HIV Treatment as Economic Stimulus: Community Spillover Effects of Mass ART Provision in Rural South Africa*

Jacob Bor (Boston University)
Zoë McLaren (University of Michigan)
Frank Tanser (Africa Centre)
Till Bärnighausen (Harvard University, Africa Centre)

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Abstract

Antiretroviral therapy (ART) enables HIV patients to remain in, or return to, the labor force. However, the spillover effects of mass ART provision on labor market outcomes of HIV-uninfected community members have not been measured. Economic theory predicts that rising labor supply among HIV-positives should reduce wages and employment levels among HIV-negatives. We assess the effect of local area ART coverage on labor market outcomes – separately for HIV-infected and HIV-uninfected adults – using longitudinal data on 21,868 individuals from a health and demographic surveillance system in rural South Africa (2001-2011). To obtain causal effects, we exploit differential rollout of ART by distance to clinic. ART scale-up led to large, statistically significant gains in employment. Contrary to our theoretical prediction, these gains were experienced by HIV-infected and HIV-uninfected community members alike. Ruling out household spillover effects as the explanation, our data suggest that ART scale-up may have led to an increase in labor demand. *JEL Codes: I15; J22; J23; O15.*

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INTRODUCTION

Antiretroviral therapy (ART) improves health and extends the life expectancy of people infected with HIV (Eggers et al. 2002; Palella et al. 1997). Since 2004, South Africa has provided ART free of charge at public sector clinics and hospitals, enrolling over 2 million patients by 2012 (Pillay 2013). South Africa has the largest number of people living with HIV (> 6 million) and the largest treatment program in the world. Mass ART provision has led to large improvements in population health. From 2003 to 2011, adult life expectancy in rural South Africa increased by 11.3 years at the population level (Bor et al. 2013).

In addition to its direct health benefits, ART also has economic impacts. The improved health of ART initiators increases their labor productivity and enables them to remain in or return to the labor force, work more hours and earn higher returns per hour worked (Thirumurthy et al. 2008; Larson et al. 2008; Habyarimana et al. 2010; Bor et al. 2012a). ART also has spillover effects on the households of patients initiating therapy, leading to changes in labor supply among other household members (Thirumurthy et al. 2008; Graff Zivin et al. 2009; Bor 2012); less time spent providing home-based care (D'Adda et al. 2009); and improved child health (Lucas & Wilson 2013) and education (Graff Zivin et al. 2009). Additionally, ART spares households the high costs of end-of-life health care and funeral expenses associated with HIV mortality (Ardington et al. 2014), insuring households against HIV-related losses of wealth (Bor et al. 2012b).

Although ART improves economic outcomes for HIV patients and their households, little is known about the spillover effects of ART rollout on other community members, including HIV-infected persons not yet on ART and people not (yet) infected with HIV. Community spillover effects of ART scale-up are theoretically ambiguous. By increasing labor supply among HIV-infected persons, mass ART provision could drive down wages and increase competition for existing jobs, negatively affecting incomes of HIV-uninfected community members. Theoretically, such an effect could largely offset the economic benefits of ART for HIV patients receiving therapy and their household members. (E.g., Young (2004) posited that HIV mortality would lead to improved labor market outcomes for survivors.) ART scale up could also raise labor demand as manufacturing firms reduce their capital-to-labor ratio in response to a healthier, more productive workforce (Marinescu 2014). The availability of ART could also lead to increased labor supply among HIV-uninfected adults by raising subjective survival expectations and improving mental health (Baranov, Bennett, Kohler 2014).

In the aggregate, ART scale-up has led to increases in labor supply and employment in South Africa, as shown in McLaren (2010), which exploits the initial placement of treatment facilities in the early days of the public sector ART rollout. These aggregate estimates include both the direct impacts on ART patients and their households and any potential labor market spillover effects on HIV-uninfected individuals. To date, no study has assessed the distribution of labor market impacts by HIV status and by household exposure to ART in South Africa.

