

# The Household Impacts of Treating HIV/AIDS in Developing Countries\*

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## **Abstract**

Recent data on the household impacts of providing antiretroviral therapy to HIV-infected adults paints a much fuller picture of the economic footprint of treatment than previously possible. With evidence from treatment programs in western Kenya and several countries within sub-Saharan Africa, we discuss a range of benefits to the households of patients receiving treatment. These benefits begin with the labor market outcomes of treated patients, who are able to significantly increase their work hours within six months after they initiate treatment. In the same time period there are significant improvements in the nutritional status and school attendance of children in patients' households, which in turn can improve the future well being of these children. The results demonstrate that treatment can mitigate the negative socio-economic consequences of HIV/AIDS. We argue that they also provide an added rationale for the continued scale-up of treatment programs, which should be viewed as investments that offer large, long-term economic returns to society.

## 1. Introduction

Since the advent of highly active antiretroviral therapy (ART)<sup>1</sup> in 1996, morbidity and mortality due to HIV/AIDS has declined substantially in industrialized countries. Owing to the widespread availability of such treatment, HIV/AIDS is often addressed as a chronic disease in these countries. In developing nations, access to the antiretroviral therapy is growing but still limited. In sub-Saharan Africa, the region most heavily affected by HIV/AIDS, the number of HIV-positive people receiving treatment has risen from 100,000 to nearly 2 million in just the past 5 years. Despite this progress, only about 30 percent of the people in need of treatment are currently able to access it. Since public provision of treatment remains the primary channel through which people in developing countries can access ART, an expansion in donor support remains critical in order to achieve the international community's goal of universal access to HIV treatment (as well as prevention, care, and support) by 2010 for all who need it (G8 communiqué). According to estimates from UNAIDS, the annual cost of achieving universal access to treatment by 2010 will be approximately \$15 billion per year, an amount much larger than current expenditures on treatment (UNAIDS 2007).

Greater support for the scale-up of treatment programs has been lacking for a number of reasons. These include skepticism that ART may not generate health and economic benefits that are sizable enough to offset its costs and a related debate about how best to allocate scarce resources in developing countries (for example, see Canning 2006). Since treatment, once initiated, must be taken for the entire duration of a person's life, there has also been concern

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<sup>1</sup> In this paper, we use the terms "ART" and "treatment" to refer to highly active antiretroviral therapy (HAART), which was introduced in 1996. HAART always consists of three antiretroviral medications. Treatment for most patients begins with a first-line regimen, but these are usually altered over time. Generic medications that combine three medications in one pill (such as Triomune) have recently become available.

about the wisdom and sustainability of current expenditures on ART. According to *The Economist*, people who begin receiving ART today will become tomorrow's "medical pensioners" whose treatment costs will become the responsibility of countries in which they live and organizations that support these countries (The Economist 2006). However, because evidence on the various impacts of providing ART has been slow to emerge, until recently it has been impossible to properly evaluate treatment programs and assess whether the expenditures on such programs may be justified on economic – as opposed to humanitarian – grounds.

In this paper, we draw upon recent research to describe the short-term impact of treatment on the socio-economic outcomes of patients and households in sub-Saharan Africa. Since the scale-up of treatment programs has been a recent phenomenon, the evidence on household impacts that we present here has been largely absent in discussions of the costs and benefits of treatment. These household impacts are an important component of the benefits that stem from treatment programs, and when taken into consideration, it is hard not to view treatment expenditures as investments that offer longer-term economic returns to households.

To see why treatment could induce a variety of positive changes in the well-being of households in low-income settings, it is instructive to consider how these households generally respond to health setbacks. Households in low-income settings face a great deal of health and economic risk and their ability to cope with such risk and ensure minimum levels of food consumption and well-being is often limited. Access to formal or informal credit and insurance against large setbacks may be lacking, so some households may have to resort to extreme measures including: partial or full withdrawal of children from school; increased employment of children's labor in family farms or business enterprises; and reductions in food consumption for some or all household members. Coping with AIDS-related adult morbidity, rather than a

temporary illness, is especially challenging. This is because individuals can expect to recover from temporary illnesses and therefore might be able, at least partially, to rely upon informal credit and insurance from friends and relatives. For chronic illnesses, however, finding individuals who are willing to provide support will be more difficult. Furthermore, since AIDS invariably results in mortality when no treatment is available, the disease may have even larger effects on the well-being of household members, particularly children who will be left without a parent.

Longitudinal household survey data we have collected in collaboration with a treatment program in western Kenya, along with limited evidence from other countries in sub-Saharan Africa, suggests that ART reverses and mitigates many of the effects of HIV on the socio-economic well-being of infected adults and their households. The starting point for these household impacts lies in the employment outcomes of adult patients who receive ART. Evidence from rural Kenya shows that after ART is initiated, there is a large and immediate increase in the amount of work performed by treated patients. These increases are in contrast to the well-documented decline in productivity that would occur for HIV-infected individuals who do not have access to treatment (Fox et al. 2004). While it is encouraging that these labor supply increases are observed in the first 6-12 months after treatment initiation, we emphasize that more evidence is needed about the long-term impacts of ART on the labor supply and other outcomes.

As adult patients become healthier and more productive due to ART, our analysis of data from Kenya suggests that the burden on children to provide substitute labor decreases substantially. Boys work significantly less on income-generating activities, while girls experience significant reductions in the amount of household chores they perform. These reductions in time allocated to labor are accompanied by increased school attendance, which is

likely to result in higher wages and improved health for these children in the future. ART also results in large improvements in the nutritional status of very young children in treated patients' households, another indicator that these short-term impacts of treatment may have long-term effects on health and economic outcomes.

While the positive benefits of ART that we document in this paper are largely private benefits realized by patients and their households, we argue that under certain conditions this evidence can provide a rationale for public support for ART. This includes the presence of borrowing constraints for households in low-income settings and the externalities that may result from improved schooling outcomes. The broader socio-economic view of ART's impact—particularly its intergenerational effects—also suggests that cost-effectiveness analyses of ART (which typically focus on the number of patient life-years saved) may substantially underestimate the benefits of treatment. Our results also call into question the arguments that resources should be allocated to HIV prevention at the expense of treatment (Canning 2006).

