HIV treatment and Economic Outcomes in Malawi

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Abstract

This paper uses variation in roll-out of antiretroviral therapy (ART) in Malawi to identify the mortality and economic effects of HIV treatment. A difference-in-difference methodology is employed to compare areas in Malawi with high versus low ART coverage per capita. Using data sets that provide measured HIV prevalence we find that increasing treatment from 1 to 3 per thousand population is associated with a two percentage point decrease in HIV prevalence, a 30% decrease in prevalence among the youngest age cohort, an approximately 33% increase in prevalence among the oldest cohorts, and 1.5 deaths per 1000 reduction in adult mortality. Our economic analysis finds that labor force participation among males increases by 10% with a variable pattern by age depending on the data set used. Female labor force participation also shows statistically significant increases, but the results are smaller and not uniform between data sets. Suggestive analysis comparing one district in Malawi, in which a comprehensive HIV treatment program and economic development effort were implemented jointly, indicates that labor force participation increased, but average hours worked declined between 2004 and 2010.

1 Introduction

HIV / AIDS causes over half of all working-age adult deaths in Southern and East Africa (UNAIDS, 2010). To combat this burden, the international community nearly tripled total development assistance for health (DAH) to approximately $28 billion over the decade ending in 2010 (IHME, 2012).

However after this remarkable growth in DAH, spending has stagnated amid financial crisis. The largest component of the expansion in DAH constituted tens of billions of dollars to expand antiretroviral therapy (ART) throughout sub-Saharan Africa (Pepfar, 2012; Global Fund, 2012). And indeed, this investment has produced significant health returns, by one estimate from South Africa, increasing prime-age adult life expectancy by over 10 years (Bor, et al. 2013). In addition, nations with HIV treatment programs heavily financed by the President's Emergency Plan for AIDS Relief (Pepfar) 16 percentage point lower adult mortality by 2008 compared to non-focus nations, even though Pepfar-focus countries began the study period with higher adult mortality (Bendavid, et al., 2012; Bendavid & Bhattacharya, 2009). Meanwhile, the global plan to eliminate new HIV infections among children by 2015, initiated in 2009, has produced a 38% reduction in new HIV infections in 21 priority nations in three years. Malawi's policy of providing antiretroviral therapy (ART) to all pregnant and breastfeeding women irrespective of CD4 count increased coverage from 13% in 2009 to 86% in 2012. Although Malawi's coverage of children with HIV is still low at 36%, the nation experienced a 52% decline in the number of HIV infections among children 2009-2012 (UNAIDS, 2013).

Previous research that measures the economic effects of HIV treatment, has focused on the impact of ART on the HIV-positive individual (Thirumurthy, Graff Zivin, & Goldstein, 2007; Bor, et al, 2012), the effects of orphanhood (Ainsworth, Beegle, & Kodi, 2005, Evans & Miguel, 2007; Case & Ardington, 2006) or treatment on the prospects of the children of the HIV-positive (Graff Zivin, Thirumurthy, & Goldstein, 2009). However, even with the large health effects found in this literature, much less attention has been paid to the economic effects of ART scale-up on the overall community. It is possible that HIV treatment may have positive or negative spillover health and economic effects on those in the area otherwise unaffected by HIV. In a era of stagnant DAH, understanding the economics effects of a large share of total DAH *at the population level* that also happens to be cost-effective (Menzies, 2011), is of particular importance.

This paper uses regional variation in ART provision in Malawi to explore the effects of treatment on both health and economic outcomes. Bendavid, et al., (2012) uses a similar strategy to explore the mortality effects of ART intensity per capita within Tanzania and Rwanda (along with their national-level analysis) and find that the adjusted odds ratios of adult all-cause mortality in areas with higher intensity ART compared to lower ART is 0.83 and 0.75 respectively. Our analysis uses Malawi Demographic and Health Surveys (MDHS) 2004 and 2010 to explore how all-cause mortality and prevalence change in ART intensive areas compared to those with lower intensity. Particular attention is paid to the change in HIV prevalence in younger cohorts as a proxy measure for the impact of ART expansion on incidence. In addition, this paper also combines data from MDHS 2000, 2004, and 2010 with Malawi's Population and Housing Census data from 1998 and 2008 to explore how variation in ART intensity affects labor-force participation among males and females.