This study uses data from the Africa Centre health and demographic surveillance site in rural KwaZulu-Natal to examine the distribution of the employment effects of ART scale-up. The Africa Centre has collected data on labor market outcomes, HIV biomarkers, and demographics through annual household surveys since 2001 on all households in a 438 km^2 surveillance area. These data have been linked at the individual level to complete clinical records from the public sector ART program. Using this unique dataset, we are able to identify the effect of community-level exposure to ART (proxied by distance to the nearest ART clinic) for different populations: HIV-infected people; HIV-uninfected people; and HIV-uninfected people living in households without any ART initiators.

We find large increases in aggregate employment, confirming previous evidence from South Africa (McLaren 2010). Employment rates rose by approximately 7 percentage points for respondents less than 5km from the nearest ART clinic relative to those 5-12kms away. Employment increased the most for HIV-infected people, but large gains in employment were observed for HIV-uninfected community members as well – contrary to our hypothesis that community spillovers would be negative.

There are a number of channels through which ART scale-up could affect labor market outcomes for HIV-uninfected community members. First, is a *subjective expectations* channel. Mass ART provision reduces perceived mortality risk and may improve mental health among community members who are HIV+ or at risk of becoming HIV+ (Okeke and Wagner 2013). This increases the returns to investment in human capital acquisition (increased educational attainment), job search (labor force participation) and work output (productivity) (Baranov and Kohler 2012; Baranov et al. 2014). Second, ART could affect labor supply of HIV-uninfected community members through a *health spillovers* channel. Untreated HIV increases the population prevalence of tuberculosis (and other infectious diseases), leading to higher exposure and incidence among persons not infected with HIV. The reduction in tuberculosis transmission from HIV+ individuals accessing ART may reduce absenteeism of HIV+ and HIV- individuals due to tuberculosis (Wood and Lawn 2011, Williams et al. 2010).

Third, along with these potential increases in labor supply, *shifts in labor demand* may also be driving changes in employment rates. Public sector treatment raises the average productivity of workers and partially insures firms against productivity losses from absenteeism, presenteeism, and turnover among HIV-infected workers. Additionally, the scale-up of ART may have had a direct employment effect due to increased hiring of health workers and auxiliary clinic staff. Finally, the increase in patient loads (ART patients must attend the clinic every month) may also stimulate market activity in the vicinity of ART clinics and may drive increases in employment among HIV-uninfected individuals.

Rising employment among HIV-uninfected community members with ART scale-up suggests that the economic benefits of ART are more broadly distributed than previously thought. These findings are important for the long-run political and fiscal sustainability of public sector disease-specific treatment programs. Additionally, our findings suggest that investments in health human capital may have important stimulus benefits and should be considered alongside more traditional infrastructure development as a component of fiscal policy in developing countries.

METHODS

Data and Study Population

We examine the impact of mass ART provision in the context of the Africa Centre's large demographic surveillance area in northern KwaZulu-Natal, a high-HIV burden region of South Africa that has been studied continuously since 2000. Data on employment status, labor force participation, and reasons for non-employment (education and other demographic, socioeconomic and health characteristics) were collected for all members of all households in the demographic surveillance area (438 sq. km). Household socioeconomic surveys were repeated approximately every two years from 2001 to 2007, and then annually through 2011, for a total of 7 survey waves. Data on the HIV status of respondents was collected through a population-based HIV biomarker surveillance (2003/2004) that had a 60% take-up/consent rate (Tanser 2008).

For the study population, the primary source of access to ART was through the local public-sector ART program, the Hlabisa HIV Treatment and Care Programme. HIV care and treatment are provided free of charge, though patients bear potentially large transport costs in accessing care (Chimbindi et al. 2015). Private sector care is rare in this community is especially rare for ART due to the high cost of antiretroviral drugs and the low rates of health insurance (Bor et al. 2013 *Science* appendix). During the period of study six of the health facilities in the surveillance area became accredited to providing

ART and began enrolling patients.[†] Dates of ART initiation from the Hlabisa HIV Treatment and Care Programme were obtained through individual level linkage of complete patient records to surveillance data. Distance from a person's place of residence (bounded structure) in 2004 to the nearest ART clinic was calculated for the complete population.