The paper is organized as follows. Section 2 reviews the evidence on the clinical and immunological impacts of ART and provides an overview of existing efforts to scale-up treatment programs. Section 3 discusses the empirical strategy for estimating the impact of treatment when randomized controlled trials are not feasible. The section goes on to discuss unique evidence from western Kenya on a range of socio-economic impacts on households of patients receiving ART: from employment outcomes of treated patients; to schooling and employment outcomes of children; and finally the nutritional status of very young children. Section 4 addresses the issue of generalizability by referring to evidence from other settings such as South Africa and Botswana. It also includes a discussion of areas where additional research is

needed. Section 5 concludes with the policy implications that flow from these household impacts of treatment.

## **2. Effectiveness and Availability of Antiretroviral Treatment**

As HIV weakens the immune system, it inevitably causes AIDS and, eventually, death if treatment is not provided. According to a prominent study conducted in Uganda, progression to AIDS – the last stage of HIV infection – takes about 9 years from the time of HIV seroconversion<sup>2</sup> (Morgan et al. 2002). During much of this period, most HIV-infected individuals can be unaware of their status and physically capable of performing all normal activities. Progression to AIDS is usually associated with substantial weight loss (wasting) and opportunistic infections such as *P. carinii* pneumonia, Kaposi's sarcoma, and tuberculosis. Without any antiretroviral therapy, death usually occurs rapidly after progression to AIDS. The Uganda study reports a median survival time of 9.2 months (Morgan et al. 2002) and an older study in Brazil reports a median survival time of 5.1 months (Chequer et al. 1992).

Highly active antiretroviral therapy (ART) has been proven to reduce the likelihood of opportunistic infections and prolong the life of HIV-infected individuals. As per the World Health Organization's guidelines, antiretroviral therapy is often initiated around the time that an HIV-infected individual develops AIDS (World Health Organization 2006). After several months of treatment, patients generally become asymptomatic and have improved functional capacity. Numerous studies have shown that antiretroviral therapy dramatically reduces morbidity and mortality among HIV-infected individuals, in both industrialized countries

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<sup>2</sup> Conversion to HIV-positive serology normally occurs 4-10 weeks after transmission. The duration of the clinical latent period has been found to vary considerably, depending upon the mode of transmission and age at transmission (Collaborative Group on AIDS Incubation and HIV Survival including the CASCADE EU Concerted Action 2000). In developing countries, limited access to health care and greater burden of other infectious diseases may expedite the progression of HIV.

(Hammer et al. 1997, Hogg et al. 1998; Palella et al. 1998) and developing ones (Laurent et al. 2002; Marins et al. 2003; Koenig, Leandre, and Farmer 2004; Coetzee et al. 2004; Wools-Kaloustian et al. 2006).

In Haiti, patients had weight gain and improved functional capacity within one year after the initiation of ART (Koenig, Leandre, and Farmer 2004). A study conducted in the township of Khayelitsha, South Africa showed that among 287 adults who received ART, 86.3 percent were still alive at 24 months after treatment began (Coetzee et al. 2004). Large and significant improvements were also observed in clinical outcomes. The median weight gain was 5.0 kg after six months of treatment and 9.0 kg after a year. The CD4 cell counts—an important indicator of disease progression, where lower counts indicate weaker immune systems—increased by a median of 134 and 288 cells/ $\mu$ L at 6 and 24 months, respectively. In western Kenya, where we conducted our socio-economic study, others have reported results that are strikingly similar to those from South Africa. In particular, mean increases in CD4 cell counts of 109 and 297 cells/ $\mu$ L were observed at 6 weeks and 36 months after treatment initiation. Mortality rates in the first two to three years of ART have also been low for patients whose CD4 cell counts were not too low (i.e. CD4 < 50) at the time of treatment initiation. Without ART, these mortality rates would undoubtedly be extremely high.

The compelling evidence that ART is effective in developing countries has accumulated in just the past five years, during which there has been substantial growth in access to treatment in sub-Saharan Africa and other HIV-affected regions of the world. The price of ART in developing countries is an important consideration in debates about treatment provision and cost-benefit analyses, but that price has been falling. First-line ART regimens used to cost more than \$10,000 per patient per year in 2000, and differential pricing was rarely employed by

pharmaceutical companies at the time. Beginning in 2001 widespread generic production of some antiretrovirals reduced these prices significantly, to as low as \$99 per patient-year for a commonly used first-line regimen (Campaign for Access to Essential Medicines 2007). It should be noted, however, that the costs of improved first-line regimens (less toxic ones that have been recommended by the WHO recently) as well as second-line regimens (used when first-line regimens fail) are considerably more expensive. Expenditures on lab tests and HIV clinic operations can also be sizable, with the sum of these non-drug costs dependent on the treatment setting and a variety of factors including the nature of existing infrastructure in the area where an HIV clinic is being established and the cost of hiring additional staff.

Much like the price reductions, growth in donor support for the provision of ART has also played a key role in scaling-up treatment to current levels. Resources from the Global Fund to Fight AIDS, Tuberculosis, and Malaria; the U.S. Global AIDS Program (known as the President's Emergency Plan for AIDS Relief); NGO support; as well as in-country government support have contributed to nearly 2 million individuals receiving ART in sub-Saharan Africa alone by the end of 2007. However, progress has been uneven across and within countries, and existing funds fall short of what is required in order to serve the nearly 5 million that need ART. The experience of treatment scale-up in South Africa, for example, illustrates many of these issues (for a discussion, see Nattrass 2006).

### **3. Household Impacts of Treatment in Kenya**

In collaboration with a treatment program that was among the first to scale-up HIV care in sub-Saharan Africa, we examined a cohort of patients receiving ART at a rural HIV clinic managed by the Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH). Founded in 2001 through collaboration between Moi University School of Medicine, Moi Teaching and

Referral Hospital, and Indiana University School of Medicine (Mamlin, Kimaiyo, Nyandiko and Tierney 2004), AMPATH has been scaling-up HIV care and treatment at government health facilities in western Kenya. As of early 2008, over 58,000 individuals across 21 health facilities were receiving HIV care from AMPATH, with approximately 23,000 clinically eligible for ART and receiving it free of charge. Details about our survey and the sample selection criteria are discussed in greater length in Thirumurthy, Graff Zivin and Goldstein (2004). Here we provide an overview of the survey and summarize the empirical strategy and results.

