Health Worker Absence, HIV Testing and Behavioral Change:
Evidence from Western Kenya*

Markus Goldstein[†], Joshua Graff Zivin[‡], James Habyarimana[§], Cristian Pop-Eleches[¶], Harsha Thirumurthy[‖]

August 2008 - Please do not cite/circulate

Abstract

HIV testing and counseling for pregnant women has been scaled-up in sub-Saharan Africa on the grounds that it enables the delivery of medicines that prevent mother-to-child transmission of the virus and promotes behavioral changes among tested women. This paper uses longitudinal data from a high HIV prevalence region to study the take-up of HIV testing and the impact of learning HIV status on a range of health and economic behaviors. We show that health-worker absence is one of the important barriers to take-up of testing among pregnant women. Using health worker absence as an instrument for the endogenous choice of getting tested, we show that learning one's HIV status results in significantly higher probabilities of receiving medication that can prevent the transmission of HIV from mother to child as well as other valuable health services at the time of delivery. We also examine

*This project would not have been possible without the support of the Academic Model for Prevention and Treatment of HIV/AIDS (AMPATH) and members of the IU-Kenya partnership. We are grateful to David Cutler, Rajeev Dehejia, Duncan Thomas, and seminar participants at Harvard for valuable comments. Many individuals contributed to the implementation of the household survey under the direction of Duncan Ngare and the authors. Anja Papenfuss and Leslie MacKeen assisted in managing the survey and the data collection was facilitated by the field supervision of June Ochanda. We also acknowledge the tremendous contributions of interviewer and data entry teams. Financial support for this project was received from the USAID, The World Bank and Yale University's Center for Interdisciplinary Research on AIDS (CIRA) through a grant from the National Institute of Mental Health to Michael Merson, M.D. (No. P30 MH 62294). Pop-Eleches acknowledges the generous support of NBER's Fellowship in Aging and Health Care. The views expressed here do not necessarily reflect those of the World Bank or its member countries. All errors and opinions are our own.

[†]The World Bank, e-mail: mgoldstein@worldbank.org

[‡]University of California, San Diego, International Relations / Pacific Studies, e-mail: jgraffzivin@ucsd.edu

[§]Georgetown University, Public Policy Institute, e-mail: jph35@georgetown.edu

[¶]Columbia University, Department of Economics and SIPA, e-mail: cp2124@columbia.edu

[‖]UNC-Chapel Hill, School of Public Health, harsha@unc.edu

the impact of testing information on investment decisions at the household level. For households of women who test HIV-negative there is an increase in children's schooling and livestock holdings, consistent with models of forward looking economic behavior.

1 Introduction

HIV testing and counseling services have been scaled-up around the world on the basis of two main arguments. First, that they serve as a gateway to treatments that prevent mother-to-child transmission.[1] Second, that informed individuals will engage in safer sex. From an economic behavior point of view, HIV testing also provides households with updated information about their life expectancy, with potentially important implications for their inter-temporal consumption and savings behavior. However, micro-level empirical evidence on these relationships is lacking, in part, because it is difficult to overcome the endogeneity issues that generally accompany the testing decision. Nonetheless, understanding these relationships is critically important given the disparate conclusions reached by a number of papers on the macroeconomic impact of HIV/AIDS.

In this paper, we use longitudinal data from nearly 600 expecting mothers at an antenatal care (ANC) clinic in western Kenya to estimate the impacts of HIV testing on household investment, education, fertility, health care utilization decisions and the transmission of HIV from mother-to-child. We conducted two waves of a survey, before and after child birth. At the time of enrollment and before clients were offered an HIV test, an intake survey was administered to elicit information on demographic and socioeconomic characteristics. The intake survey was followed by a longer household survey that was administered at the women's homes a few months after delivery. To avoid the selection problems that bias OLS estimates of the impact of HIV testing, we instrument for the testing decision with an indicator of health worker absence on the day when pregnant women first seek antenatal care.

Our analysis contributes to the literature on the effect of information (or expectations) about future health status on forward-looking health and economic behavior. A recent strand of this literature looks at the effect of HIV/AIDS on a range of economic outcomes, with population-level measures of HIV prevalence serving as indicators of future health and longetivity.[2] While two notable studies (Coates et al. 2006 and Thornton 2008) have

[1] A single dose of nevirapine, an antiretroviral medication, provided at the time of delivery reduces the probability of mother-to-child transmission by about 50 percent. A short course of highly active antiretroviral therapy before child birth is even more effective (Global HIV Prevention Working Group (2006).

[2] See Fortson (2008) on the impact of HIV prevalence on schooling and Oster (2007) on risky behavior.

evaluated the impact of providing HIV testing at the individual level on the adoption of safer sex practices[3], much less is known about the impacts of learning HIV status on a broader set of economic behaviors, such as investment in assets, children education and fertility. It should be noted that the separation of the different mechanisms through which information about HIV status affects economic behavior is empirically difficult. HIV testing provides information not only about one's own future health and longevity, but potentially also about the longevity of one's partner and children. Our data do not permit a separation of each of these different channels.[4] Nevertheless, the reduced form impacts estimated in our analysis are vital to corroborating the assumptions underlying the results of a number of important macro-economic papers on the impact of HIV/AIDS. Each of these papers make various assumptions about the primary channels through which the epidemic affects long term well-being, with opposite assumptions about the response of fertility (see Young 2007 and Kalemli-Ozcan 2006) and human capital investments (Young 2005 and Bell, Devarajan and Gersbach 2006) to the epidemic.

The second contribution of this paper is to the burgeoning literature on service provider absence in developing countries (see Chaudhury et al. 2005 for an overview of teacher and health worker absence). While a few papers have looked at the impact of health provider absence on the quality and provision of health services (see Banerjee, Deaton, and Duflo 2004)[5], we provide the first estimates, to our knowledge, of the health impacts that result from such absence.

Our empirical strategy begins with a validation of health service provider's absence as an instrument for women's HIV testing decisions. The lone prevention-of-mother-to-child-transmission (PMTCT) trained nurse was absent from work on approximately 9 percent of the days when the ANC clinic was open. First time visitors to the ANC clinic who arrived on a day when the PMTCT nurse was absent were nearly 60 percentage points less likely to have tested for HIV over the entire course of their pregnancy. This impact of

[3]Coates et al. (2006) find an increase in self-reported safe sexual behavior amongst a cohort of voluntary counseling and testing clients in Kenya. Thornton (2008) finds little evidence of a change in demand for condoms in Malawi.

[4]An important mechanism that is consistent with our results is the change in behavior due to changes in information on life expectancy (see Jayachandran and Lleras Muney 2008).

[5]Bjorkman and Svensson (2007) show a large positive impact of higher community monitoring on health outcomes that possibly operates through higher provider attendance. Duflo and Hanna (2005) and Das et al. (2007) look at the impact of teacher absenteeism on educational outcomes.

nurse absence on HIV testing is large and robust to controlling for pre-test beliefs about HIV status and the day of the week on which the first ANC visit occurred. We also show that the nurse's absence is uncorrelated with a wide range of observable characteristics of pregnant women in the study. Finally, we provide a number of additional institutional details and robustness checks that further validate the instrumental variables strategy.

The second part of our empirical strategy focuses on the impact of HIV testing on health care utilization decisions. Our instrumental variables estimates suggest that women who test HIV-positive are over 20 percentage points more likely to report receiving PMTCT medications than women who do not get tested. Based on the medical efficacy of PMTCT medications in preventing HIV transmission, this behavioral effect is an important benefit of HIV testing. In addition, women who test HIV-positive are about 20 percentage points less likely to breastfeed their child, which is another important channel of mother-to-child transmission of HIV. Our results also reveal an increase in demand for additional health care services that increase the probability of a safe delivery: women who get tested are about 22 percentage points more likely to have sought the assistance of a professional nurse or doctor during delivery and 21 percentage points more likely to deliver at a hospital than women who do not get tested for HIV. These results indicate that health worker absence—by reducing the likelihood that pregnant women are tested for HIV—has far-reaching implications for the health outcomes of women and their children.