There are other papers that use a similar identification strategy to investigate the effects of expanded HIV treatment. For example, Levinsohn, et al., (2013) for labor market participation in South Africa, Lucas and Wilson (2013) for child anthropometric outcomes in Zambia, and Friedman (2012) for risky sexual behavior in Kenya. Levinsohn, et al. (2013) use propensity-score matching with nationally-representative data and find that being HIV positive is associated with a 6 to 7 percentage point likelihood of unemployment and 10 to 11 percentage points for lower-educated individuals. Friedman (2012) finds that ART is associated with increases in risky behavior as measured by pregnancy rates and self-reported sexual activity, but that ART's introduction is still predicted to reduce incidence because of its effect on reduced transmission. For example, Tanser, et al. (2013) shows that an HIV-uninfected individual living in a community with 30% to 40% ART coverage was 38% less likely to acquire HIV compared to uninfected individuals in areas with ART coverage of less than 10%. Lucas and Wilson (2013) estimate the impact of Zambia's ART scale-up between 2001 and 2007 on child anthropometrics. They use a triple difference identification by comparing groups pre- and post- scale-up, ART treatment intensity, and comparing likely HIV positive versus negative adults. They find that ART introduction in households with likely HIV-positive fathers leads to children with higher weight-for-age and a lower probability of being underweight. These results suggest that ART's impact could also affect the formation of human capital, raising long-term growth.

Variation in ART per capita coverage in by Malawi's five geographic regions is used to identify the impact of ART on health and economic outcomes. First, we show that ART coverage intensity varies significantly within Malawi. We then show that both prevalence and adult mortality also varies by ART intensity. After that, we use ART zone intensity to explore the differential effect of ART coverage before and after ART scale-up. Using two different data sets, we find that moving from a low- to high-intensity zone is associated with a an approximately 7 percentage point (10%) increase in labor force participation among males.[1] In addition, using data on hours

[1] Using DHS data 2000, 2004, 2010 and Census data 1998 and 2008, the treatment effect estimate is 7 percentage points and using data from the Integrated Household Survey 2004

worked to explore the extensive margin of labor supply, we find that moving from the lowest- to highest-zone is associated with a 5.9 increase in hours worked.

This current study also estimates the economic effects of a four-year-old intervention by the non-governmental organization Partners in Health (PIH). Initiated in 2008, PIH's project provides universal ART to the 15% of the working-age population with HIV / AIDS in Neno District, Malawi. Overall, PIH has invested $12 million to construct hospitals, clinics, housing, and roads and currently employs over 1,000 local health care workers. Unique to PIHs health interventions, the NGO espouses a comprehensive perspective on what constitutes disease treatment. Therefore, the intervention also included adult-literacy classes, job skills training, and has improved district transportation infrastructure. Given that poverty is most often the root cause of illness, their work intends to reduce both poverty and disease simultaneously.

In addition, suggestive evidence is presented on the difference in economic outcomes between the PIH intervention district - Neno - compared to the rest of Malawi. The causal impact of PIHs intervention is identified using a difference-in-difference methodology by comparing changes in outcome variables between Neno and control districts. The suggestive evidence indicates that work increases in Neno compared to the rest of Malawi, but that average hours worked declined.

These results show that donor funding for HIV/AIDS treatment, in addition to significantly reducing mortality burden, also produces positive economic benefits in the district receiving aid among those unaffected by HIV in the household. Although funding for ART is promoted solely for its health benefit, this study indicates that, if well-designed, ART investment may also help address the poverty at the root of the HIV/AIDS epidemic.

The paper proceeds as follows: section 2 describes the previous literature on HIV and economic outcomes, section 3 describes the methods used to identify ART's impact on Malawi overall, section 4 describes our analysis specific to Neno district, while sections 5 and 6 provide discussion and conclude, respectively.

2 HIV and Economic Outcomes

Given the relative recency of ART treatment successes, much of the evidence on the impact of HIV on economic outcomes comes from the economic decline associated with adult mortality on children or adult morality itself. Previous

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and 2010, the treatment effect estimate is 6.5 percentage points.

studies have found that parental death reduces child's schooling by 0.9 years (Ainsworth, Beegle, & Kodi, 2005), as well as reducing school attendance and education expenditure (Evans & Miguel, 2007); (Case & Ardington, 2006).

When it comes to studies that explore the effect of HIV treatment on labor force outcomes, one of the most important uses a longitudinal socioeconomic household data collected over a year in rural western Kenya and linked to longitudinal medical information (Thirumurthy, et al., 2008). Using a random sample of nonpatients as a control group and variation in the treatment exposure prior to the survey, they show that health improves nonlinearly with treatment, dramatically after treatment initiation and more slowly thereafter. They also find that the provision of ART produces a large and significant increase in labor supply among AIDS patients. Within six months of treatment initiation, a 20% increase in the likelihood of labor force participation and a 35% increase in hours worked was observed.