### ***3.1. Survey Data***

Our study was based at Mosoriot, one of AMPATH's HIV clinics, based within a government-run primary health care center. This clinic provides free HIV/AIDS medical care, including all relevant tests and ART, to infected individuals who enroll in care. The rural region that is served by the health centre has a population of 35,383 individuals living in 6,643 households (Central Bureau of Statistics 1999). Crop farming and animal husbandry are the primary economic activities of households in the survey area.

We conducted three waves of household surveys between 2004 and 2006, and data from these surveys have allowed us to examine how a variety of measures of socio-economic well-being change due to ART.<sup>3</sup> There was an interval of roughly six months between the first two waves and an interval of eighteen months between the second and third waves.<sup>4</sup> The survey questionnaires collected a range of comprehensive socio-economic information on households and resembled those used by the World Bank's Living Standards Measurement Surveys. Questions were included about demographic characteristics, health, agriculture, assets, income

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<sup>3</sup> Patients who came to the clinic from outside the clinic's catchment area were interviewed at the clinic rather than at home.

<sup>4</sup> As our analysis of the third wave of data is ongoing, this paper primarily emphasizes the results based on the first two waves of data.

and employment, children's school enrollment and attendance, and time allocation to household chores. Teams of male and female enumerators interviewed the household head and spouse, and anthropometric measurements were made for children under the age of 5 years. For in-clinic interviews, all information was obtained from the AMPATH patient.

The survey sample consists of two different groups of households. The first group comprises 503 households chosen randomly from a census of all households in the clinic catchment area without an AMPATH patient (census sample households). In this sample, the HIV status of respondents is usually unknown, unless the respondent gives a self-report of having gone for an HIV test and testing HIV-positive or HIV-negative. The second group comprises 260 households enrolled in the study at the HIV clinic because they contained at least one adult HIV-positive AMPATH patient (at various stages of HIV disease). Of these 260 households, we focus here on the 200 households in which the HIV-positive patient had sufficiently advanced disease that they began receiving ART prior to Wave 2 (we refer to these as ART households).<sup>5,6</sup> Upon completion of the first two waves of the survey, we used the AMPATH Medical Records System (AMRS)—which contains electronic records of clinical and treatment-related information on all patients—to establish which patients in our sample were receiving ART and when they began receiving it. When examining the labor market outcomes of treated patients, we focus on the 191 adult ART recipients who appear in both of the first two

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<sup>5</sup> We include in this sample 2 adults (and their household members) who were originally part of the census sample but enrolled in the AMPATH clinic and began receiving ART between waves. As we discuss below, several other patients in the ART sample also initiated ART between waves.

<sup>6</sup> The analysis in this paper excludes the 60 households with HIV-positive AMPATH patients who were in the early stages of HIV disease and were not yet sick enough to require ART (according to WHO treatment guidelines). We exclude this group from our analysis in this paper because these untreated HIV-positive patients would not have experienced significant health changes during the survey period. The small sample size of these HIV households also limits our ability to use them as a control group in the data analysis. All analysis in the paper is thus restricted to the 200 households with ART recipients and households from the census sample.

waves of the survey. For other household-level outcomes, we focus on the children living in patients' households.

### ***3.2. Empirical Strategy***

Estimating the effect of any intervention ideally requires experimental information from groups that do and do not receive the treatment of interest. In the absence of such data, a variety of non-experimental techniques can be used to assess the impact of the intervention and at the very least determine whether the estimated impacts are likely to underestimate or overestimate the actual impacts. Since the strong evidence on the clinical effectiveness of ART makes randomized controlled trials of ART unethical, we use our longitudinal data from the cohort of ART recipients and census sample individuals to establish the household impacts of treatment.

When observing changes over time in the socio-economic outcomes for the ART recipients, one overarching concern in attributing these changes to the medical treatment is that the changes may be driven by omitted (i.e. confounding) variables that would bias estimates. Given the nature of outcomes we study here, seasonal changes associated with weather and the agricultural season are a key concern. For example, comparing employment levels measured during the middle of the growing season to a later observation that may have occurred during harvest might suggest large labor increases as a result of treatment while these effects were simply an artifact of survey timing. For this reason we make use of data from the census sample to control for the secular trends in the outcome variables within the survey region. Furthermore, to adjust for individual-specific characteristics that may be associated with the average outcome levels for each individual, the regressions we estimate include individual fixed effects. This method can thus be described as a difference-in-difference strategy, in which the outcome variable's changes over time for the ART sample (which represents the "treatment" group) are

compared to changes over time for the census sample (which serves as the “comparison” group).<sup>7</sup>

Since clinical evidence on the impacts of ART suggest that the largest and most significant health improvements occur shortly after ART initiation, we also divide the ART sample into two groups of patients: those who are just beginning treatment at the time of the Wave 1 interview (treatment naïve group) and those who have already been on treatment for more than 100 days as of Wave 1 (treatment non-naïve group). In the results that follow, we document how the temporal patterns in the key outcomes differ for these two groups of ART recipients and their households.

### ***3.3. The Impact of ART on Treated Patients’ Employment Outcomes***

In many ways the impact of ART on the employment outcomes of patients is the starting point for household impacts, since the ability of an adult to work and contribute income to the household has both income and/or substitution effects that may drive many decisions regarding children’s employment and schooling as well food consumption levels. Prior to ART initiation, adult patients at AMPATH’s HIV clinic are significantly less likely to engage in income-earning activities than other adults in the catchment area. Their households are also poorer than households in the clinic’s catchment area. Such comparisons are supported by the literature on the economic impacts of AIDS. As Fox et al. (2004) show in their study of workers at a Kenyan tea plantation, the onset of AIDS leads to significant reductions in productivity. As we discuss in this section, our results suggest that treatment can substantially mitigate the employment effects of HIV/AIDS.