Using the same instrumental variables strategy, we examine the impact of testing on household investment decisions. We find sizable behavioral responses in the households of women who learn that they are HIV-negative. Compared to households of women who do not get tested for HIV, households of women who test HIV-negative have changes in forward-looking behavior that are consistent with the predicted response to a longer planning horizon. In particular, these women's households are more likely to increase their livestock holdings and their children are more likely to be enrolled in school. The opposite effects do not hold as strongly for women who test HIV-positive, perhaps because disclosure of status to spouses and household members is considerably lower for this group. Contrary to prevailing assumptions about the AIDS epidemic and fertility in the macroeconomic literature, we do not find any evidence of changes in fertility preferences in response to learning HIV status.

We further explore these results by examining how the behavioral responses differ by the degree of surprise and the extent of updating based on differences in subjective beliefs about being HIV-positive. Boozer and Philipson (2000), for example, argue that the amount of new information contained in an HIV test result—as measured by the difference between the test result and subjective beliefs before the test—determines the magnitude of the behavioral response. While we acknowledge the low power of our tests, our results do not show consistent differences in behavioral outcomes based on the degree of surprise and updating among pregnant women. This tentative finding is consistent with the general idea advanced by Loewenstein et al. (2001), which would suggest that learning status definitively is a more salient feature of the test result than the size of the informational update.

The remainder of the paper is organized as follows. Section 2 provides background information on HIV testing and counseling during antenatal care and describes the data, Section 3 presents the empirical strategy, Section 4 presents results on the effects on health-worker absence, the relationship between HIV testing and subjective beliefs about HIV status, as well as the main results on the impact of learning HIV status on behavior. Section 5 concludes.

2 Background and Data

The data used in this study were collected by the authors between July 2005 and February 2007. The first wave of data was collected as an in-clinic survey between July 2005 and February 2006. The second wave was a household-based survey implemented between May 2006 and February 2007. The study enrolled a sample of pregnant women attending an antenatal clinic at a rural health center in western Kenya. The health center is located in Maseno Division, a region that has a population of over 60,000 individuals and lies within Kenya's Nyanza Province. The health center serves a predominantly rural population even though a number of patients from the peri-urban areas of Maseno division use the clinic. The ethnic composition of clinic users is predominantly Luo although about 10 percent of the sample are Luhya. HIV prevalence in Nyanza Province is the highest of all the provinces in Kenya. Data from the 2003 Demographic and Health Survey (DHS) suggests that 18.3 percent of adult women in the province are HIV-positive, compared to a national average of just under 7 percent. The health center offers outpatient, inpatient and antenatal care services. It also includes an HIV care and treatment clinic that is managed by the Academic Model for Prevention and Treatment of HIV/AIDS (AMPATH) program. The AMPATH program provides PMTCT services for pregnant women who are HIV-positive as well as highly active antiretroviral therapy (HAART) for patients who have developed AIDS at no cost to the patient.

Typically, women make two to three visits to the antenatal clinic during their pregnancy. In addition to receiving routine antenatal care, women are offered HIV testing and counselling during their first visit. If they decline the test during the first visit or if a PMTCT nurse counsellor is not present, the women are generally offered HIV testing and counselling during subsequent visits. Women who test HIV-positive are counselled on ways to prevent transmission of the virus to her partner and her child. For PMTCT, the women are typically referred to the AMPATH's HIV clinic, which is in the same health center. AMPATH provides a full course of HAART to these women during the period before and after delivery (there is no charge for the treatment, and the administrative data from AMPATH allow us to establish whether the women in the study enroll in AMPATH).[6] Women are also encouraged to deliver at the health center.

Enrollment into the study was limited to pregnant women visiting the ANC for the first time between July 2005 and February 2006. During enrollment, a short intake questionnaire was administered *prior* to engaging with the staff at the ANC (this is referred to as wave 1 of the study). This questionnaire obtained information on socioeconomic status, fertility preferences, HIV knowledge and subjective beliefs about a woman's own HIV status as well as her partner's. Data on the presence of the PMTCT nurse on any given day, whether the pregnant women consented to the HIV test, and the test result itself (with patient consent) were obtained from the administrative records of the antenatal clinic.[7] Since patients who did not test during the first visit could test on subsequent

[6]Women who enroll in the AMPATH program may have different unobservable characteristics compared to women who do not enroll in the program. Since HIV-positive women self-select into the AMPATH program, we do not estimate separate effects for HIV-positive who did and did not enroll in the program.

[7]The PMTCT nurse was defined as absent if on a given day when the ANC clinic was open there was no entry in the PMTCT logbook. We also kept separate records of PMTCT nurse absenteeism in order

visits to the ANC, the administrative records were used to routinely update the HIV testing status of enrolled women. During the first wave, we also obtained consent from the women to visit them at their homes after delivery.[8] Only a handful of first round respondents did not consent to be visited. 591 women who were interviewed at the clinic during wave 1 were located in wave 2, and sample attrition between rounds was under 10 percent.[9] The second wave of the study was part of a large community-based study of maternal health. This wave of the study included a longer survey questionnaire that included a household roster, questions on education, health, consumption, marriage, sexual behavior, assets, income, and transfers. Interviews were also conducted with the husband or cohabiting partner of each woman (if he was present). The geographical coordinates of households and anthropometric data on women and children were also collected during the home visits.

In order to ensure comparability of our data with nationally representative data, questions were worded similarly to those in the DHS. Care was taken to ensure that interviews were conducted with sufficient privacy. Wave 1 of the study lasted approximately 40 minutes, including the time taken for obtaining informed consent. Three experienced female enumerators conducted the interviews in Kiswahili, Luo or Luhya depending on the language preferences of the subjects. Due to the time and space constraints in administering the survey at the antenatal clinic, a relatively small number of questions could be asked. This implies a limited number of outcomes for which panel information is available.

The average age of the 591 women interviewed in both waves of the survey is 24.7 years, and 59 percent of them report having completed primary school. Just over one third of the women report being married, while 40 percent report living with their partner and 20 percent report being unmarried or living separately from their partner. On several important dimensions, our sample is comparable to the 2003 DHS sample from Nyanza Province. Nearly three quarters of the women in both samples live in houses that have a roof made out of durable materials. Along the dimension of desired fertility, both samples

to make sure that days on which all ANC visitors refused the test are not coded as days of PMTCT nurse absence. Such a coincidence did not occur during our sample period.

[8] Using the expected date of delivery from the administrative records, household visits for the intake respondents were scheduled for approximately two months after delivery.

[9] In the majority of cases we could not complete the household interview because the respondent could not be located, despite considerable efforts to track down respondents as far as Nairobi.

report a similar average desired number of 4 children. Knowledge about HIV/AIDS is very high in both samples. Nearly 90 percent of women in both samples report knowing that an individual who appears healthy can have HIV and that HIV can be transmitted from a mother to a child. A similar proportion of women in both samples report knowing someone who has died of HIV/AIDS. In terms of subjective beliefs about one's own HIV status, just over 30 percent of women in both samples report having a moderate or high chance of being HIV-positive. Finally, testing rates appear considerably higher in our sample; women enrolled at the ANC are 3 times more likely to have tested. This difference is likely driven by the temporal differences on testing and the availability of ARVs (see Wilson 2007).[10]

3 Empirical Strategy

Our main econometric challenge for estimating the impact of HIV testing on behavioral outcomes is the fact that a significant proportion of women who receive antenatal care at the clinic do not actually get tested for HIV. In our sample, just over 75 percent of women get tested during any of their visits to the clinic. Ordinary least squares estimates of the impact of testing may therefore be biased since unobservables that drive the testing decision could be related to changes in the behavioral outcomes. We address this selection issue by using an instrumental variables strategy. On about 10 percent of the days when the ANC is open, the PMTCT nurse who is supposed to conduct HIV counseling is absent from the hospital, even though the pregnant women still receive standard prenatal care from other ANC staff. The PMTCT nurse's absence on the day of a woman's first visit is strongly associated with whether that woman tests at any point during her pregnancy. This effect holds even after controlling for the day of the week and is uncorrelated with the background variables of the women in our sample. Even though some of the women who show up on days with an absent PMTCT nurse do eventually get tested for HIV on subsequent visits, absence of the PMTCT nurse at the first prenatal visit is a strong

[10]There is also a sharp difference in mosquito net ownership: nearly twice as many women in our sample report owning a mosquito net compared to the DHS sample. The difference likely arises from the temporal difference and the aggressive marketing and distribution of mosquito nets that has taken place in this area in the intervening period.

predictor of HIV testing during pregnancy.

