihood of labor force participation and employment for Black African women.

Dependent variable:	Participation		Employment	
Variable	(1)	(2)	(3)	(4)
Distance to nearest clinic < 3 miles	0.074***	0.002	0.034**	-0.000
	(0.013)	(0.017)	(0.016)	(0.018)
Distance to nearest clinic 3-15 miles	0.017*	-0.002	0.009	-0.011
	(0.010)	(0.013)	(0.010)	(0.011)
Completed the Matric (High school)	0.066***	0.057***	0.108***	0.082***
	(0.009)	(0.008)	(0.011)	(0.010)
Completed some post-Matric education	0.165***	0.127***	0.310***	0.207***
	(0.018)	(0.021)	(0.020)	(0.028)
Spouse resides in household	-0.023***	-0.058***	-0.038***	-0.067***
	(0.009)	(0.008)	(0.010)	(0.010)
Number of adults in household	-0.011***	-0.010***	-0.030***	-0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
PSU Fixed Effects	No	Yes	No	Yes
Number of obs.	76,413	76,413	76,413	76,413
R^2	0.11	0.20	0.13	0.24

Notes: Standard errors in parentheses are clustered at the main place level. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Omitted category is individuals who are 15-75 miles from the nearest clinic. *** - Significant at the 99% confidence level, ** - 95% level, * - 90% level.

tion treated grows, but they are 0.7 percentage points more likely to be employed when one percentage point more of the neighborhood population is treated. It is worth noting that the coefficients on the other covariates are virtually identical to the estimates from Empirical Strategy 1.

5 Discussion

This paper provides new evidence on the impact of improved access to AIDS treatment on employment outcomes in South Africa. Using geographic and temporal variation in the rollout of ARV clinics, I find that having a clinic between 3 and 15 miles away increases labor force participation by 2 percentage points and employment by 3.3 percentage points for Black men. There are no discernible effects of the distance to the nearest clinic for women. As clinics grow over time, I find that

Table 7: The effect of the fraction of the neighborhood receiving treatment on the likelihood of labor force participation and employment of Black African men.

Dependent variable:	Participation		Employment	
Variable	(1)	(2)	(3)	(4)
Fraction of neighborhood treated	0.000	-0.005**	-0.001	0.004**
	(0.001)	(0.002)	(0.001)	(0.002)
Completed the Matric (High school)	0.025***	0.024***	0.060***	0.047***
	(0.009)	(0.008)	(0.010)	(0.010)
Completed some post-Matric education	0.049**	0.073**	0.125***	0.115***
	(0.014)	(0.011)	(0.018)	(0.020)
Spouse resides in household	0.034**	0.051**	0.057***	0.090***
	(0.007)	(0.008)	(0.010)	(0.011)
Number of adults in household	-0.030**	-0.025**	-0.057***	-0.049***
	(0.002)	(0.002)	(0.002)	(0.002)
PSU Fixed Effects	No	Yes	No	Yes
Number of obs.	61,590	61,590	61,590	61,590
R^2	0.15	0.25	0.23	0.34

Notes: Standard errors in parentheses are clustered at the main place level. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Omitted category is individuals who are 15-75 miles from the nearest clinic. *** - Significant at the 99% confidence level, ** - 95% level, * - 90% level.

Table 8: The effect of the fraction of the neighborhood receiving treatment on the likelihood of labor force participation and employment of Black African Women.

Dependent variable:	Participation		Employment	
Variable	(1)	(2)	(3)	(4)
Fraction of neighborhood treated	0.003***	-0.003	0.003***	0.007***
	(0.001)	(0.003)	(0.001)	(0.002)
Completed the Matric (High school)	0.066***	0.057***	0.108***	0.082***
	(0.009)	(0.008)	(0.011)	(0.010)
Completed some post-Matric education	0.169***	0.127***	0.312***	0.207***
	(0.019)	(0.021)	(0.020)	(0.028)
Spouse resides in household	-0.022***	-0.058***	-0.038***	-0.067***
	(0.009)	(0.008)	(0.010)	(0.010)
Number of adults in household	-0.011***	-0.010***	-0.030***	-0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
PSU Fixed Effects	No	Yes	No	Yes
Number of obs.	76,405	76,405	76,405	76,405
R^2	0.11	0.20	0.13	0.24