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<sup>7</sup> A key assumption of the difference-in-difference approach is that there are no time-varying characteristics that differ between the ARV sample and the census sample and are also correlated with trends in the outcome variables of interest.

Our survey recorded information on two outcomes that measure an individual's employment status: (1) an indicator of participation in any economic activities during the past week, and (2) the total number of hours worked in the past week. For all household members older than 8 years, the survey recorded this information in each wave for three types of activities: wage and salaried jobs, farming on the household's owned or rented land, and non-farm self-employed work. Our measure of market labor supply is defined as the total hours devoted to all of these activities.<sup>8</sup>

The first indication that both the health and employment status of patients are influenced by ART is provided in Figures 1 and 2. The two figures display the relationship between the duration of time on ART and patients' CD4 cell counts (Figure 1) and hours worked in the past week (Figure 2). The response of CD4 cell count is highly non-linear: at 10-20 weeks, the median CD4 count has risen to levels at which patients are generally asymptomatic ( $CD4 > 200$ ). Subsequent changes are smaller and less consistent. A similar non-linear relationship is found for patients' body mass index (not shown). Figure 2 shows a striking resemblance between the response in CD4 cell count and the response in hours worked, suggesting that the two outcomes are closely related.

When we examine the link between ART and labor market outcomes in regressions that better adjust for omitted variables, we find that ART does indeed lead to a large and significant increase in employment outcomes (Table 1). These changes can be observed in just the six months between the waves 1 and 2 of the survey. Adults receiving treatment are 8.5 percentage points more likely to participate in the labor force in Wave 2 than in Wave 1 (column 1), controlling for various seasonal factors that are evident in both the ART sample and the census

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<sup>8</sup> Information on labor supply of household members was typically provided by the household head, except in the case of clinic interviews, during which the patient provided all information about the household.

sample.<sup>9</sup> Hours worked in the past week also increases significantly in the six months between survey waves, by 4.6 hours (column 2). Relative to the levels in Wave 1, this implies a large increase in labor supply for the entire sample of ART patients: labor force participation rates rise by almost 11 percent, and weekly hours worked rise by 19 percent.

As noted in Section 3.2, the ART recipients can also be divided into treatment naïve and non-naïve groups based on how long they have been on treatment at the time of Wave 1. Columns 3 and 4 of Table 1 show a stronger and even more striking result. The individuals with by far the largest increase in employment outcomes between the two waves are the treatment naïve patients who began receiving ART less than 100 days prior to the Wave 1 interview. The size of these increases is substantial: over the course of six months, patients who have just initiated ART show a 17 percentage point increase in labor force participation rates and work 7.9 hours more per week. Given Wave 1 employment levels of 65.1 percent participation rate and 20.3 hours for this group, the estimates imply a 26 percent increase in participation rates and a 39 percent increase in number of hours worked. In contrast, the other ART recipients in our sample show no statistically significant change in outcomes between waves, suggesting that earlier employment gains are maintained through continued treatment. Thus, the story that emerges from these data is that in the first six months of ART, there are large increases in labor supply. In the second six months of ART, there are no additional changes in labor supply. This temporal pattern in the labor supply response among treated patients very closely resembles the health responses (in BMI and CD4 count) reported in Section 4. As we discuss in Section 4, additional follow-up is necessary in order to establish the longer-term effects of ART. The third wave of

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<sup>9</sup> The coefficient of the variable “Patient on ART \* Wave 2” indicates how much the outcome variable changed between Wave 1 and Wave 2 for patients on ART, after controlling for time trends with data from the census sample.

data we have collected represent one opportunity to estimate such effects (analysis is ongoing), but additional long-term studies of patients receiving ART is also necessary.

*Gender differences in labor supply impacts*

The survey data from each wave of the survey show that men are more likely to be engaged in market labor market activities than women (summary statistics are available in Thirumurthy, Graff Zivin, and Goldstein 2008). We also find gender differences for some components of market labor supply: women are much less likely to work for a wage, but equally likely to work in a non-farm business. This raises the question of whether the labor market impacts of ART differ according to the gender of the patient being treated. To test for such differences, we estimated the impacts separately for men and women.

Importantly, we find that for male patients in the early stages of treatment (treatment naïve in Wave 1), there is no significant increase in labor force participation rates but a large and significant increase of 12.7 hours in weekly labor supply between rounds (a 43 percent increase relative to their average weekly hours worked in wave 1). Among male patients, therefore, those already working prior to initiation of ART are the ones who increase their labor supply after treatment. For women in the early stages of treatment, there is a large and significant increase of 21.8 percentage points in the labor force participation rate between rounds (a 35 percent increase relative to their average participation rate in round 1), but no significant increase in weekly hours worked. This is consistent with our intuition since men have high levels of labor market participation to begin with. Most of their response to improved health takes the form of additional hours worked. Alternatively, for women, initial labor market participation is low, so labor supply is the natural margin for change.

It should be emphasized again that all the results above are *not* based on a comparison of a treatment group consisting of ART recipients to a control group consisting of HIV-positive patients who require ART but do not get it. The medical literature clearly indicates that the latter group will experience continued declines in health and possibly death within 6-12 months. As such, our estimated employment impacts above are likely *underestimates* of the full impact of treatment. This makes the size of the employment impacts above even more striking.

### ***3.4. Household Impacts***

Households in which an adult member falls sick and becomes less able to work may be forced to rely on children to cope with the loss of income and the need for care giving. Our research addresses whether ART—when given to adults after they develop AIDS—improves children’s welfare in a manner consistent with the dramatic improvements in adult patient health. Focusing on several important aspects of children’s lives, the household survey data from Kenya provide a unique opportunity to answer this question. While many of our results are discussed in greater detail in Graff Zivin, Thirumurthy and Goldstein (2006), we provide an overview of them here. In particular, we examine the impact of ART on the amount of time children spend working; on the amount of time they spend in school; and on measures of current nutritional status (for very young children).