The first step of our empirical strategy is to estimate the overall effect of testing on a range of behavioral outcomes. The estimation of the overall impact of testing is of interest because it allows us to understand how the expansion of HIV testing could affect the course of the HIV epidemic as well as socioeconomic responses at the household level. We propose the following first difference regression specification:

$$\Delta y_i = \beta_o + \beta_1 \Delta X_i + \gamma_1 T_i + (\varepsilon_{it+1} - \varepsilon_{it}) \tag{1}$$

where Δy is the change in one of our outcome variables of interest (such as livestock holdings, child investments, fertility preferences) between the two survey rounds, X is a set of control variables, and T is an indicator for receiving an HIV test during a visit to the prenatal care clinic between the survey rounds. The coefficient of interest is γ_1, which indicates the change in behavior between rounds for women who had an HIV test. Since our first wave questionnaire was administered at the clinic and had to be very brief, it included fewer questions than the extensive household survey that we implemented in the field in the second round. Therefore a number of our outcomes of interest are only measured in the second wave and for these variables we will run a levels regressions instead of the first difference regressions described above.

We use the presence of the PMTCT nurse on the day of the first ANC visit to deal with the endogeneity of taking the test. As discussed previously, the PMTCT nurse is absent from the antenatal clinic on 10 percent of the days when the ANC is open. In specification (1) above, we instrument for T_i with an indicator for the nurse's presence on the day of first prenatal visit.

However, there are many reasons to expect the behavioral response to testing for HIV will depend on the test result that is obtained. Compared to a woman who learns she is HIV-negative, a woman who tests HIV-positive will face different incentives to change her behavior (due to the fact that she is more likely to transmit the virus to her child or partner, as well as the fact that her household's horizons may be revised). Indeed, as discussed by Boozer and Philipson (2000), the effects of learning HIV status may be underestimated if we do not adequately control for the amount and type of new information gained from learning HIV status. Below we propose an empirical strategy to estimate the impact of testing by HIV test result. Assuming we had information on the HIV status of all women in the sample, we could estimate the following equation:

$$\Delta y_i = \beta_o + \beta_1 \Delta X_i + \gamma_1 T_i + \gamma_2 HIV\_POS_i + \gamma_3 T_i * HIV\_POS_i + \Delta\varepsilon_i \qquad (2)$$

where HIV_POS_i is an indicator variable taking value 1 if the woman is known to be HIV-positive during the course of her pregnancy. The instruments are indicators for nurse's presence and the interaction term, nurse presence*HIV_POS, for T_i and $T_i * HIV\_POS_i$ respectively. This IV strategy permits the estimation of the causal effect of testing HIV-negative (γ_1) as well as the causal effect of testing HIV-positive ($\gamma_1 + \gamma_3$). The latter effect would be estimated by comparing the trends in the outcome variable for HIV-positive women who do learn their status from testing to the trends for HIV-positive women who do not learn their HIV status. The need to control for the effect of being HIV-positive (γ_2), independent of whether women get tested and learn their status definitively, stems from the possibility that these women may have beliefs about their status or trends in characteristics that differ from those of HIV-negative women and cause them to modify their behavior over time.

But in practice we do not know the HIV status of women who do not get tested during their pregnancy and therefore cannot estimate γ_2. The challenge therefore is to create proper comparison groups for women who get tested and learn they are HIV-negative and HIV-positive. Under a plausible structural assumption that $\gamma_2 = 0$ in the equation above we instead estimate the following specification:

$$\Delta y_i = \beta_o + \beta_1 \Delta X_i + \gamma_1 T_i + \gamma_2 T_i * HIV\_POS_i + \gamma_3 * \pi_i + \Delta\varepsilon_i \qquad (3)$$

This specification contains an additional variable (π_i) that controls for the subjective beliefs that women have about their chances of having HIV/AIDS during wave 1 of the survey (i.e. just before their first antenatal clinic visit). A formal interpretation of our structural assumption is that:

$$E[\Delta y_i^{+ve}|T_i = 0, \pi_i, \Delta X_i] = E[\Delta y_i^{-ve}|T_i = 0, \pi_i, \Delta X_i] \quad (4)$$

In words, conditional on not testing, there is no difference in expected changes in y over time whether true status is HIV-positive or HIV-negative *after controlling for subjective beliefs at the time of her first ANC visit* and any other changes in observable characteristics. One concern might be that there are unobserved differences in health trends between HIV-positive and -negative women, which in turn affect their trends in y. However, this is unlikely to be the case since pregnant women who happen to be HIV-positive are likely to be in the early stages of HIV infection which means that they are asymptomatic and generally healthy. We therefore assume that for women who do not get tested, their subjective beliefs about HIV status during the first wave of the study are a sufficient statistic for actual HIV status. This implies that their actual (unobserved) HIV status should not exert any independent effects on behavior. As we show below, the data on pre-testing subjective beliefs contain meaningful information about underlying status, and they are also updated accurately upon learning HIV status.

Another alternative to specification 3 above, is to split the sample into two groups. Group 1 contains those who test HIV-positive and those who do not test and group 2 contains those who test HIV-negative and those who do not test. Then using the basic testing specification, we estimate the following equation separately for the two groups:

$$\Delta y_i = \beta_o + \beta_1 \Delta X_i + \gamma_1 T_i + \gamma_4 * \pi_i + (\varepsilon_{it+1} - \varepsilon_{it}) \quad (5)$$

In this case, we have just one endogenous variable (T_i) in the specification and one instrumental variable (presence of the PMTCT nurse). The interpretation of $\widehat{\gamma}_1^+$ would be the effect of testing for women who test HIV-positive and similarly $\widehat{\gamma}_1^-$ would be the effect of testing for women who test HIV-negative, with the comparison group being women who do not test but have similar subjective beliefs in wave 1. In the results below, we focus on estimates of equation 3 but results of equation 5 are similar and available from the authors.

4 Results

This section presents the results from examining the effects of HIV testing on a variety of behavioral outcomes. Our analysis is restricted to 591 pregnant women who were enrolled in our study during their first visit to the antenatal clinic and were found at home during wave 2 of the survey. Table 1 presents summary statistics of several key variables, for the entire sample of 591 women as well as the sub-samples of women who tested HIV-negative and HIV-positive. As noted earlier, 77 percent of women enrolled in our study and located in wave 2 were tested for HIV during one of their antenatal clinic visits (not necessarily on the first visit, during which they were enrolled in the study). Among those tested, nearly 20 percent obtained an HIV-positive result. For 91 percent of the women, a PMTCT nurse was present on the day of the first ANC visit. Several outcomes pertaining to the pregnancy and delivery are of interest. First, women's self-reported information during wave 2 on whether testing and counselling services were offered at the ANC correspond well to the actual testing rate indicated by the PMTCT logbooks (the self-reported rates are in fact slightly higher). While nearly half the women in our sample report that they delivered their child with the assistance of a traditional birth attendant and at home, 38 percent reported having had the assistance of a doctor or medical professional.

Table 1 also summarizes the other outcome variables that we examine. Some of these outcome variables are discussed further below. Subjective beliefs about one's chances of having HIV/AIDS were measured in each wave on a scale of 1-4 (with 1 indicating "no chance at all" of having HIV and 4 indicating a "great chance"). The mean for this subjective measure of beliefs is 2.24 in wave 1. For women who tested HIV-positive, the mean in wave 1 is clearly higher than the mean for HIV-negative women. The survey also sought to learn about the fertility preferences of women. In wave 1, 71 percent of women reported a desire for more children (in addition to the current pregnancy). One important measure of wealth, the number of cows or calves owned by the woman's household, indicates that the women who tested HIV-positive come from households that are slightly poorer than those of HIV-negative women.

4.1 PMTCT nurse presence as an instrumental variable

The decision to undergo an HIV test is likely to be driven by a number of factors. For example, the sexual behavior of women and their perceptions of their sexual partners' HIV risk will undoubtedly influence the desire to get tested. A number of other factors such as the perceived risk of domestic violence stemming from disclosure of test results and the perceived benefits of PMTCT services will also affect demand for an HIV test. The endogeneity of the testing decision is therefore likely to confound the identification of the impact of testing on a variety of behavioral outcomes. However, the supply of HIV testing and counselling services also influences the likelihood of getting tested. In order for testing and counselling to occur, a PMTCT nurse must be present at the clinic. As Table 2a indicates, information on the absence of this nurse provides us with a plausible identification strategy because it helps determine whether women who attend the antenatal clinic actually get tested for HIV. When we examine whether or not women get tested during the course of their pregnancy, the presence of a PMTCT nurse who offers testing and counselling services during the day of the first antenatal visit increases the probability that a woman is tested during her pregnancy by 58 percentage points. Since women who attend the clinic on a day when the PMTCT nurse is absent may not have another opportunity to be tested, the results indicate that the absence of the PMTCT nurse during the first visit happens to be critical.