Another study exploring the effect of adult HIV treatment on intrahousehold resource allocation, looking specifically at schooling and health - weight for height- outcomes for children in households with HIV-positive adults using the same data from Kosirai division, Kenya and variation in treatment before the survey. They find (Zivin Graff, Thirumurthy, & Goldstein, 2009) significant increases in weekly hours of school attendance, especially for girls, and suggestive evidence of nutritional improvements. However, as the authors acknowledge, this study does not contain the experimental counterfactual group, that is, a since all households with HIV were provided free treatment there are no exogenously determined group of HIV positive households that are without treatment to be compared with.

This paper also seeks to provide evidence on a larger paradox in development economics concerning the differences in estimated effects of health investments at the macro and micro level. That is, the positive estimates of the effects of health on economic growth are an order of magnitude larger (Gallup and Sachs, 2001) than studies at the micro-level (Bloom, Canning, and Fink (2009); Weil (2007); Ashraf, Lester, and Weil, 2008 or even negative (Acemoglu and Johnson, 2007). Manuelli (2011) uses a model of human capital accumulation that allows for feedback between the consequences and the likelihood of suffering from a particular disease and the decision to invest in knowledge. The paper finds that the long-run effect of eradicating HIV/AIDS and malaria can be large in output per worker.

When it comes to the health effects of ART, in the most comprehensive study of its kind, Bendavid, et al., (2012) use data from 41 Demographic and Health (DHS) surveys in 27 sub-Sahara African nations to investigate the impact of the President's Emergency Plan for AIDS relief (Pepfar) on 12 focus countries compared to 18 non-foucs nations between 1998-2008.

They find that adjusted odds ratio of all-cause mortality among adults in focus versus non-focus Pepfar nations between 2004-2008 of 0.84. They also use Pepfar's within-nation operational intensity in Tanzania and Rwanda to estimate that the adjusted odds ratio of mortality for adults in higher intensity districts was 0.83 and 0.75 in these nations respectively. As done in this paper, Bendavid et al (2012) measure program intensity as 1) annual number of people newly starting ART per capita by district. However, they look at mortality only, not prevalence changes nor economic outcomes. They also focus on the comparision between Pepfar versus non-Pepfar nations, whereas we explore the effects of ART for a nation outside this support framework.

Another important debate around the roll-out of ART includes the question of whether the large increase in provision of HIV treatment produces positive or negative externalities on other parts of the health system by either improving care provision overall or siphoning scarce resources respectively. Using data from Malawi and Ethiopia, Rasschaert, et al. (2011) suggest that overall functional health facilities increased.

3 ART roll-out in Malawi

In 2004, Malawi's HIV prevalence was 11.8% among adults 15-49. In 2010, urban prevalence was 17.4% and rural prevalence was 8.9%, while higher prevalence was observed among higher wealth quintiles (DHS, 2010, p.197). Within this environment of high HIV prevalence Malawi began its nationwide HIV treatment program in 2004. To be eligible to provide ART, a health provider was required to implement a certification process in which staff went through education for medical treatment related to HIV and the facility's ability to provide ART was evaluated. Once a health facility passed this certification process, their provision of ART began. By 2010, ART coverage was 71% among eligible adults and 36% eligible children 0-14 in (UNAIDS, 2013). In June, 2010, 396 clinics were (290 static, 106 mobile) and about 360,000 patients were being provided ART (Harries, et al., 2011). In addition, 225,000 adults were alive as of June 2010, most of whom would have died within 1-2 years without treatment (Harries, et al., 2011).

Unique to Malawi, the nation has produced quarterly cohort analyses of patients starting antiretroviral therapy since treatment initiation, providing accurate data on how many patients are alive and on treatment at any given moment (Libamba et al. 2006). Number of patients on treatment information along with drugstock assessments permits rational drug procurement policies. We take advantage of these sources of information to follow ART roll-out in

Malawi by year and geographic area.

4 Methods

4.1 Data

Three separate nationally representative data sets from Malawi are used to evaluate the effect of ART roll-out. These include the Malawi Integrated Household Survey (IHS) and the Malawi Demographic and Health Survey (DHS), which both have waves in 2004-2005 and again in 2010, and the Malawi Census 2008. All three surveys measure labor supply, migration, (subjective) disability, and household assets, while the IHS and DHS also measure a wider range of health status, HIV/AIDS knowledge, risky-sexual behavior, and demographic information.

Table 1 shows the data availability for each survey year and also the number of households available for the Neno district in which Partners in Health implemented its intervention. Data sets used are the Malawi DHS 2000, 2004, and 2010, Malawi's 10% population sample obtained from IPUMS from 1998 and 2008 and the Integrated Household Survey from 2004 and 2010.