Information on the amount of time children spent on various activities was generally obtained from the adult respondent in each household. In order to make a comparison across activities and obtain accurate information, a recall period of 7 days was chosen.

*Impacts on school attendance.* Turning first to the school attendance of children between 8-18 years of age, we find that between the first two waves of the study, there were large and significant increases in hours of school attended in the past week. The first three columns of

Table 2 examine the impact of ART for all children, boys, and girls, respectively. Children in the census sample serve as a “control” for other factors that may be influencing labor and schooling outcomes.

The largest increases in hours of school attended occur for children of ART recipients who were treatment naïve in Wave 1. As column 1 shows, the increase in weekly hours of school attendance in the six months between waves 1 and 2 is 6.4 hours for these children (representing a 21 percent increase relative to their average attendance level in Wave 1<sup>10</sup>). For children in households with an adult who was not treatment naïve, there is no significant change in weekly hours attended. This suggests that significant increases in attendance occur in the first six months after ART is initiated for an adult household member and *remain* at higher levels after six months. In columns 2 and 3, our findings indicate that there are significant increases in hours of attendance for *both* boys and girls in households of ART recipients who are treatment naïve in Wave 1. The increase in school attendance of 8.7 hours for boys is especially large, representing a 29 percent increase relative to their average attendance level in Wave 1.<sup>11</sup> Girls also experience a large and significant increase of 6.5 hours of school attended in the past week. In both cases, the increase in hours of attendance occurs within roughly six months after ART initiation. There is also some evidence of prolonged increases in boys’ school attendance, as those in households on ART recipients who were not treatment naïve in Wave 1 additionally experience a significant increase between waves 1 and 2. This more persistent effect could be due to the fact that boys’ reductions in labor activities show a more drawn out response to treatment, as we will see below.

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<sup>10</sup> The average hours attended is 30.47 for children in households with adult ART recipients who were treatment naïve in Wave 1 or who began treatment shortly after Wave 1.

<sup>11</sup> The average hours attended are 30.15 for boys in households with adult ART recipients who were treatment naïve in Wave 1 or who began treatment shortly after Wave 1.

Ideally, the schooling trends of children in ART households would be compared to those of children in households where ART is needed but not available (a counterfactual group). As we discussed for the case of patients' employment outcomes, such a comparison would reveal the "full" impact of ART on children's schooling. In the absence of such a comparison group, we rely on the literature to reveal what might happen to children's school outcomes in the absence of ART (i.e. if adult morbidity and mortality were to occur). Using longitudinal data from KwaZulu-Natal, South Africa, Case and Ardington (2006) show that children who lose a mother are significantly less likely to remain in school and complete significantly fewer years of schooling than similar-age children whose mothers are alive. The impact of paternal death on children's schooling, on the other hand, is considerably weaker. Beegle, De Weerd and Dercon (2006) examine the long-term consequences with longitudinal data (spanning 13 years) from the Kagera region of Tanzania. They find that maternal death results in a significant reduction in the number of years of schooling completed as well as lower height. There is also evidence from Kenya that children's outcomes begin to worsen even in the years prior to a parent's death, when the parent may be sick with AIDS (Evans and Miguel 2007). In light of these results, it seems likely that the impact of ART on the schooling outcomes of treated adults' children would be *larger* if we compared the children to a counterfactual group (rather than the census sample).

These impacts on school attendance imply that expenditures on ART today can yield benefits to families for years to come. Given the substantial returns to education in developing countries, these results highlight the "investment" aspect of expenditures on ART, underscoring the importance of paying attention to not just the clinical outcomes and productivity of adult patients who receive ART, but also to a broader set of outcomes pertaining to the children of

treated patients. They suggest that the future economic prospects of societies can be brighter as a result of treating adults who are sick today.

*Impacts on child labor.* A natural explanation for the higher school attendance levels in ART households is that these households have a lower demand for children's labor after adult patients become healthier and more productive. It stands to reason therefore that we should observe reductions in the number of hours worked by children once ART is provided. Indeed, there is strong evidence in favor of such a response within the ART households in our study.

In columns 4, 5, and 6 of Table 2, we examine the responses in hours worked in labor market activities (farm, business, or wage labor). There is a large and significant reduction of 4.5 hours in the weekly hours worked for all children in households of ART recipients who were treatment naïve as of Wave 1. For boys in households of ART recipients who were treatment naïve as of Wave 1, there is an average decrease in market labor supply (7.5 hours) in the six months between waves 1 and 2 that is remarkably similar to the estimated increase in weekly hours of school attendance (8.7 hours). The continued decline between waves 1 and 2 in the labor supply of boys in households of patients who were not treatment-naïve in Wave 1 is also accompanied by a corresponding increase in hours of school attendance. Thus, labor reductions for boys associated with improvements in adult patient health closely track increases in their school attendance over the corresponding time period.

The lack of any treatment effect on the market labor supply of girls should be interpreted with caution. Girls in the survey area spend significantly more time in non-market labor activities (such as household chores and care-giving) than market ones. If girls experience decreases in their non-market labor supply when an adult household member becomes healthier due to ART, this will not be captured in the market labor supply measures reported in Table 2.

Indeed, in a recent paper that examines richer time allocation data from waves 1 and 3 of the survey, we have found evidence of significant declines in the number of hours girls spend performing household chores such as water and firewood collection (d'Adda, Goldstein, Nangami, Graff Zivin, and Thirumurthy 2008). This points to the importance of gathering information on multiple activities to which time is allocated, not just market labor activities.

*Impacts on early-childhood nutrition.* Along with increased productivity and income of treated adults comes the possibility that their households can consume more food. This is especially likely to affect the welfare of very young children, whose nutritional status is highly sensitive to changes in food consumption. Our research indicates that these children experience large and significant improvements in their nutritional status, as measured by the Z-score of their weight-for-height. This is a measure of nutritional status that is sensitive to short-term growth disturbances caused by factors such as inadequate food intake (World Health Organization, 1995). Prior to the initiation of ART for adult patients, their children are more malnourished than other children in the clinic's catchment area. Yet this difference is completely erased within six months after ART is initiated, with the weight-for-height measures of children increasing by over 0.5 standard deviations (Graff Zivin, Thirumurthy, and Goldstein 2006). The children in ART households who benefit the most are in fact those who display wasting ( $Z\text{-score} < -2$ ) prior to ART initiation. Such nutritional improvements at early ages have significant implications for the cognitive development, future school performance and employment outcomes of these children (Thomas and Strauss 1997; Glewwe, Jacoby, and King 2001). These may well represent the most long-lasting benefits that society obtains by providing treatment to HIV-infected adults today.