One concern might be that absence of the PMTCT nurse is more common during certain days of the week such as market days, and that women who attend the clinic on these days may be less likely to be tested for reasons unrelated to nurse absence. Column 2 of Table 2a indicates that even when we control for the day of the week during which the first ANC visit took place, the large and significant effect of the nurse's absence remains. Similarly, the result is robust to the inclusion of controls for the subjective expectations that women have about their own HIV status before they are tested. In Table 2b, we provide further evidence that the presence of a PMTCT nurse on the day of a woman's first antenatal visit is uncorrelated with characteristics of pregnant women. We report the results from a cross-sectional regression of the indicator of nurse presence on a variety of characteristics about the pregnant woman. By and large, the likelihood that a nurse is absent on the woman's first antenatal visit is uncorrelated with observable characteristics such as the age and education of the women. Higher ownership of livestock (cows and calves) does appear to be associated with higher likelihood of having a nurse present on the day of the first visit, but apart from that no other important variables are significantly associated with nurse presence.[11]

The identifying assumption underlying our analysis is that after controlling for observable characteristics, such as the day of the week of the visit or the priors about HIV/AIDS, the demand for testing for women who visit the clinic on days when the nurse is present is the same as on days when she is absent. Our empirical strategy would be invalid if for example a selected subsample of women with particular unobservable characteristics who want to avoid testing come to the clinic for ANC care on days when the PMTCT nurse is absent (or more likely to be absent).

A number of institutional details and additional robustness checks may help assuage any remaining doubts about this identification strategy. First, based on our two year long experience working with the clinic, absences of the medical staff are rarely preannounced or advertised. Second, since the majority of women travel significant distances to the clinic it is unlikely that they could have access to such information at home, even if it were available. Third, the average rate of nurse absence (9 percent of days) and the variation by day of week, which ranges from 4 percent on Mondays to 20 percent on Fridays, is small enough that strategically choosing to visit on a day when testing can be avoided seems unlikely. This possibility is made all the more implausible by the fact that women may always decline to be tested for HIV (20 percent of women who visit on a day when the nurse is present do indeed decline to be tested). Fourth, we have performed a number of additional robustness checks (not reported) and found no consistent relationship between the characteristics of women and the day of the week when they visit the ANC clinic. For example, there is no significant relationship between the distribution of beliefs that women have about HIV/AIDS and the day of the week when they visit the ANC clinic, as well as the distribution of beliefs about HIV status and the presence of the PMTCT nurse.

To summarize, for the purpose of this paper – to examine the impact of testing on a

[11]Our IV results are robust to controlling for inital level of livestock. In addition, we control for day of the week on which the first ANC visit is made in all of our regressions.

variety of socioeconomic outcomes – the results presented in this section suggest that the indicator variable for whether or not a PMTCT nurse is present at the clinic can provide a plausibly exogenous source of variation that is unlikely to be correlated with other variables that might affect testing. Thus, the presence of the PMTCT nurse can serve as an instrumental variable to control for the selection process that may be occurring when women decide whether to get tested.

While PMTCT nurse absence exerts a large effect on testing, it should be emphasized that the nurse's rate of absence at the clinic is considerably lower than levels that have been documented in other developing country settings (see Chaudhury et al., 2005). Average levels of absence for nurses from a multi-country study are more than three times as large. Anecdotal evidence from the study area suggests that the reasons for absence include official reasons such as collection of salaries and attendance at workshops, illness of self/members of the family and funeral attendance. Nevertheless, we find that PMTCT nurse absence can be useful for identifying the causal effect of learning HIV status, and in addition our first-stage result alone underscores an important point: that even low rates of health worker absence can have large consequences for public health.

4.2 Subjective beliefs and HIV testing

While Tables 2a and 2b show why the data on the PMTCT nurse's absence can be useful for dealing with the endogeneity of women's testing decisions, robust estimation of the impact of learning HIV status requires identifying an appropriate comparison group for the women who do get tested and learn their status. As noted in Section 3, the sample of women who did not get tested during the course of their pregnancy can serve as a reasonable comparison group provided that these women's subjective beliefs about their HIV status serve as a good proxy for actual HIV status (data on these beliefs during the first antenatal clinic visit are available for all women enrolled in our study, regardless of whether they tested for HIV or not). This allows us to pool testers and non-testers in the regressions reported below. The assumption can be called into question, however, if subjective beliefs are not good indicators of women's HIV status and, particularly if underlying status exerts independent effects on future behavior, independent of beliefs.

In Table 3, we examine the relationship between subjective beliefs in wave 1 and actual

HIV status using the sample of women who *did* get tested for HIV during one of their antenatal visits. We confirm that subjective beliefs contain useful information about the women's actual HIV status. Column 1 of Table 3 shows that compared to women who reported "no chance at all" of having HIV/AIDS at the time of enrollment, women who reported a "moderate" or a "great" chance were approximately 17 and 27 percentage points more likely to test HIV-positive (these differences are statistically significant). These results persist even when we control for factors such as the day of the week during which the first ANC visit occurred. Adding observable characteristics of women in column 3 (such as age, education, and wealth) reduces the predictive power of beliefs slightly, as indicated by the p-value of the joint test. However, even then, we reject the null of no-information in reported beliefs at the 5% level. The results in Table 3 indicate that data on subjective expectations do indeed contain important information about the risk of being HIV-positive, and as such these data can plausibly be used as a proxy for HIV status of women who did not learn their HIV status during their pregnancy.

A natural question that can be answered using the second wave of survey data is whether women update their subjective beliefs after learning their HIV status. Proper updating would be consistent with the results above, which confirm the predictive power of reported beliefs in wave 1. This would also provide additional motivation for the possibility that women may change their forward-looking behavior after learning their HIV status.[12] We therefore estimate equation 3 with the dependent variable being the change in subjective beliefs between waves 1 and 2. Since greater subjective risk of having HIV is indicated by larger numbers in the subjective measure, a positive change over time implies that the respondent's subjective belief about her HIV status shifted towards a *higher* probability of having HIV/AIDS in wave 2. In Table 4 we present results from estimating OLS and IV regressions that estimate the effect of learning HIV status on subjective beliefs. As the results in column 1 show, women who test HIV-positive update their subjective beliefs substantially compared to women who do not test but have similar pre-test subjective beliefs (the sum of the coefficients γ_1 and γ_2 in equation 3) and also

[12] It could be argued, however, that changes in behavior as a result of learning one's HIV status need not be accompanied by updated subjective beliefs if, for example, women did not understand the question on subjective beliefs about HIV status, or if women who tested HIV-positive deny their HIV status when reporting subjective beliefs in the second round.

compared to HIV-negative women (the coefficient γ_2 in equation 3). On a scale of 1-4 (4 being the highest chance of having HIV/AIDS and 1 being no chance), the IV estimates imply that the average increase in the subjective belief index is 0.5 index points greater for HIV-positive women than the corresponding change for HIV-negative women. HIV-positive women display an even larger increase in the subjective belief index compared to women who do not get tested but have similar prior beliefs about their HIV status. The results in column 1 are fairly similar under the OLS and the IV specifications, suggesting that in this case the endogeneity of the testing decision does not lead to large bias in the estimated coefficients. The results also indicate that women who test HIV-negative do not significantly change their subjective beliefs.[13] The results in Tables 3 provide convincing evidence that women's reported subjective beliefs in wave 1 of the study have a great deal of predictive validity, and moreover, as Table 4 show, the reported beliefs do indeed get updated (on average) in ways we would expect based on women's HIV test result.

As further evidence that learning about HIV occurs after the HIV test, column 2 of Table 4 shows that women who test HIV-positive also significantly change their subjective beliefs that *their main partner* is HIV-negative (the belief is measured as a binary indicator variable). In the OLS and IV regressions, compared to women who do not test for HIV but have similar prior beliefs about their HIV status, women who test HIV-negative have no significant decrease in their subjective belief that their partner is HIV-negative. On the other hand, women who obtain an HIV-positive test result report a decrease in their subjective belief that their partner is HIV-negative that is 23 percentage points greater than the change reported by women who test negative.