The study population was defined to include only those individuals who resided in the demographic surveillance area prior to 2004, and could thus be assigned a "distance to clinic" exposure that predated the scale-up of ART in 2004. We observed economic outcomes for migrants 18 years and over regardless of place of residence, so long as they continued to be members of a household in the surveillance area. Attrition due to loss to follow-up or permanent out-migration from the surveillance area was low, at a rate of 3.3 per 100 person-years. Including non-resident household members in the study is appropriate because they may return to the surveillance area to seek HIV care and treatment (Olgiati et al. 2012) or when they are dying (Welaga et al. 2009). The full dataset included 92,693 employment status observations from 21,868 individuals. The study population is extensively described in Tanser et al. (2008).

[†] From 2004 through 2010, HIV patients were eligible to initiate ART if they had a CD4 count <200 cells/μL (Department of Health 2004). In April 2010, eligibility was extended to pregnant women and patients with active TB with a CD4 count <350 cells/μL for (Department of Health 2010); and in August 2011 to all adults with a CD4 count <350 cells/μL (Hlabisa Hospital 2011).

Empirical strategy

We estimated difference-in-difference (DID) models, comparing outcomes for respondents living close to ART clinics (0-2km, 2-5km) with outcomes for people living far from clinics (5-12km), over the period 2001 – 2011. We estimated models of the form:

$$y_{it} = \alpha DTClinic_i + \beta year_{it} + \gamma year_{it} * DTClinic_i + \delta year_{it} * X_i + \eta_i + \epsilon_{it}$$

Our DID models consist of regressing a labor market outcome $\boldsymbol{y_i}$ on indicators for distance to clinic (0-2, 2-5, 5-12 [ref group] defined for 2003/4 residence), indicators for year of survey (2001, 2003/4 [ref group], 2005/7, 2008/9, 2010/11), and interactions between distance and survey wave which generates the DID coefficient matrix, $\boldsymbol{\gamma}$, our main set of outcomes. We also controlled for time-varying covariates, namely: the interaction of survey year with baseline demographic characteristics (age group, sex and education level triple interactions) and geographic characteristics (distance to major road, minor road, school). Where noted in the tables, we included individual fixed effects to adjust for time-invariant unobservable individual characteristics (α is not estimated in models with FE).

We estimated three sets of DID models. First, we assessed the effect of clinic proximity on ART coverage (the ART-to-population ratio) over time. Second, we analyzed labor market outcomes in the full study population, assessing the reduced form effect of clinic proximity on the probability of employment, labor force participation, and non-employment due to illness, over time. Third, we analyzed labor market outcomes separately by HIV status and by whether a person lived in a household with an ART initiator. We included 2001 data in our models as a check that trends were not differential prior to the scale-up of ART.

RESULTS

Community exposure to ART

Distance to an ART clinic was strongly related to the proportion of the population on ART, which is our best measure of community-level exposure to ART, including knowledge of the availability of ART and of its positive effects on health. Though the first patients were initiated on ART in July 2004, only approximately 0.1% of the population was initiated by the survey round in 2005 (Table 1). By the 2007 survey wave, 0.6 percent of the total population residing 5-12km from the ART clinic was initiated on ART and this rose by 1 to 1.6 percentage points each year, reaching a rate of 6.2 percent in 2011. Initiation rates were between 0.4 to 1.4 percentage points higher in the population residing 2-5km from the nearest ART clinic, but none of these estimates were statistically significant. We do observe statistically significantly higher initiation rates in the population residing closest to the ART clinics. From 2009 onwards initiation rates were 2.6 to 3.0 percentage points higher – a 50% higher probability of take-up compared to those who live furthest from the clinics.

Effects on labor market outcomes

As ART coverage increased from 2004 onwards, we found large and significant increases in employment among adults close to clinics relative to those living far from clinics (Table 2). These results were robust to inclusion of time-varying demographic and geographic controls, as well as individual level fixed effects. These 4 to 8 percentage point increases amount to 10-20% gains in employment off baseline employment rates of about 40%. As a check on our identifying assumption that observed changes were due to ART scale up, we found no evidence of pre-2004 trends in employment status (Table 2), which was the only employment outcome collected in 2001.