Notes: Standard errors in parentheses are clustered at the main place level. Sample includes individuals aged 25-44 who live in households containing a 25-44 year old (including self). Omitted category is individuals who are 15-75 miles from the nearest clinic. *** - Significant at the 99% confidence level, ** - 95% level, * - 90% level.

a one percentage point increase in the fraction of the neighborhood population receiving treatment decreases labor force participation by 0.5 percentage points and raises employment by 0.4 percentage points for men. Women exhibit similar patterns.

Empirical Strategy 1 picks up the impact of having a clinic whereas Empirical Strategy 2 also picks up the effect of existing clinics growing over time. For Empirical Strategy 1, I expected the coefficient on the indicator for a clinic being within 3 miles to be larger than that for being between 3 and 15 miles. One explanation for the opposite result is that the most meaningful change in access for men is when the distance to the nearest clinic falls below 15 miles. It may reflect that neighborhoods with a clinic less than 3 miles away likely already have a clinic between 3 and 15 miles away and have already adjusted their labor market attachment accordingly. Also, nearer clinics may be newer clinics that have treated fewer people.

It is not surprising that improved access to ARV treatment, measured by the fraction of the neighborhood treated, leads to an increase in employment for men and women, however, the decrease in labor force participation for both sexes is unexpected. The 0.5 percentage point decrease in the likelihood of labor force participation for men may reflect a return to equilibrium for men who increased their participation in response to a clinic opening, but were unable to find work. It does not appear to reflect an increase in investment in education or training since enrollment in educational programs (broadly defined) does not rise over this period (results not shown). Further analysis is required to investigate these possibilities.

I observe a slightly larger impact on the likelihood of employment for women than for men, but the difference by gender is not statistically significant. I expected to find a larger effect for women than men for three reasons. First, the HIV prevalence rate among women is almost twice the rate among men (Shisana et al. 2005). Second, women generally outnumber men more than two-to-one at treatment facilities, exceeding the ratio that can be explained by differences in prevalence alone (Nattrass, 2008; Muula et al. 2007). Third, women are more likely to be exposed to spillover effects within the household because of their traditional role as care-givers.[32]

One limitation of this study is that I cannot examine outcomes separately by HIV status because my data lack information on individual HIV status.[33] I focus my analysis on the sample of households most likely to contain an HIV+ person based on the age profile of HIV prevalence, but cannot differentiate between households with an HIV+ member and those without. It is difficult to find household and individual characteristics that reliably predict HIV status other than race (Levinsohn et al. 2010). The treatment effect is heterogeneous along many dimensions: HIV status, the stages of HIV infection, an individual's perceived risk of acquiring HIV, and the number of household members that are infected. Individuals who have converted to AIDS should have a substantially larger treatment effect than those who believe they are unlikely to be HIV+ (regardless of their actual HIV status) and have no HIV+ household members.

My results underscore the potential benefits of providing targeted labor market interventions alongside the rollout of AIDS treatment. Considering that my estimates average over the entire population, including HIV- individuals and HIV+ individuals in the latent stage of HIV infection, the implied labor market impact for households that obtain ARV treatment is substantial. For example, if only the approximately 20 percent of men in the sample who are HIV+ are affected by access to treatment, then the estimated 2 percentage point increase in participation when a clinic opens nearby would imply a 10 percentage point increase for HIV+ men. This is slightly higher than the 8.5 percentage point increase found by Thirumurthy et al. (2008) for ARV patients, suggesting that latent HIV+ individuals do respond to improved access. If these positive labor market effects aren't taken into account when designing health policy in South Africa, ARV treatment may be under-supplied.

[32]I find evidence of spillover effects among older women aged 45-64 in households that include at least one member aged 25-44, but not in older women or men in households without prime-aged members. (Results not shown.)

[33]The design does, however, allow me to incorporate general equilibrium and spillover effects, which are not generally discernible from the typical ARV studies that collect information from ARV patients only, but not their households, neighborhoods or local labor markets.

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