Given the evidence that HIV testing affects the subjective HIV risk assessments of women who get tested, we now examine whether HIV testing leads to modifications in a variety of individual and household decisions.

[13] Additional results not reported here show that when we examine the change in a binary indicator of whether the respondent reported that she had a "great" or "moderate" chance of having HIV/AIDS, we find a significant increase in the probability that women who test HIV-positive report having such chances in the second wave than in the first wave.

4.3 Effect of HIV testing on likelihood of receiving PMTCT services

The most immediate impact of HIV testing and counselling during antenatal care is that it can increase the likelihood that women take-up important services that can affect child delivery outcomes. The first and foremost reason for offering HIV testing during antenatal care is that it identifies HIV-positive women who can be given medications for the prevention of mother-to-child transmission of HIV. To enhance the chances that PMTCT medications are taken at the time of delivery, it is typically advised that HIV-positive women deliver in a health center or at the very least use a professional birth attendant who can administer the PMTCT medications. More broadly, for all women who take advantage of HIV testing and counselling, the PMTCT counsellor reinforces the importance of delivering at a health center or using birth attendants.[14] Since pregnant women and their households may weigh the costs of delivery in a formal setting against the perceived benefits, information gained during pre- and post-test counselling sessions may alter the trade-offs towards safer delivery and greater take-up of PMTCT medications.

The impact of HIV testing and counselling on these antenatal, delivery, and postnatal outcomes is reported in Table 5. Panel A shows the results from OLS regressions while panel B shows the results from IV regressions that use the PMTCT nurse's presence at the clinic as an instrument for getting tested. As in the interpretation of the results of Table 4, we are interested in multiple comparisons – i.e. women who test HIV-negative compared to women who do not test but share similar pre-test beliefs about their HIV risk (γ_1 in equation 3), women who test HIV-positive compared to women who test HIV-negative (γ_2 in equation 3), as well as women who test HIV-positive compared to women who do not test but share similar pre-test beliefs ($\gamma_1+\gamma_2$ in equation 3).

Column 1 of Table 5 examines data from wave 2 on women's self-reports about whether or not they received treatment for PMTCT (the question asked whether the women were given any medication before or during delivery to prevent HIV/AIDS transmission). For women who tested HIV-negative, both the OLS and IV estimates show no significant impact of learning HIV status on the likelihood of reportedly getting PMTCT medication.

[14] This evidence is based on an interview at the clinic with the PMTCT nurse.

This result is consistent with the fact that PMTCT medications are generally given to HIV-infected mothers only. Column 1 shows that women who tested HIV-positive are significantly more likely to report getting PMTCT medications than HIV-negative women (the IV estimates in panel B indicate they are 18 percentage points more likely to get medications). The F-statistic indicates that positive testers are also significantly more likely to report getting PMTCT medications than non-testers with similar subjective beliefs about their HIV status.

In columns 2 and 3 we show that HIV testing also has a significant impact on the delivery choices of women. The IV results suggest that compared to women who do not get tested for HIV, women who test are 21 percentage points more likely to have delivered in a hospital setting and also 22 percentage points more likely to report having the assistance of a professional (nurse or doctor) during delivery. Women who test HIV-positive are not signficantly more or less likely than those who tested HIV- to have relied on professional assistance or hospitals, which is due to the fact that the pre- and post-test counselling urges all testers (independent of status) to choose these delivery options. These results suggest that HIV testing and counselling during antenatal care has beneficial impacts on the choices made by *both* HIV-positive and HIV-negative women.

We also examine whether HIV testing influences the likelihood of breastfeeding. This is based on women's self-reports about whether they are breastfeeding their newborn child during wave 2 of the study. We find no significant effect on the likelihood of breastfeeding by women who test HIV-negative. However, we find that obtaining an HIV-positive result does have a significant effect on the likelihood of breastfeeding. Since breastfeeding newborn children is generally discouraged for HIV-positive mothers (due to likelihood of transmitting HIV), these results suggest an important prevention benefit stemming from HIV testing and counselling. Women who test HIV-positive are about 22 percentage points less likely to report breastfeeding than women who test HIV-negative. The results above represent the first estimates of the effect of health provider absence on health outcomes that we are aware of.

4.4 Effect of HIV testing on investment behavior

Our results so far indicate a sizeable impact of testing and counselling on the prevention of new infections around the time of delivery. In this section, we turn our attention to socio-economic decision-making and analyze the impact of learning HIV status on forward-looking behavior. As previously mentioned, HIV testing provides the households in our sample with new information about their future health and life expectancy, which could lead them to make adjustments in their consumption and saving behavior. We focus on all the outcomes that were included in *both* rounds of data collection and plausibly represent such behavior. We analyze changes in child-related investments, measured by changes in the desired number of children as well as school enrollment of children. In addition, we analyze changes in household investments using a measure of livestock holdings.[15]

We first discuss the impact of HIV testing on those who test HIV-negative. In both waves of the study, women were asked whether they desired any additional children beyond the pregnancy during which enrollment in the study occurred. Changes in these responses due to the learning of HIV status are noteworthy in light of the recent debate about the fertility response to the HIV/AIDS epidemic (see Young, 2007 and Kalemi-Ozcan, 2006). Columns 1, 3, and 5 of table 6 estimate specification 1, while columns 2, 4, and 6 estimate specification 3. We can see that the average effect of HIV testing on changes in fertility preferences is not statistically significant (column 1). For women who test HIV-negative, our results also do not provide any evidence that fertility preferences change in response to the test result. For instance, in column 2, the IV estimates are not statistically significant at conventional levels, although the size of the impact (5 percentage points) is large and positive.

There is strong evidence that schooling utilization improves significantly in the households of women who learn they are HIV-negative. The IV estimates indicate that, relative to households of non-testers, these households have an increase of 21 percentage points in the fraction of their children between 6 and 18 years who are reported to be enrolled in school during the past six months (column 4). This finding is consistent with the possi-

[15] In addition to the fertility, education and livestock variables, the only other investment variable included in both rounds was a question about landholdings. We have excluded this variable since many women did not report/know the size of their household's landholdings. We have decided not to use any of the investment outcomes included only in the second round in order to avoid selective reporting.

bility that obtaining an HIV-negative test result signals a higher life expectancy, leading those households to invest more in their children. Turning to another measure of investment – the number of cows and calves owned by the women's households – we again find strong evidence that investment increases the most in the households of women who learn they are HIV-negative. As column 6 of Table 6 shows, for these women's households the number of cows and cattle owned increases by over 2 between the first and second waves of the study (a change that is statistically significant).[16] In sum, our evidence indicates that the households of women who find out that they are HIV-negative increase their investment levels. This finding is consistent with the behavioral response to an increase in life expectancy in a standard inter-temporal model of saving and investment. Turning to the behavioral responses of women who test HIV-positive, the results in Table 6 do not indicate that these women and their households change their investment levels significantly more than non-testers. This is true for all three forward-looking behaviors studied – fertility preferences, schooling patterns, and livestock holdings.

4.5 Heterogenous Effects and Updating

One theory of the relationship between information and behavioral change would suggest that, rather than simply the type of new information provided (i.e. the test result of HIV-positive or -negative), it is the amount of new information that ultimately determines how much behavioral change should occur. The amount of new information, in this case, would be measured by the extent to which the test result differed from women's subjective beliefs about their HIV status in wave 1 (we refer to this as the level of surprise presented by the test result). Alternatively, the amount of new information could be represented by the change in women's subjective beliefs between waves 1 and 2 (we refer to this as the extent of updating about own HIV status that takes place after the test). In the last two tables of the paper, we examine whether the level of surprise and updating for women has an effect on changes in investment behavior. In Table 7, we estimate the impact of obtaining an HIV-positive result while controlling for binary measures of whether women were surprised by the test result and whether they updated their HIV status. In Table 8,

[16] This result is robust to controlling for the initial level of livestock. Doing this addresses concerns that our estimates correspond to a natural rates of growth of livestock and not purposive accumulation.

we estimate the impacts of obtaining an HIV-negative result. Our results indicate that by and large, the extent to which the test result differs from subjective beliefs does not have an effect on behavior. Similarly, whether or not women update subjective beliefs about their own HIV status does not influence behavior. While these results need to be interpreted with care since they are imprecisely estimated, they suggest that the effect of learning one's HIV status definitively dominates any effects that stem from whether or not women were surprised by the test result or updated their reported subjective beliefs. For further discussion of the psychological underpinnings of this possibility, see Loewenstein et. al (2001).