4.2 Validating the Instrument

The DHS 2004 and 2010 both randomly selected a 1/3rd subsample of households that were then provided with an HIV test for for eligible women 15-49 and eligible men 15-54. In addition, anemia testing was conducted for eligible children age 6-59 months and anthropomorphic measures were also taken for children 0-5 and women 15-49 in the same subsample selected households. Between the two DHS surveys, measured HIV prevalence declined from 11.8% of adults between 15-49 in 2004 to 10.6% in 2010. In addition, prevalence by region varied by considerably, being X in the north, X in the center, and X in the South. However, this small observed change in prevalence between DHS surveys masks considerable variation in prevalence by age. Figure 1 shows measured HIV prevalence by 5- or 10-year age cohort. The expect impact of ART on HIV is ambiguous because when effective it both elongates lives and also has the potential to reduce infectiousness and therefore HIV incidence among younger cohorts. Figure 1 indicates how prevalence changes by age cohort between 2004 and 2010 DHS samples. The figure indicates that before and after the roll-out of Malawi's ART program, the epidemic has become older as prevalence decreased at younger ages and increased for the oldest cohorts, a pattern of HIV prevalence consistent with ART treatment. Figure 3 highlights this point by showing the statistical significance of prevalence changes between 2004 and 2010. We find that ART treatment produced a statistically significant decrease in a proxy for incidence, HIV prevalence among 15-24 year olds. The expected impact of ART on mortality however is unambigious. Figure 4 shows that the average relationship between ART coverage intensity and adult mortality is negative, as anticipated. Adult mortality is calculated using full adult sibling death histories from the DHS (see appendix for detailed explanation of calculation procedure).

4.3 Difference-in-Differences

To identify the differential effect of ART on outcome Y_{it} by zone, a difference-in-difference model is employed in the following way:

$$Y_{it} = \alpha + \delta_t + \gamma_z + \pi \ (ART\ intensity_{zt}) + X_{it}\beta + \epsilon_{it} \tag{1}$$

where δ_t represent year fixed effects, γ_z zone fixed effects, and π is our quantity of interest, the differential change in outcome variable Y_{it} by zone and year ART intensity. Individual level covariates are also used to control for individual-variation by zone, X_{it}, matrix of individual-level control covariates. As with any difference-in-difference model, the primary assumption here is that the trends in each zone for outcome variable Y_{it} would have been the same absent the treatment, the differential application of ART intensity.

5 Results

Tables 2 and 3 show regression results using equation 1 . The first row of table 2 shows the average differential change in LFP associated with being a resident of the high- compared to low-intensity ART coverage zone. This indicates that, on average, moving from the lowest to highest ART intensity zone is associated with a 7 percentage point (10%) increase in those reporting labor force participation for all ages among males. Table 4 estimates the same regression from equation 1 using data from two waves of the Integrated Household Survey in 2004 and 2010 and finds the same quantitative results that male LFP participation increases by 6.5%. Column [2] with covariates doesn't change results substantially and LFP increases more among males greater than 35 years old than those younger for the DHS / Census sample. However, we observe greater LFP increases for those less than 35 using the IHS data set. For females, tables 3 and 5 shows that female LFP increases in both the Census / DHS sample and for the IHS. But, in both samples LFP rises for the less-than-35s.

6 PIH's Neno-District Intervention

This paper also estimates the economic effects of a four-year-old intervention by Partners in Health (PIH) in Neno District, Malawi. Initiated in 2008, this PIH project provides universal ART to the 15% of the working-age population with HIV / AIDS. Overall, PIH has invested $12 million to construct hospitals, clinics, housing, and roads and currently employs over 1,000 local health care workers. Unique to PIHs health interventions, the NGO espouses a comprehensive perspective on what constitutes disease treatment. Therefore, the intervention also included adult-literacy classes, job skills training, and has improved district transportation infrastructure. Given that poverty is most often the root cause of illness, their work intends to reduce both poverty and disease simultaneously. Partners in Health intervention in Neno district Malawi began in 2007. This research intends to explore the differential effect of PIH's program in Neno compared to the rest of Malawi. It also seeks to provide evidence on the relative strengths and weaknesses of health service provision through a government compared to NGO model.

This suggestive analysis explores how LFP and hours worked for males and females vary in Neno district compared to the rest of Malawi. The specification tested is a standard difference-in-difference with a year, district, and, the quantity of interest, the interaction term between year and treatment area. Table 8 shows that residing in Neno is associated with a larger increase in LFP for males and females between 2004 and 2010 compared to the rest of Malawi, significant at the 10% level. However, table 9 indicates that residing in Neno is associated with a decrease in hours worked for male and females compared to residence in other areas of Malawi.