*Impacts on the elderly.* The impacts of ART on the labor supply of adult patients could also have implications for the time allocation patterns of the elderly. During the periods when HIV-infected adults become sick, it is possible that the elderly household members adjust their own labor supply or other activities such as caregiving. For example, in a different setting of Cambodia and Thailand, Knodel (2008) has found that parents of adults who die due to AIDS are more likely to provide shelter and give care to children orphaned by the adult death. An important omission from the labor supply questionnaires used in Kenya is that no information was recorded on the market labor supply of the elderly. Data was collected on the non-market labor supply of the elderly, and analysis of these data is ongoing. One hypothesis that remains to be tested, nonetheless, is whether ART results in reduced labor demand for the elderly who reside in the households of treated adults. On this note, we turn to a wide range of other questions regarding the impact of ART that have yet to be addressed.

#### **4. Evidence from Elsewhere and Directions for Future Research**

Much of the evidence presented so far has been from one clinic in western Kenya. Moreover, these data focus on what happens to ART recipients and their households during the *short-term* horizon of the first 6-12 months of ART. While this evidence documents large socio-economic benefits from providing ART, additional research from other ART programs suggests that these results are generalizable. Two studies from southern Africa indicate that the employment effects of ART on treated patients are quite large. Studying a cohort of patients receiving ART in the township of Khayelitsha, Coetzee and Natrass (2004) find evidence of significant improvements in the labor force participation rates of ART recipients. Habyarimana, Mbakile, and Pop-Eleches (2007) examine human resource data from two mines of the Debswana Diamond Company in Botswana, which provides free firm-based ART to its employees. Using data on absenteeism

rates of workers, the authors find large increases in absenteeism of HIV-infected workers in the year prior to ART initiation. Subsequent to ART initiation, there is a rapid decrease in absenteeism rates. In the period from 2-4 years after ART initiation, treated workers have low absenteeism rates that are similar to those of other mining workers at the Company. Similar evidence has been obtained from South Africa, albeit over a short time horizon of 6-12 months after ART initiation. Based on the evidence from Botswana, then, it appears that the short-term impacts of ART are sustained in the medium-term as well (at least for the case of treated patients' employment). Studies that collect richer household-level information from ART recipients are very much needed in order to learn more about the long-run impacts of ART as well as the generalizability of those results, particularly on children's health and education.

Thus far, we have viewed most of the impacts of ART through the lens of the patient's labor supply. At the same time, ART for people with AIDS (and the prospect of obtaining ART for those in the early stages of HIV infection), through its tremendous capacity to extend life may also change people's planning horizons and thereby lead them to undertake greater investments in the future. Indeed, such a change in perspective may be partly responsible for the human capital investments we documented earlier. Additional work on planning responses could highlight some of the other benefits of ART. For example, those who live longer may invest more in physical capital, have greater environmental stewardship, and engage in additional preventive health behaviors.

Many of the impacts of ART that we have documented are welfare-improving, but changes in sexual behavior in response to treatment availability have the potential to erode some of these benefits. The concern is that for those individuals not in treatment (especially currently uninfected individuals), the availability of ART could result in a lower perceived cost of

engaging in risky sexual behavior.<sup>12</sup> If this were the case, scaling-up ART could pose a challenge to HIV prevention efforts. Empirical research on this topic is crucial, as the magnitude of these effects will help assess the need for companion interventions when ART is scaled-up. It is reassuring that the evidence to date on the sexual behavior of ART recipients themselves indicates that ART results in *reduced* risky behavior and HIV transmission (Bunnell et al. 2006). Absent more direct evidence on community behavior, the provision of more information and counseling to HIV-negative individuals and those of unknown status seems prudent.

In the long-run, for ART to be effective and household impacts to persist, a high rate of adherence to medications is essential. Given that many treatment programs have only been functioning for a limited number of years, evidence on long-term adherence levels and household impacts is, by definition, lacking. Early evidence indicates that patients are highly adherent to ART (Orell, Bangsberg, Badri and Wood 2003), but research on barriers to adherence is necessary (Mills et al. 2006). Similar, longitudinal studies of patients on ART are needed in order to understand the long-term household impacts of treatment.

Properly estimating the costs of ART is another area for further work would be of value. The \$99 annual cost of first-line treatment regimens cited earlier is only one part of the overall costs, as there are other expenditures associated with treatment programs – such as facility construction, staffing, and laboratory tests. These costs are likely to vary according to the locations and socio-economic settings in which treatment programs operate. Moreover, the sustainability of the foreign donor support that enable some treatment programs to be established is an important issue in light of the fact that an interruption in drug supplies for patients receiving ART could result in treatment failure and the development of drug resistance.

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<sup>12</sup> This is considerably less of a concern for those on ART since these drugs significantly reduce infectivity.

## 5. The Economic Rationale for Scale-up of ART

Antiretroviral therapy provides large and significant socio-economic benefits to treated patients and their households. While the benefits from the labor productivity impacts alone outweigh the current costs of treatment (Thirumurthy, Goldstein, and Graff Zivin 2008), a more comprehensive assessment of the costs and benefits of ART is needed for a thorough economic evaluation of this intervention.<sup>13</sup> Additional evidence from large treatment programs and over the long-term is also necessary before drawing stronger policy conclusions. However, the increase in patients' employment outcomes over the short-term is clearly a first step in quantifying the benefits of ART, one that is particularly large in light of the "no ART" counterfactual scenario in which rapid death would occur. This increase in patients' employment frees up time for their children, who can attend more school as a result. In addition, some of the income resulting from patients' employment pays for the cost of the food that leads to improvements in child nutrition. Thus, a second step in the assessment of benefits from ART should account for the long-run investment effects of improvements in education and nutrition at this critical juncture in children's lives.