Labor force participation rates in the areas closer to clinics rose from 2005 to 2011, however these effects were smaller than the effects on employment. The largest increases were for respondents living 2-5km from the nearest ART clinic in the last two survey waves, which suggests an inverted U-shape. We found some evidence of reductions in reported non-employment due to illness as ART was scaled up (of borderline significance), but these changes only account for about 20% of the employment effect.

Effects on employment of HIV-infected and HIV-uninfected community members

To gain further insight into the distribution of economic impacts of ART scale-up and the potential spillover effects, we examined effects by HIV status (as measured in the 2003/4 HIV biomarker survey) and ART initiation status (as determined from clinical data) of respondents and their households to determine the relative sizes of the direct effect on HIV-positives versus the indirect effects on HIV-negatives.

We found large increases in employment among HIV-infected individuals with ART scale-up (Table 3). From 2004 to 2011, employment had risen by a statistically significant 12.3 percentage points for respondents within 2 km of the nearest ART clinic, relative to changes among respondents living 5-12 km from the nearest clinic.

However, we also found large increases in employment among HIV-uninfected individuals who do not live with individuals who ever initiated ART (Table 3). In 2008/9 and 2010/11, employment rates were between 5.6 and 7.0 percentage points higher for respondents within 5km from the nearest ART compared to those 5-12km away. Similar results hold for HIV-uninfected respondents who do not live with persons identified as HIV-infected from the 2003/4 biomarker survey.

DISCUSSION

In rural South Africa, ART scale-up has led to large gains in employment. Who has benefited from these large public investments in treatment for a single disease? Our results present new evidence of positive spillover effects of ART scale-up on employment of HIV-uninfected community members, through channels that operate outside the household. Given that one out of three adults is HIV-infected in this setting and fewer than one in ten adults are initiated on ART, the aggregate gains in employment are explained primarily by the gains among the HIV-negatives rather than the improved health of the HIV-positives. Our findings thus cast the distributional impacts of mass ART provision in new light.

In a general equilibrium setting, the theoretical predictions of an increase in labor supply of HIV-positives as ART scales up imply fewer employment opportunities for HIV-uninfected individuals as new entrants drive wages downwards and HIV-positives displace HIV-negatives from jobs and job queues. However, the increases in employment among HIV-uninfected community members suggest that ART scale up increased labor supply of

HIV-uninfected individuals and/or increased labor demand. Our results are consistent with increased labor demand as public ART provision raises the productivity of the average worker and partially insures firms against low productivity of HIV+ workers. We plan to supplement the analysis with data from national surveys to evaluate whether there is evidence of rising wages during this period. The primary limitation of our analysis is that we are unable to rule out the direct employment effect of ART clinics hiring workers or the stimulation of market activity near clinics. We anticipate addressing this in future drafts of the paper.

The previously ignored spillover benefit of ART on HIV-uninfected community members outweighs the direct economic effect of ART that has heretofore been the focus of most of the literature on ART provision in sub-Saharan Africa. The larger implication of our results is that the literature is likely to have underestimated the drain on the total economy caused by the HIV epidemic (and the economic benefits of treating or preventing HIV) by failing to adequately measure the economic spillovers on HIV-negatives.