7 Discussion

Although this presents one of the first analyses to identify the impact of When it comes to limitations, as could be case with any difference-in-difference methodology, other zone-level or Neno-level trends could be driving the results that we find. That is, the differential increases may be the result of something pre-existing trend in the higher intensity treatment areas unrelated to ART coverage. For the Neno analysis, other confounders exist such as the fact that the district Neno was created as a new district around the same time as the intervention. Also, analysis based on small sample size. One specific program that also could confound this analysis is Malawi's Farm Input Subsidy Program (FISP). This was a government-funded initiative to provide fertilizer subsidies to farmers around Malawi in 2009-2010 and could have produced differential effects by zone.

8 Conclusion

One piece of evidence to support the fact that these LFP results are not due to differential economic changes by zone but instead capacity increases from improved health is a field experiment which showed very low labor elasticity among the poor in rural Malawi (Goldberg, 2012). That is, with low labor elasticity, it is unlikely that another trend unrelated to the improvement in health capacity from ART produced the results we find.

Moreover, our analysis has potential to shed light on the difference between macro estimates of the effect of health on income that are 1-2 orders of magnitude larger than the micro estimates (Reviews can be found in Strauss and Thomas, 2007 and Bleakley, 2010). These results show an initial analysis which indicates that HIV treatment has positive labor market effects for both those on treatment and spillover effects for society overall.

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9 Figures and Tables

Table 1: **Data Availability**

Data Source	**Households - All Malawi**	**Households - Neno**
DHS 2000	16,313	238
DHS 2004	14,959	151
DHS 2010	30,195	963
IHS 1997-1998	10,698	80
IHS 2004-2005	11,252	140
IHS 2010-2011	12,271	384
Census 1998 10% Sample	991,393	About 6,500
Census 2008 10% Sample	1,341,977	11,009

Table 2: **Male Labor Force Participation by ART intensity (Census and DHS)**

	DHS & Census	DHS & Census	DHS & Census >35	DHS & Census <35
	(1)	(2)	(3)	(4)
ART Intensity	4.301	4.487	5.309	3.635
	(.0003)***	(.0003)***	(.0002)***	(.0003)***
CW (ref CE)	.026	.024	.031	.021
	(3.03e-07)***	(3.61e-07)***	(5.37e-07)***	(2.88e-07)***
N	-.078	-.063	-.014	-.063
	(2.09e-07)***	(1.80e-07)***	(4.46e-07)***	(1.71e-07)***
SE	.004	-.002	.009	-.006
	(3.23e-07)***	(2.96e-07)***	(2.77e-07)***	(3.67e-07)***
SW	-.036	-.031	-.009	-.032
	(1.52e-06)***	(1.31e-06)***	(1.26e-06)***	(1.19e-06)***
Covariates?	No	Yes	Yes	Yes
Obs.	547802	545232	159988	385815
R^2	.019	.21	.06	.29

(* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Table 3: **Female Labor Force Participation by ART intensity (Census and DHS)**

	DHS & Census	DHS & Census	DHS & Census >35	DHS & Census <35
	(1)	(2)	(3)	(4)
ART Intensity	.573	.084	1.878	-.508
	(.00004)***	(.00007)***	(.00006)***	(.00006)***
CW (ref CE)	.010	.053	.024	.052
	(2.59e-07)***	(4.21e-07)***	(2.87e-07)***	(4.25e-07)***
N	-.052	-.019	-.035	-.013
	(5.19e-07)***	(3.71e-07)***	(5.35e-07)***	(3.61e-07)***
SE	.013	.010	.004	.010
	(2.05e-07)***	(2.23e-07)***	(1.46e-07)***	(2.32e-07)***
SW	-.089	-.026	-.069	-.025
	(5.97e-07)***	(3.18e-07)***	(6.34e-07)***	(3.23e-07)***
Covariates?	No	Yes	Yes	Yes
Obs.	584881	582560	140644	442331
R^2	.059	.172	.086	.186

(* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Table 4: **Effect of ART intensity on reported work in last 7 days for males 2004-2010.**

	Males	Males	Males < 35	Males > 35
	(1)	(2)	(3)	(4)
ART Intensity	4.582	3.835	4.116	2.640
	(1.202)***	(1.049)***	(1.368)***	(1.252)**
CW (ref CE)	-.043	-.017	-.006	-.038
	(.010)***	(.010)	(.013)	(.013)***
N	-.032	-.021	-.011	-.042
	(.011)***	(.011)*	(.014)	(.014)***
SE	-.040	-.039	-.040	-.032
	(.011)***	(.010)***	(.013)***	(.013)**
SW	-.082	-.043	-.052	-.018
	(.014)***	(.012)***	(.015)***	(.015)
Year 2010 FE	-.185	-.171	-.190	-.112
	(.023)***	(.021)***	(.027)***	(.026)***
Covariates?	No	Yes	Yes	Yes
Obs.	24027	23980	16907	7073
R^2	.017	.153	.161	.027

Data Sources: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$).