5 Conclusion

Using a panel dataset of close to 600 pregnant women who sought antenatal care in a high HIV prevalence area of Kenya, we first assess the impact of health provider absence on HIV testing and health outcomes. We then use this relationship to identify the impact of learning HIV status on a variety of economic behaviors.

Our analysis starts by showing that health-worker absence is one of the important barriers to take-up of testing among pregnant women. We then try to understand the implications of absence of health facility staff for public health. Compared to pregnant women who do not get tested for HIV due to health worker absence, women who test HIV-positive are significantly more likely to receive PMTCT medications at the time of delivery. They are also more likely to deliver their child at a health care facility or in the presence of a trained health professional. Combining our estimates with data on patient flow at the antenatal clinic and the effectiveness of medications in reducing mother-to-child transmission (see the Appendix for details on calculations), nurse absence contributes to an additional .37 infections per 1,000 live births. This absence rate observed in our study is much lower than has been found elsewhere. If we were to apply the same estimates to the 35 percent absence rate documented in some other developing country settings (Chaudhury et al. 2005), then nurse absence would be responsible for about 1.46 additional infections per 1,000 live births. These numbers appear staggeringly large when compared to the rather small expenditure that would be required to provide substitute nurse coverage in the clinic and this suggests that policies to address health worker absence would prove to be important and worthwhile investments.

The main part of the analysis uses nurse absenteeism as an instrumental variable to identify the effect of information about health status on a variety of economic outcomes. Our analysis of investment responses to learning HIV status provides evidence that is consistent with models of forward-looking economic behavior. Households of women who test HIV-negative acquire more livestock and are more likely to send their children to school. In this part of Kenya, where livestock is one of the principal components of household wealth and the returns to children's education are extremely high (Psacharopoulos 1994), such behavior has implications for the long-term well-being of these families. At the same time we do not find evidence for a change in fertility preferences as a result of testing.

More generally, our findings that the responses to learning HIV status are large in terms of investment in human capital and productive assets and negligible in terms of fertility preferences have important implications for the literature on the long-run macroeconomic implications of HIV/AIDS. Contrary to the findings in this paper, both Young (2007) and Kalemli-Ozcan (2006) emphasize fertility as the primary channel through which the epidemic affects economic growth. The results on investment in this paper are consistent with the assumptions in Bell, Devarajan and Gersbach (2006), and to a limited extent Young (2005), where investment-in-human-capital channel is the primary channel.

References

Allen, T., and Heald. S., 2004. "HIV/AIDS policy in Africa: what has worked in Uganda and what has failed in Botswana?" Journal of International Development, 16, 1141–1154.

Banerjee, Abhijit & Angus Deaton & Esther Duflo, 2004. "Wealth, Health, and Health Services in Rural Rajasthan," American Economic Review, American Economic Association, vol. 94(2), pages 326-330, May.

Bell, Clive & Shantayanan Devarajan & Hans Gersbach, 2006. "The Long-Run Economic Costs of aids: A Model with an Application to South Africa," World Bank Economic Review, Oxford University Press, vol. 20(1), pages 55-89.

Boozer, Michael & Tomas Philipson, 2000. "The impact of public testing for human immunodeficiency virus." The Journal of Human Resources, 35(3):419–446.

Central Bureau of Statistics (CBS) [Kenya], Ministry of Health (MOH) [Kenya], and ORC Macro. 2004. Kenya Demographic and Health Survey 2003. Calverton, Maryland: CBS, MOH and ORC Macro

T. J. Coates, O. A. Grinstead, S. E. Gregorich, D. C. Heilbron, W. P. Wolf, K. H. Choi, J. Schachter, P. Scheirer, A. van der Straten, M. C. Kamenga, M. D. Sweat, I. De Zoysa, G. Dallabetta, K. R. O'Reilly, E. van Praag, D. Miller, M. Ruiz, S. Kalibala, B. Nkowane, D. Balmer, F. Kihuho, S. Moses, F. Plummer, G. Sangiwa, M. Hogan, J. Killewo, D. Mwakigile, and C. Furlonge, 2000 "Efficacy of voluntary HIV-1 counselling and testing in individuals and couples in Kenya, Tanzania, and Trinidad: A randomised trial". Lancet, 356(9224):103–112, 2000.

Chaudhury, Mazmul & Jeffrey Hammer & Michael Kremer & Karthik Muralidharan & F. Halsey Rogers, 2006. "Missing in Action: Teacher and Health Worker Absence in Developing Countries," Journal of Economic Perspectives, American Economic Association, vol. 20(1), pages 91-116, Winter.

Das, Jishnu & Dercon, Stefan & Habyarimana, James & Krishnan, Pramila, 2007. "Teacher shocks and student learning : evidence from Zambia," Journal of Human Resources, 42 (4).

Canning, David. 2006. "The Economics of HIV/AIDS in Low-Income Countries: The Case for Prevention," Journal of Economic Perspectives, American Economic Association, vol. 20(3), pages 121-142, Summer.

Duflo, Esther & Hanna, Rema, 2005. "Monitoring Works: Getting Teachers to Come to School," CEPR Discussion Papers 5426, C.E.P.R. Discussion Papers, revised

Duflo, Esther & Dupas, Pascaline & Kremer, Michael & Sinei, Samuel, 2006. "Education and HIV/AIDS prevention : evidence from a randomized evaluation in Western Kenya," Policy Research Working Paper Series 4024, The World Bank, revised

Dupas, Pascaline, 2007. “Relative Risks and the Market for Sex: Teenagers, Sugar Daddies and HIV in Kenya,” mimeo.

Fortson, Jane, 2008. ”Mortality Risk and Human Capital Investment: The Impact of HIV/AIDS in Sub-Saharan Africa”, mimeo.

Global HIV Prevention Working Group. 2006. “New Approaches to HIV Prevention: Accelerating Research and Ensuring Future Access”.

Jayachandran Seema & Adriana Lleras-Muney, 2008. ”Life Expectancy and Human Capital Investments: Evidence From Maternal Mortality Declines,” NBER Working Papers 13947.

Kalemli-Ozcan, Sebnem. 2006. ”AIDS, ”Reversal” of the Demographic Transition and Economic Development: Evidence from Africa,” NBER Working Papers 12181

Loewenstein, G., E. Weber, C. Hsee, and N. Welch (2001), Risk as feelings. Psychological Bulletin 127, 267-286.

Oster, Emily. 2007. ”HIV and Sexual Behavior Change: Why Not Africa?,” NBER Working Papers 13049.

Psacharopoulos G. 1994. “Returns to investment in education: a global update”. World Development 22: 1325-1343.

Strauss, John & Duncan Thomas, 1998. “Health, Nutrition, and Economic Development,” Journal of Economic Literature, American Economic Association, vol. 36(2), pages 766-817, June.

Svensson, Jakob & Bjorkman, Martina, 2007. “Power to the people : evidence from a randomized field experiment of a community-based monitoring project in Uganda,” Policy Research Working Paper Series 4268, The World Bank, revised .

Thornton, Rebecca, 2008. “The Demand for and Impact of HIV Testing: Evidence from a Field Experiment”, *forthcoming* American Economic Review

Wane, Waly & Gauthier, Bernard, 2007. ”Leakage of public resources in the health sector : an empirical investigation of Chad,” Policy Research Working Paper Series 4351, The World Bank, revised

Wilson, Nicholas, 2007. “Antiretroviral Therapy and Demand for HIV Testing: Evidence from Zambia”, Brown University Mimeo

Young, Alwyn, 2005. “The Gift of the Dying: The Tragedy of Aids and the Welfare of Future African Generations,” The Quarterly Journal of Economics, MIT Press, vol. 120(2), pages 423-466, May.

Young, Alwyn, 2007. “In Sorrow to Bring Forth Children: Fertility in the midst of the Plague of HIV,” *forthcoming* Journal of Economic Growth.