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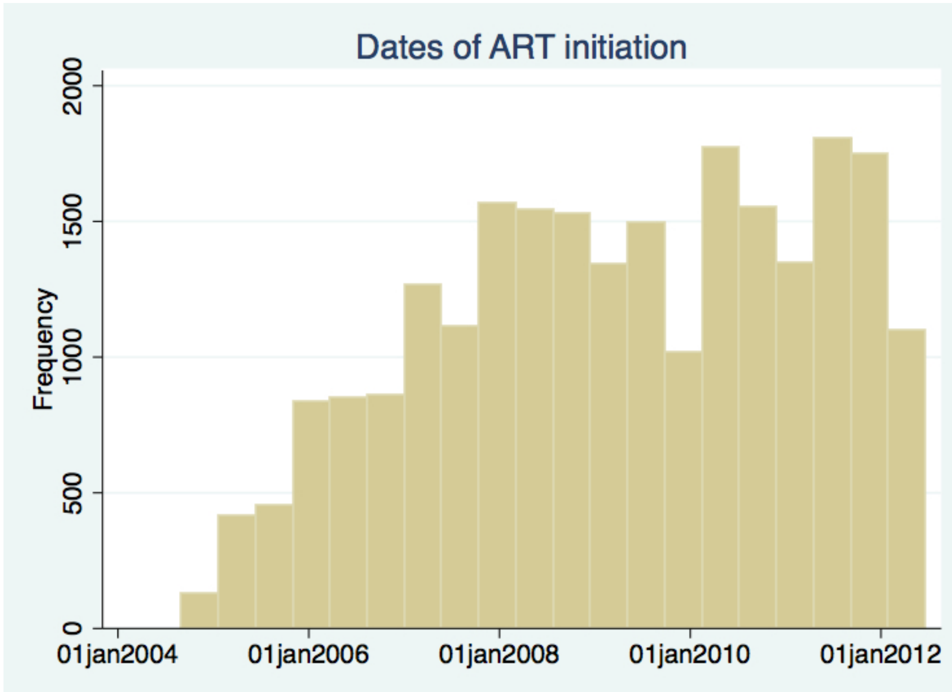

Fig 1. Scale-up of ART in the surveillance area.

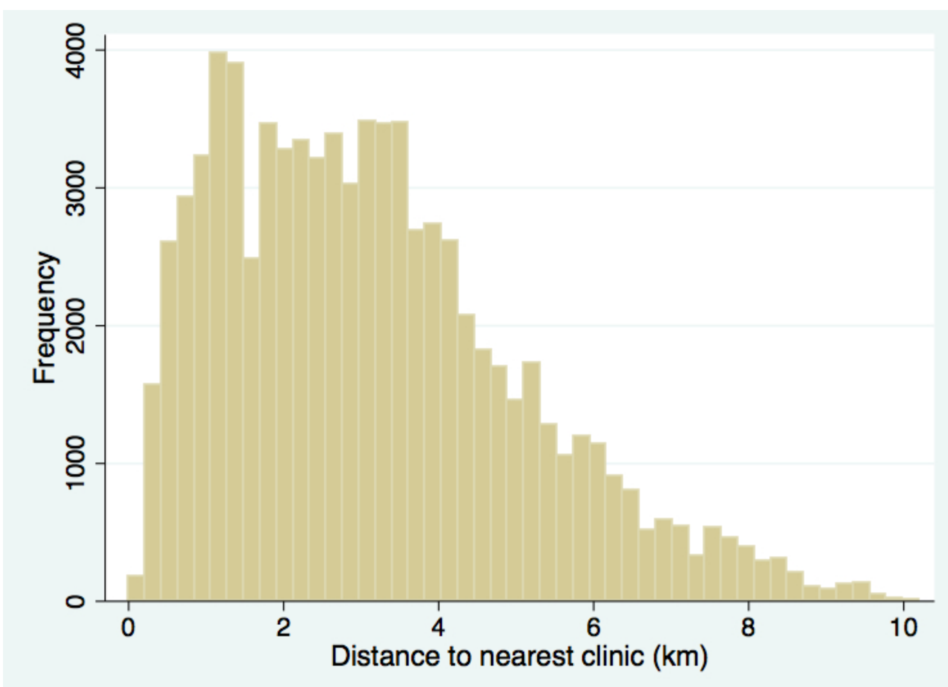

Fig 2. Distance to a clinic for residents of the surveillance area.

Table 1. ART coverage over time, by distance to clinic.

Year	*Proportion who have initiated ART in ref group, 5-12km*	Difference between 0-2km and ref group	Difference between 2-5km and ref group
2005	0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
2007	0.006**	0.006	0.004
	(0.003)	(0.004)	(0.003)
2008	0.020***	0.013**	0.006
	(0.005)	(0.006)	(0.006)
2009	0.036***	0.026***	0.011
	(0.006)	(0.009)	(0.008)
2010	0.046***	0.030***	0.014
	(0.007)	(0.009)	(0.008)
2011	0.062***	0.028***	0.007
	(0.008)	(0.010)	(0.009)
Obs. = 43,109, R^2 = 0.030, coef. (s.e.), *** p < .01, ** p < .05, * p < .1			

Notes: Column 1 shows predicted probabilities of ART take-up in the reference group, i.e. among persons residing 5-12km from a clinic. Columns 2 and 3 show the difference-in-difference coefficients describing the difference in ART coverage for people living 0-2km and 2-5km relative to the reference group (Column 1). Standard errors are in parentheses. ART reached a higher proportion of people (and faster) in the areas close to clinics relative to the areas further from clinics.