Table 5: **Effect of ART intensity on reported work in last 7 days for females 2004-2010.**

	Females	Females	Females $<$ 35	Females $>$ 35
	(1)	(2)	(3)	(4)
ART Intensity	3.568	3.062	3.495	1.094
	(1.334)***	(1.184)***	(1.336)***	(2.159)
CW (ref CE)	-.051	.014	.013	.017
	(.012)***	(.012)	(.013)	(.019)
N	-.023	.013	.014	.008
	(.013)*	(.012)	(.014)	(.020)
SE	-.018	-.021	-.032	.014
	(.012)	(.011)*	(.013)**	(.019)
SW	-.137	-.050	-.057	-.023
	(.016)***	(.014)***	(.016)***	(.026)
Year 2010 FE	-.158	-.133	-.148	-.076
	(.026)***	(.024)***	(.027)***	(.041)*
Covariates?	No	Yes	Yes	Yes
Obs.	24043	24020	18275	5745
R^2	.017	.136	.145	.04

Data: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Table 6: **Effect of ART intensity on reported hours worked in last 7 days for males 2004-2010.**

	Males	Males	Males < 35	Males > 35
	(1)	(2)	(3)	(4)
ART Intensity	352.621	346.940	373.296	240.523
	(71.667)***	(59.160)***	(70.982)***	(102.389)**
CW (ref CE)	1.077	-1.697	-1.201	-2.852
	(.663)	(.572)***	(.691)*	(.934)***
N	-1.952	-3.633	-3.720	-3.391
	(.699)***	(.606)***	(.734)***	(.962)***
SE	-.482	-1.218	-1.827	.443
	(.676)	(.561)**	(.673)***	(.947)
SW	-.633	-3.245	-4.068	-.831
	(.941)	(.717)***	(.849)***	(1.246)
Covariates?	No	Yes	Yes	Yes
Obs.	24736	24229	17086	7143
R^2	.056	.161	.172	.086

Data Sources: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$).

Table 7: **Effect of ART intensity on reported hours worked in last 7 days for females 2004-2010.**

	Females	Females	Females < 35	Females > 35
	(1)	(2)	(3)	(4)
ART Intensity	265.843	224.512	260.436	68.876
	(61.830)***	(53.207)***	(59.751)***	(106.316)
CW (ref CE)	-.990	-1.293	-1.255	-1.549
	(.552)*	(.482)***	(.562)**	(.788)**
N	-.796	-1.517	-1.302	-2.083
	(.625)	(.530)***	(.616)**	(.889)**
SE	-1.626	-1.999	-2.572	-.177
	(.581)***	(.510)***	(.581)***	(.889)
SW	-3.741	-3.304	-4.117	-.395
	(.833)***	(.653)***	(.735)***	(1.255)
Year 2010 FE	-12.876	-9.367	-9.941	-6.758
	(1.204)***	(1.035)***	(1.176)***	(1.955)***
Covariates?	No	Yes	Yes	Yes
Obs.	24449	24122	18360	5762
R^2	.03	.058	.058	.035

Data Sources: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Table 8: **Differential Change in Work in Last Week, Neno Compared to Rest of Malawi, 2004-2010.**

	Female	Female	Male	Male
	(1)	(2)	(3)	(4)
Const.	.742	.478	.844	.543
	(.005)***	(.043)***	(.004)***	(.040)***
Post-Trt	-.089	-.074	-.097	-.098
	(.008)***	(.007)***	(.007)***	(.006)***
Neno	.136	.091	.044	.037
	(.029)***	(.028)***	(.025)*	(.024)
Post-Trt*Neno	.039	.026	.062	.059
	(.037)	(.036)	(.036)*	(.034)*
Covariates?	No	Yes	No	Yes
Obs.	24043	24020	24027	23980
R^2	.01	.135	.015	.151

Data: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Table 9: **Differential Change in Hours Worked in Last Week, Neno Compared to Rest of Malawi, 2004-2010.**