Table 1: Summary Statistics

	All women enrolled			**HIV- women**			**HIV+ women**		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Variables									
School years completed	7.07	1.83	587	7.08	1.83	363	6.94	1.83	90
Tested for HIV	0.77	0.42	591						
Tested HIV-positive	0.20	0.40	456						
Nurse present at first ANC visit	0.91	0.29	591	0.97	0.17	366	0.98	0.15	90
Received counselling/testing - self-report	0.88	0.32	590	0.92	0.27	365	0.88	0.33	90
Had assistance of professional at delivery	0.38	0.49	591	0.40	0.49	366	0.38	0.49	90
Delivered at the health center	0.18	0.39	591	0.20	0.40	366	0.18	0.38	90
Delivered in the health center or hospital	0.39	0.49	591	0.40	0.49	366	0.41	0.49	90
Data from Waves 1 and 2									
Subjective belief about HIV status (Scale 1-4 increasing in risk)									
Wave 1	2.24	0.88	587	2.21	1.02	363	2.59	1.10	90
Wave 2	2.22	1.06	576	2.14	1.02	359	2.77	1.12	86
Desires more children									
Wave 1	0.71	0.46	591	0.71	0.46	366	0.64	0.48	90
Wave 2	0.67	0.47	590	0.68	0.47	365	0.58	0.50	90
Number of cows owned									
Wave 1	2.10	3.48	589	2.31	3.93	364	1.74	2.75	90
Wave 2	1.43	4.33	591	1.67	5.28	366	0.77	1.71	90
Average school enrollment rate of children in household									
Wave 1	0.66	0.39	223	0.64	0.39	199	0.77	0.33	24
Wave 2	0.60	0.41	223	0.59	0.41	199	0.70	0.44	24
Data from Wave 2 only									
Mother reports breastfeeding newborn child	0.95	0.22	591	0.99	0.10	366	0.76	0.43	90

Notes: SD is the standard deviation and N is the sample size. Source: Sample of women enrolled during first ANC clinic visit (wave 1) and interviewed at home after delivery (wave 2).

Table 2a: Effect of nurse absenteeism on testing

	Tested for HIV (1)	Tested for HIV (2)	Tested for HIV (3)
PMTCT Nurse Present	0.584	0.577	0.568
	(0.061)**	(0.063)**	(0.063)**
Day of week = Tuesday		0.052	0.056
		(0.050)	(0.050)
Day of week = Wednesday		0.102	0.105
		(0.048)*	(0.048)*
Day of week = Thursday		0.079	0.086
		(0.047)+	(0.047)+
Day of week = Friday		-0.027	-0.026
		(0.056)	(0.056)
HIV subjective beliefs			
Moderate chance			0.022
			(0.053)
Small chance			-0.038
			(0.046)
No chance at all			-0.073
			(0.057)
Constant	0.241	0.209	0.243
	(0.058)**	(0.071)**	(0.079)**
Sample Size	591	588	584
R-squared	0.16	0.18	0.18
F-statistic	93.09	84.71	81.07

Notes: The dependent variables are defined in Table 1. "Tested for HIV" takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. PMTCT Nurse Present takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 2b: Predictors of PMTCT nurse presence

	Nurse present at time of woman's first visit	
	(1)	(2)
Age in years	0.001	0.001
	(0.002)	(0.002)
Completed primary school	-0.020	-0.017
	(0.026)	(0.026)
Married	0.021	0.027
	(0.039)	(0.038)
# of church attendances (past 4 wks)	0.011	0.012
	(0.004)*	(0.004)**
Number of sexual partners (past 6 mths)	0.007	0.010
	(0.035)	(0.034)
Boils drinking water	0.035	0.038
	(0.026)	(0.025)
HIV subjective beliefs		
Moderate chance	0.012	0.010
	(0.039)	(0.040)
Small chance	-0.029	-0.032
	(0.037)	(0.038)
No chance at all	-0.071	-0.078
	(0.049)	(0.049)
Livestock ownership	0.003	0.003
	(0.002)	(0.002)*
House has non-grass roof	-0.033	-0.032
	(0.028)	(0.028)
Household resides in clinic catchment	-0.001	-0.001
	(0.028)	(0.028)
Day of week = Tuesday		-0.013
		(0.029)
Day of week = Wednesday		-0.028
		(0.030)
Day of week = Thursday		-0.085
		(0.033)**
Day of week = Friday		-0.193
		(0.046)**
Constant	0.865	0.909
	(0.081)**	(0.080)**
Observations	577	574
R-squared	0.03	0.08

Notes: The variables are defined in Table 1. "Nurse present at time of woman's first visit" takes value 1 if the PMTCT nurse was present at the ANC clinic on the day of the first visit during a particular pregnancy, 0 otherwise. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 3: Subjective beliefs before HIV test and actual test results

	Tested positive (1)	Tested positive (2)	Tested positive (3)
Chance of having HIV- great	0.272	0.267	0.226
	(0.097)**	(0.098)**	(0.098)*
Chance of having HIV- moderate	0.171	0.168	0.126
	(0.081)*	(0.082)*	(0.080)
Chance of having HIV- small	0.077	0.079	0.055
	(0.059)	(0.059)	(0.059)
Day of week controls?	N	Y	Y
Other controls	N	N	Y
Mean of dep. variable	0.197	0.197	0.197
Sample Size	453	452	452
Chi2-statistic	12.55	11.75	8.81
prob>Chi2	0.01	0.01	0.03

Notes: The results are based on probit regressions; marginal effects are reported. The variable "tested positive" takes value 1 if a pregnant woman was tested HIV positive during any visit at the ANC clinic during pregnancy, 0 otherwise. The omitted category among the subjective belief responses is "Chance of having HIV - no chance at all." Other controls include age, education, marital status and wealth. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 4: Effect of testing on HIV-related knowledge

	Change in subjective beliefs about HIV own status	Change in self-reported beliefs that partner is HIV -
	(1)	(2)
Panel A:OLS		
Tested for HIV	0.075	0.074
	(0.109)	(0.065)
Tested positive	0.577	-0.291
	(0.135)**	(0.076)**
Constant	-1.683	0.117
	(0.186)**	(0.104)
F-test: Tested+Positive=0	17.68	5.91
prob>F	0.00	0.02
Panel B: IV		
Tested for HIV	0.369	-0.127
	(0.303)	(0.165)
Tested positive	0.507	-0.233
	(0.150)**	(0.087)**
Constant	-1.900	0.264
	(0.285)**	(0.155)+
F-test: Tested+Positive=0	10.71	6.21
prob>F	0.00	0.01
Controls included?	Y	Y
Sample Size	569	584

Notes: The dependent variables are defined in Table 1. Tested for HIV takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. The variable "Tested positive" takes value 1 if the HIV test was positive, 0 otherwise. Controls include pre-test priors and day of the week. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 5: Effect of Testing on PMTCT Outcomes by HIV status and AMPATH enrollment

	Given any medication to prevent MTCT (1)	Delivered at hospital (2)	Had assistance of professional at delivery (3)	Breastfed baby (4)
Panel A:OLS				
Tested for HIV	0.005	0.092	0.103	0.012
	(0.020)	(0.049)+	(0.048)*	(0.015)
Tested positive	0.183	-0.001	-0.034	-0.214
	(0.044)**	(0.060)	(0.059)	(0.044)**
Constant	0.071	0.411	0.416	0.925
	(0.035)*	(0.079)**	(0.079)**	(0.029)**
F-test: Tested+Positive=0	16.06	1.83	1.07	19.49
prob>F	0.00	0.18	0.30	0.00
Panel B: IV				
Tested for HIV	0.028	0.212	0.225	0.029
	(0.059)	(0.124)+	(0.121)+	(0.056)
Tested positive	0.181	-0.033	-0.068	-0.225
	(0.047)**	(0.067)	(0.066)	(0.046)**
Constant	0.052	0.322	0.325	0.914
	(0.055)	(0.115)**	(0.114)**	(0.048)**
F-test: Tested+Positive=0	10.92	2.67	2.14	9.48
prob>F	0.00	0.10	0.14	0.00
Controls included?	Y	Y	Y	Y
Sample Size	571	576	576	576

Notes: The dependent variables are defined in Table 1. Tested for HIV takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. The variable "Tested positive" takes value 1 if the HIV test was positive, 0 otherwise. Controls include pre-test priors and day of the week. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 6: Effect of Testing on Socio-Economic Behavior