Table 2. Aggregate labor market effects of ART scale-up

DID estimates	Employed	Employed	LFP	UE, sick
2001 * 0-2km	0.017	0.003	---	---
	(0.014)	(0.017)		
2001 * 2-5km	-0.002	-0.012	---	---
	(0.013)	(0.014)		
2005/7 * 0-2km	0.042***	0.039***	-0.021	-0.008
	(0.012)	(0.014)	(0.017)	(0.007)
2005/7 * 2-5km	0.030***	0.021*	0.004	-0.005
	(0.011)	(0.012)	(0.014)	(0.006)
2008/9 * 0-2km	0.050***	0.072***	0.021	-0.013
	(0.014)	(0.016)	(0.018)	(0.008)
2008/9 * 2-5km	0.039***	0.043***	0.039**	-0.001
	(0.013)	(0.014)	(0.016)	(0.007)
2010/11 * 0-2km	0.069***	0.090***	0.021	-0.014*
	(0.014)	(0.018)	(0.020)	(0.008)
2010/11 * 2-5km	0.053***	0.055***	0.048***	-0.006
	(0.013)	(0.015)	(0.017)	(0.007)
Controls	N	Y	Y	Y
Observations = 92,693, Individuals =21,868, Controls = geography, demographics, individual FE, *** p < .01, ** p < .05, * p < .1				

Notes: Table shows difference-in-difference coefficient matrix (interaction terms only, main terms suppressed). Each coefficient shows the differential change in outcomes over time for people living close to clinics (0-2, 2-5 km), relative to changes observed for people living far from clinics (5-12km). All changes over time were assessed relative to a 2003/2004 reference period. Outcomes are probabilities of employment, labor force participation, and unemployment due to illness. Each column is a separate regression model. Standard errors are in parentheses. Table 1 shows large gains in employment among people living close to clinics as ART is scaled up. However, only about 20% of these gains were explained by reductions in unemployment due to illness.

Table 3. Labor market effects of ART scale-up, by HIV status.

DID estimates	Employed, HIV+'s	Employed, HIV-'s with no ART in BS
2001 * 0-2km	0.080	-0.004
	(0.055)	(0.037)
2001 * 2-5km	0.022	-0.005
	(0.047)	(0.030)
2005/7 * 0-2km	0.085*	0.036
	(0.049)	(0.031)
2005/7 * 2-5km	0.038	0.027
	(0.041)	(0.024)
2008/9 * 0-2km	0.055	0.069**
	(0.060)	(0.033)
2008/9 * 2-5km	0.053	0.056**
	(0.051)	(0.026)
2010/11 * 0-2km	0.123**	0.070**
	(0.060)	(0.035)
2010/11 * 2-5km	0.068	0.069**
	(0.054)	(0.028)
Observations	7,698	22,055
Individuals	1,521	4,823
*Adjusted for geography, demographics, individual FE, *** p < .01, ** p < .05, * p < .1*		

Notes: Table shows difference-in-difference matrix of coefficients. Each coefficient shows the differential change in employment over time for people living close to clinics (0-2, 2-5 km), relative to changes observed for people living far from clinics (5-12km). All changes over time were assessed relative to a 2003/2004 reference period. The left hand column includes only people who were identified as HIV-positive in the 2003/2004 HIV biomarker surveillance. The right hand column includes only people who were identified as HIV-negative in the 2003/2004 surveillance and did not have an ART initiator living in the bounded structure (homestead) during follow-up. Each column is a separate regression model. Standard errors are in parentheses. Large gains in employment with ART scale-up were observed for HIV-infected and HIV-uninfected community members alike.