	Female	Female	Male	Male
	(1)	(2)	(3)	(4)
Const.	21.674	-4.864	33.770	3.301
	(.276)***	(1.911)**	(.328)***	(2.222)
Post-Trt	-7.688	-4.983	-12.875	-9.567
	(.353)***	(.301)***	(.429)***	(.359)***
Neno	9.973	9.070	5.779	8.782
	(2.263)***	(1.771)***	(2.270)**	(1.783)***
Post-Trt*Neno	-10.762	-10.063	-10.497	-11.465
	(2.403)***	(1.937)***	(2.495)***	(2.062)***
Covariates?	No	Yes	No	Yes
Obs.	24449	24122	24736	24229
R^2	.029	.057	.053	.158

Data: Integrated Household Survey 2004 and 2010. Household weights used and cluster-robust SE's at the household level are used. (* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$)

Figure 1: **HIV Prevalence by Age Cohort in 2004 and 2010.**

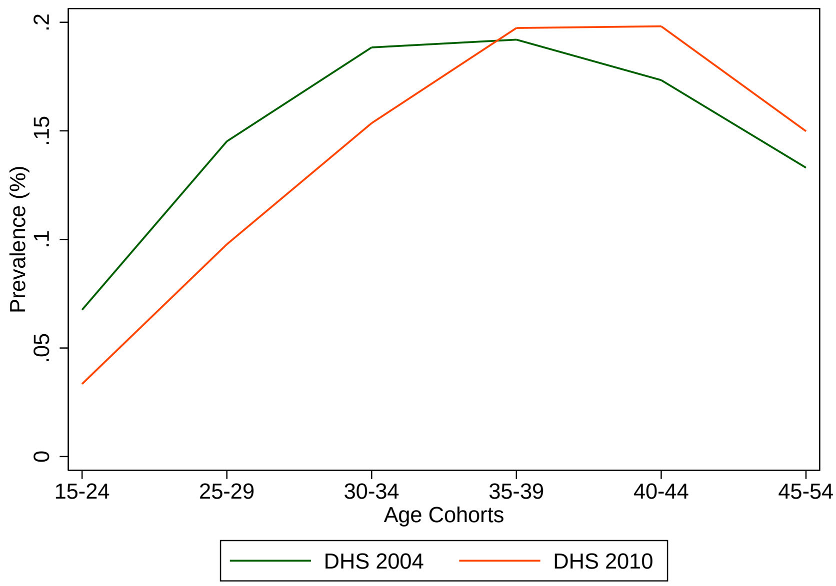


Figure 2: **Change in HIV prevalence by age cohort between 2004 and 2010 (using DHS surveys).**

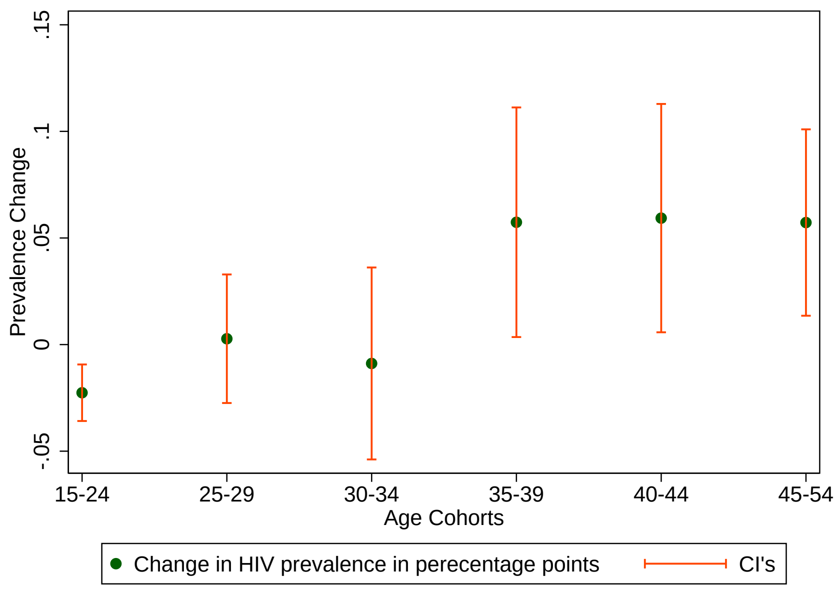


Figure 3: **Change in HIV prevalence by ART coverage intensity between 2004 and 2010.**