It is illuminating to consider the long-run effects, for example, of the improvements in child nutrition within ART households. Without the provision of ART, children would be more likely to remain malnourished, the costs of which are highlighted by Behrman et al. (2004). First, malnourished children are less likely to survive into adulthood. Second, malnourished children are more likely to be susceptible to disease, which has societal costs given that primary health care is generally subsidized. Third, malnutrition is associated with lower educational

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<sup>13</sup> It should be noted that calculating the impact of ART on household income using the estimated impacts on labor supply is difficult because the appropriate wage rate to use is not obvious. Those with HIV may not be able to obtain average local wage rates if they are less productive (if their health has not been fully restored, or even after their health has been restored) or if there is HIV-related stigma and discrimination.

attainment for a range of reasons, including an inability to concentrate in class. It is striking that in the absence of ART, children may be doubly cursed as malnutrition and labor burdens will reduce both the quality and quantity of their schooling experience. Lastly, poor early-childhood nutrition will affect labor productivity in adulthood. For example, Thomas and Strauss (1997) show that the height of adults (which can proxy for early childhood nutrition) is associated with higher wages in Brazil. Since the provision of ART to adults improves children's nutritional status and thereby avoids these future consequences of malnutrition, the long-term benefits of ART go well beyond the increase in treated patients' income.

Additionally, emerging work on early childhood development drawing on neuroscience and economics may show that ART affects several outcomes of children beyond those of nutrition and schooling. In a review of early childhood development programs, Knudsen, Heckman, Cameron, and Shankoff (2006) extrapolate from animal studies to argue that "these findings, that both differences in, and disruptions of, close affiliative bonds early in life can have lifelong effects on the development of social behaviors, raise important concerns regarding the extent to which analogous early life experiences influence human development." (p. 10157). A growing strain of neurobiological studies of children also show that severe stress including parental death, particularly when not offset with professional assistance, can lead to both long term physical and mental health problems (for a review, see Center on the Developing Child at Harvard University 2007). Such effects are suggestive of other benefits from the provision of ART, and they deserve further investigation.

It is important to note, however, that the impacts discussed thus far are predominantly private benefits – realized by treated individuals and their immediate family members. While our analysis suggests that treatment is a worthwhile investment for individuals and their families

(uncertainty regarding the long-term notwithstanding), the case for public subsidies and thus international involvement in treatment is less obvious and is a matter for further theoretical and empirical investigation. There are four main issues that would provide justification for public support. Firstly, borrowing constraints, which are a significant concern in low-income settings, may serve as a hindrance to privatizing the market for ART since the flow of costs and benefits occur on different time scales (costs incurred during a period of sickness, and benefits realized at least 6-12 months later). Secondly, the provision of treatment may generate social externalities that will not factor into the decisions of private actors in the *healthcare* marketplace. For example, ART is known to reduce the transmission of HIV and thus imparts important benefits to the sexual partners of those on treatment. On the other hand, by lowering the perceived costs of infection, treatment may lead to more sexually promiscuous behavior. Thirdly, incomplete adherence to ART can lead to virologic failure and drug resistance. If a poorly adherent patient is more likely to spread this strain of the disease, the social costs of such behavior are higher. Finally, in an extension of the human capital discussion above, the social returns to education may exceed private returns and hence any intervention that improves children's education (directly through the education effect of ART or indirectly through improved nutrition leading to improved educational outcomes) could provide some justification for a subsidy. This paper does not delineate the magnitude of all these factors, but suggests issues for further research.

Finally, it is worth considering the potentially large macroeconomic impacts associated with the effects of ART we have documented here, particularly in countries with high HIV prevalence. The model developed by Bell, Devarajan and Gersbach (2006) predicts drastic economic declines (e.g. household incomes of about half in three generations' time), absent interventions to address the problem of HIV/AIDS. The key to this model is the hollowing out

of the human capital core that would have sustained growth. Indeed, the important assumptions here are supported indirectly by our evidence on the household impacts of ART. The provision of ART can thus be one of the critical tools for avoiding the potentially large intergenerational economic effects of HIV/AIDS, and this provides a powerful argument for public support for ART (in combination with other interventions) to ensure economic growth and efficiency (Devarajan and Goldstein 2007).

In this paper, we have shown on the basis of studies in Kenya and elsewhere that, in the first two to three years after ART is initiated, patients receiving the treatment realize large socio-economic benefits. However, ART alone is not enough to stop the scourge of HIV/AIDS. The development of interventions that can effectively stem the spread of HIV/AIDS are certainly necessary and should be scaled-up when they become available. Nonetheless, short of a cure, many countries will still be faced with millions of infected individuals, many of them adults. The experience of several treatment programs in Africa indicates that ART can not only prevent the loss of this current generation of workers, but also restore their economic productivity and help prevent the negative impacts on the health and education of the next generation.