	Change in desire for more children		Change in avg. school enrollment of children (6-18 years) in household		Change in livestock	
	(1)	(2)	(3)	(4)	(5)	(6)
<u>Panel A:OLS</u>						
Tested for HIV	0.001	0.009	0.026	0.030	-0.077	0.005
	(0.050)	(0.051)	(0.036)	(0.037)	(0.415)	(0.477)
Tested positive		-0.044		-0.018		-0.421
		(0.055)		(0.038)		(0.459)
Constant	-0.004	0.001	-0.071	-0.071	-1.412	-1.366
	(0.081)	(0.082)	(0.054)	(0.054)	(1.040)	(1.049)
F-test: Tested+Pos=0		0.26				1.48
prob>F		0.61				0.22
<u>Panel B: IV</u>						
Tested for HIV	0.037	0.050	0.201	0.212	1.946	2.168
	(0.112)	(0.119)	(0.115)+	(0.120)+	(1.190)	(1.290)+
Tested positive		-0.057		-0.053		-0.993
		(0.063)		(0.045)		(0.570)+
Constant	-0.033	-0.028	-0.215	-0.215	-3.060	-2.976
	(0.114)	(0.113)	(0.109)*	(0.109)*	(1.456)*	(1.449)*
F-test: Tested+Pos=0		0		2.56		1.56
prob>F		0.94		0.11		0.21
Controls included?	Y	Y	Y	Y	Y	Y
Sample Size	583	583	370	370	579	579

Notes: The dependent variables are defined in Table 1. "Tested for HIV" takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. The variable "Tested positive" takes value 1 if the HIV test was positive, 0 otherwise. Controls include pre-test priors and day of the week. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 7: Effect of Testing on Behavioral Outcomes for HIV+ women, by surprises and updates

	Change in desire for more children	Change in avg. school enrollment of children (6-18 years) in household	Change in livestock
	(1)	(2)	(3)
Panel A:OLS			
Tested for HIV	0.032	-0.029	-0.418
	(0.084)	(0.059)	(0.459)
Surprised	0.028	0.026	-0.211
	(0.107)	(0.080)	(0.567)
Updated	-0.120	0.088	-0.187
	(0.133)	(0.069)	(0.743)
Constant	0.052	-0.113	-0.221
	(0.066)	(0.065)+	(0.449)
Panel B: IV			
Tested for HIV	0.156	0.279	1.538
	(0.288)	(0.297)	(1.30)
Surprised	-0.061	-0.216	-1.723
	(0.241)	(0.235)	(1.10)
Updated	-0.134	0.088	-0.264
	(0.139)	(0.070)	(0.79)
Constant	0.025	-0.179	-0.655
	(0.085)	(0.105)+	(0.507)
Controls included?	Y	Y	Y
Sample Size	210	129	208

Notes: The dependent variables are defined in Table 1. "Tested for HIV" takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. "Surprised" takes value 1 if the woman's subjective belief about her status prior to the HIV test was "small risk" or "no risk at all." "Updated" takes value 1 if the woman's subjective belief about being HIV-positive was higher after the test than before the test. Controls include pre-test priors and day of the week. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Table 8: Effect of Testing on Behavioral Outcomes for HIV- women, by surprises and updates

	Change in desire for more children	Change in avg. school enrollment of children (6-18 years) in household	Change in livestock
	(1)	(2)	(3)
Panel A:OLS			
Tested for HIV	0.031	0.031	0.172
	(0.052)	(0.046)	(0.565)
Surprised	-0.018	-0.003	-0.414
	(0.084)	(0.044)	(0.518)
Updated	0.004	0.001	-0.259
	(0.098)	(0.040)	(1.011)
Constant	-0.036	-0.055	-0.895
	(0.056)	(0.045)	(0.528)+
Panel B: IV			
Tested for HIV	0.085	0.249	2.736
	(0.132)	(0.177)	(1.564)+
Surprised	-0.036	-0.109	-1.264
	(0.095)	(0.096)	(0.739)+
Updated	0.002	0.014	-0.249
	(0.100)	(0.038)	(1.063)
Constant	-0.070	-0.170	-2.570
	(0.094)	(0.101)+	(1.108)*
Controls included?	Y	Y	Y
Sample Size	477	309	473

Notes: The dependent variables are defined in Table 1. "Tested for HIV" takes value 1 if a pregnant woman was given an HIV test during any visit at the ANC clinic during pregnancy, 0 otherwise. "Surprised" takes value 1 if the woman's subjective belief about her status prior to the HIV test was "high risk" or "moderate risk." "Updated" takes value 1 if the woman's subjective belief about being HIV-positive was lower after the test than before the test. Controls include pre-test priors and day of the week. Robust standard errors in brackets. **, * and + indicate statistical significance at the 1, 5 and 10 percent level respectively.

Appendix A:

Below we provide a more detailed explanation for the imputation of the number of HIV infections that could be averted by the elimination of nurse absences. First we provide an estimate of the prevalence rate of eventual non-testers whose first ANC visit happened on a day when the nurse is absent. Second we combine these estimates with information from the medical literature on the relationship between PMTCT medication and reductions in HIV transmission at birth. Third we calculate the impact of absence on the number of transmissions in a given year for the absence level at our clinic, as well as for typical absence rates in the health sector in developing countries more generally.

Based on a number of plausible assumptions, we generate five distinct estimates of the prevalence rate of pregnant women who did not test due to nurse absence on the first ANC visit:

1.) We assume that the prevalence rate of non-testers is equal to the prevalence rate of testers (19.7%)
2.) We assume that the prevalence rate of non-testers is equal to the adult prevalence rate in the 2003 Kenyan DHS for the Nyanza region (18.3%).
3.) We assume that the prevalence rate of women who turn up for their first ANC visit on days when the nurse is absent (group 1) is the same as on days when she is present (group 2). Among eventual testers for these two groups, the prevalence rate is 19.9% (group 2) and 15.4% (group 1). The testing rates for these groups are 82.5% (group 2) and 24.1% (group 1). The resulting prevalence rate for non-testers who would have tested if the nurse was present is 21.8%.
4.) We use the background characteristics of the women who test to predict in a regression framework the prevalence of all non-testers (20.7%).
5.) We use the background characteristics of the women who test to predict the prevalence of all non-testers whose first visit is on a day when the nurse is absent (19.1%).

Across each of the five different assumptions, the calculated prevalence rate for the group of interest is roughly 20% and varies between 18.3% and 21.8%.

Using the estimates reported in UNAIDS (2005), rates of mother-to-child transmission and the impact of different PMTCT regimens are as follows:

1. Default mother to child transmission rate without any intervention: 32%
2. No intervention, long breastfeeding (18-24 months): 35%
3. No intervention, short breastfeeding (6 months): 30%
4. No intervention, replacement feeding: 20%
5. Single-dose NVP (mothers & infants), combined with short (6 months) breastfeeding (6 months): 16%
6. Single-dose NVP (mothers & infants), combined with replacement feeding: 11%
7. AZT long (from 28 weeks) and single-dose NVP (mothers & infants), combined with short breastfeeding (6 months): 10%
8. AZT long (from 28 weeks) and single-dose NVP (mothers & infants), combined with replacement feeding: 2%

According to the treatment regimen in place at the time of the survey, the most common treatment was AZT long with single-dose NVP combined with short breastfeeding, which has an estimated transmission rate of 10%. Therefore the treatment with PMTCT in our setting reduces the transmission rate at birth among HIV positive women by approximately 22 percentage points (32% to 10%).

On a typical day, a PMTCT nurse conducts testing and counseling to an average of 4.1 pregnant women. When she is absent, about 58% of first time ANC visitors do not test during the pregnancy. Since the prevalence rate is estimated to be around 20% for this group and testing increases the chance of receiving medication to prevent MTCT for those who are positive by 18 percentage points, this means that a one day absence results in roughly .09 (=4.1*.58*.2*.18) positive women do not receive PMTCT. This translates into an *increase* in the HIV transmission from the mother to the child of .019 (.09*.22) cases. If we apply this estimate to the typical absence rate in our clinic (9%), then nurse absence contributes to an additional .42 infections per year (assuming 250 working days in a year). If we apply these estimates to the much larger absence rates found in the literature (35%), then nurse absence contributes to about 1.65 infections per year per nurse.

Taking into account the fraction of women that visit ANC clinics (88%) and neonatal mortality (33 per 1000 live births), these numbers translate into 0.37 infections per 1000 live births (9% absence) and 1.46 infections per 1000 live births (35% absence rates).