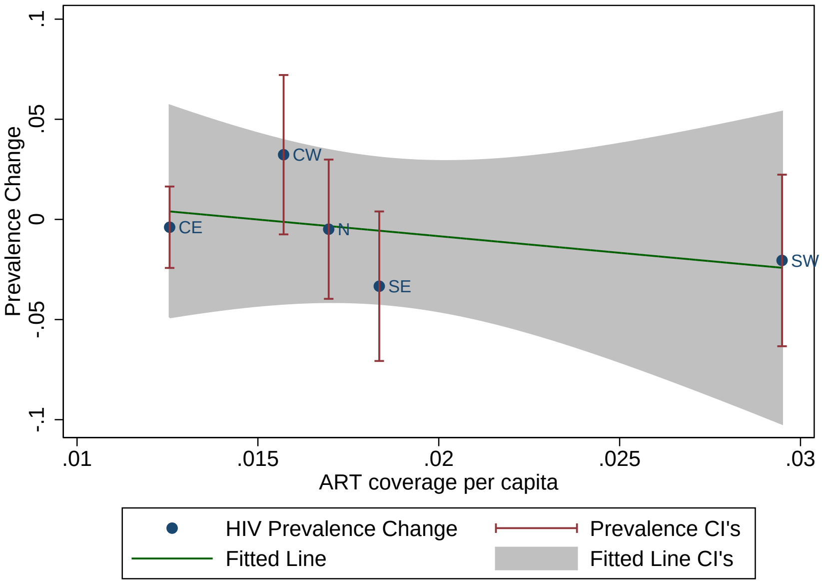
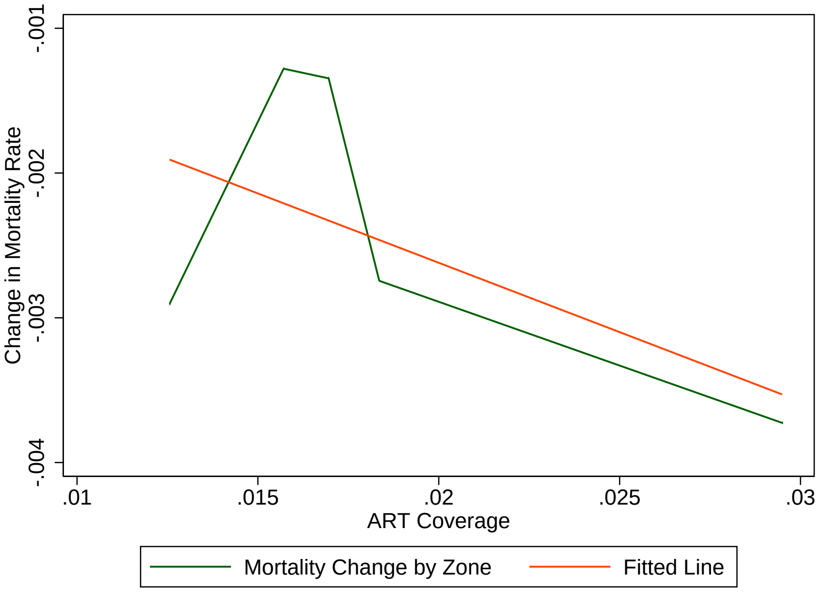


Figure 4: **Change in mortality by ART coverage per capita.**



10 Appendix

10.1 Adult Mortality Calculation

We calculate the age-specific mortality rates for women and men age 15-49 based on the survivorship of sisters and brothers of women respondents using the Malawi DHS 2004 and 2010. These mortality rates are calculated for the period of 0 to 6 prior to the surveys and therefore mimic the calculations employed by DHS itself (see DHS 2004 and DHS 2010 for the results and DHS Statistics - Adult and Maternal Mortality section for detailed explanations of the method). Following the DHS methods, we calculate mortality rate as the number of deaths in the 0-6 year period divided by the total number of exposure years in a given period. For those that live through the entire period, 7 years of exposure are counted and for those that died, exposure is the year of death and all years before in the calculation window. Although the there is no information asked regarding the location of each respondent's siblings, our main innovation is to calculate zone-specific mortality rates. As such, we initially make the assumption that siblings are located in the same zone as the respondent sibling. To validate this assumption, we note that migration rates are relatively low using the IHS and Census. In addition, we could perform a sensitivity analysis by implementing a logistic regression to predict the likelihood migration for a given individual and apply these probabilities to re-calculate mortality rates (will have to think about how to implement such a sensitivity analysis).

10.2 DHS HIV prevalence collection

As is noted in the DHS full report for 2004 and 2010, HIV prevalence data were obtained from testing dried blood spot (DBS) samples voluntarily provided by women 15-49 and men 15-54 who were interviewed in the 2004 and 2010 Malawi DHS. The DBS were collected using the finger stick method. Of the 15,957 eligible subjects, 87% provided DBS specimens.