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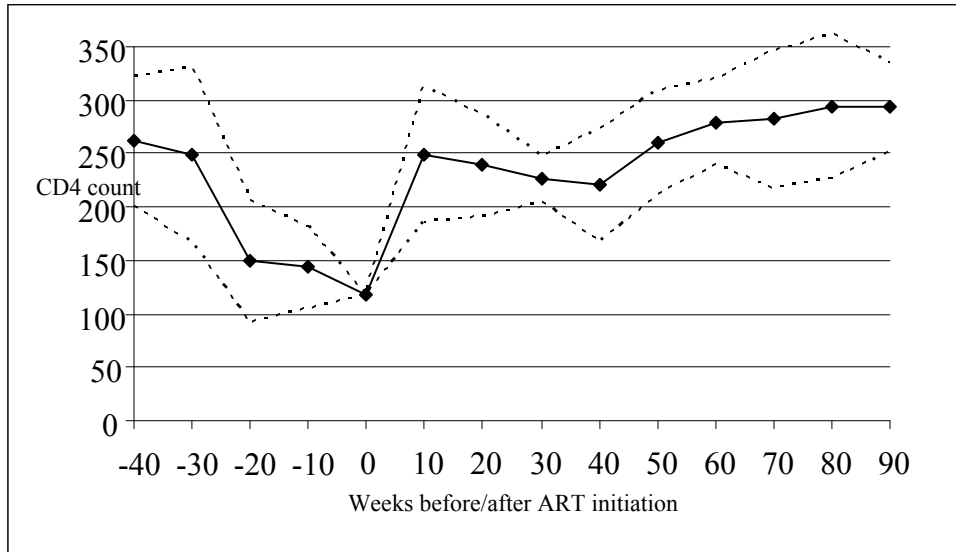
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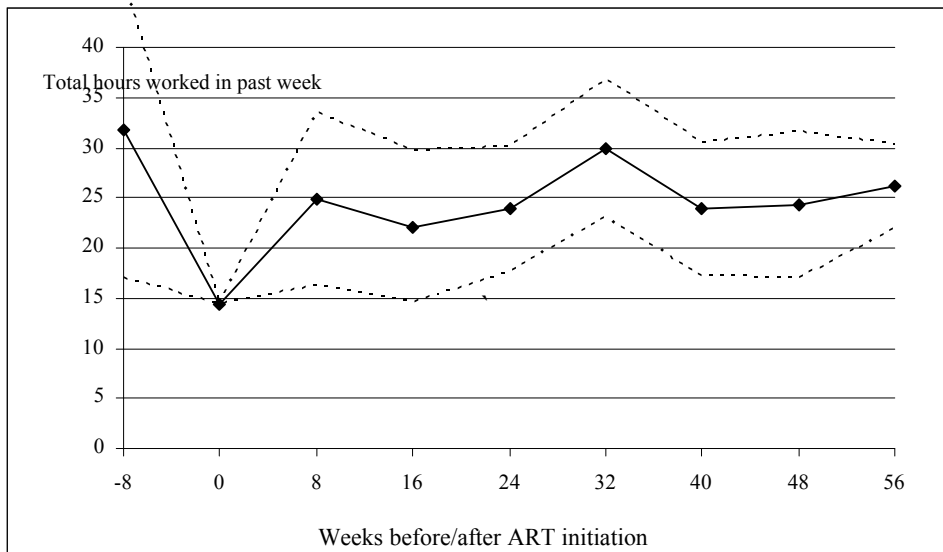
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**Figure 1. CD4 Count Before and After Initiation of ART**



Notes: Figure is generated using CD4 count data in the AMPATH Medical Records System for *all* patients receiving ART at the Mosoriot HIV Clinic. The figure shows the average CD4 count (solid line) in ten week intervals prior to each point in time before or after treatment initiation. The figure also shows the 95 percent confidence intervals (dashed lines) obtained from estimating a linear regression of individuals' CD4 counts on dummy variables for each interval (with the omitted interval being the ten weeks prior to treatment initiation).

**Figure 2. Weekly Hours Worked Before and After Initiation of ART**



Notes: Figure is generated using authors' survey data and shows the average number of hours worked in the past week (solid line) in eight week intervals prior to each point in time before or after treatment initiation. The figure also shows the 95 percent confidence intervals (dashed lines) obtained from estimating a linear regression of individuals' hours worked on dummy variables for each interval (with the omitted interval being the eight weeks prior to treatment initiation). The sample consists of the 191 ART recipients who appear in both waves of the household survey data.

**Table 1. Impact of ART on Labor Supply**

Dependent Variable:	(1)	(2)	(3)	(4)
	LFP	Hours	LFP	Hours
	Individual fixed effects			
Patient on ART * Wave 2	0.085 (2.42)**	4.575 (1.88)*		
Treatment-naïve patient on ART * Wave 2			0.170 (3.07)***	7.860 (2.44)**
Treatment non-naïve patient on ART * Wave 2			0.015 (0.38)	1.920 (0.69)
Constant	0.879 (38.68)***	35.976 (16.96)***	0.879 (39.28)***	35.979 (16.98)***
Observations	2954	2954	2954	2954
Number of adults	0.69	0.75	0.69	0.75

**Notes:** Errors clustered at the household level for each wave and robust t-statistics in parentheses (\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%). Dependent variable LFP indicates whether the individual was engaged in any labor market activity in the past week and Hours is total number of hours devoted to labor market activities in the past week. All regressions include individual fixed effects, a Wave 2 indicator, as well as ten month-of-interview indicators (with one month from each wave omitted to avoid collinearity with the Wave 2 indicator).

**Table 2. Impact of ART on Children's School Attendance and Market Labor Supply**

Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)
	Hours of school attended			Hours worked in past week		
	Individual fixed effects					
	All kids	Boys	Girls	All kids	Boys	Girls
ART hh (treatment naïve) * Wave 2	6.393 (2.792)**	8.673 (3.854)**	6.513 (3.241)**	-4.475 (2.046)**	-7.452 (3.185)**	-0.812 (2.740)
ART hh (treatment non-naïve) * Wave 2	1.893 (2.548)	4.902 (2.770)*	-1.035 (3.941)	-3.276 (1.996)	-7.473 (2.897)**	1.192 (2.833)
Constant	23.649 (3.097)***	23.527 (3.885)***	22.643 (4.144)***	21.776 (2.978)***	27.513 (4.019)***	13.159 (4.595)***
Observations	960	518	442	916	502	414
R-squared	0.83	0.83	0.85	0.78	0.82	0.68

**Notes:** Errors clustered at the household level for each wave and robust t-statistics in parentheses (\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%). The dependent variable is the total number of hours of school attended in the past week (columns 1-3) and the total number of hours devoted to income-generating activities in the past week (columns 4-6). Observations for which school attendance was reported to be below normal because of school holidays during the past week are excluded from the sample. The number of observations in columns 4-6 is smaller than the 960 observations used in columns 1-3 because labor supply information is missing for 44 children. All regressions include individual fixed effects, a Wave 2 indicator, as well as ten month-of-interview indicators (with one month from each wave omitted to avoid collinearity with the Wave 2 indicator).