The impact of the AIDS pandemic on health services in Africa: Evidence from Demographic Health Surveys

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1. Introduction

In the past twenty years, the AIDS crisis has had crippling effects on the health care systems of many countries in sub-Saharan Africa. The increase in morbidity that accompanies HIV has greatly increased demand for health services. At the same time, the pandemic has compromised the ability of health systems to deliver care, as health professionals fall ill and leave the system, and as health budgets shift resources toward AIDS and the vertical delivery of care for those infected with HIV (Lancet 1995, Jones et al 2003, Colvin 2005, Easterly 2008).

AIDS often places a large tax on households' budgets. Prime-aged adults who fall ill may need to leave the labor force. Other family members may also find it necessary to change their work patterns, in order to care for the sick. These costs, together with the financial costs of covering illnesses associated with AIDS, can lead to 'medical poverty traps' (McIntyre et al 2005).

These strains on health systems and households have taken their toll. In this paper, we document the impact of the AIDS crisis on non-AIDS related health services in eight sub-Saharan African countries. Using multiple waves of Demographic and Health Surveys (DHS) for each country, we examine antenatal care, birth deliveries, and rates of immunization for children born between 1988 and 2003. We find deterioration in the delivery of nearly all of these dimensions of health care over this period. The most recent DHS survey for each country collected data on HIV prevalence, which allows us to examine the association between HIV burden and health care. We find that erosion of health services is highly correlated with increases in AIDS prevalence. Regions of countries that have light AIDS burdens have witnessed small or no declines in health care, using the measures noted above, while those regions currently shouldering the heaviest burdens have seen the largest erosion in treatment for pregnant women

and children. Using semi-parametric techniques, we can date the beginning of the divergence in health services between high and low HIV regions to the mid-1990s.

We begin in Section 2 by introducing the DHS data we use to examine the impact of HIV on health care delivery. We discuss our estimation strategy in Section 3. We present evidence on the associations between HIV and health services in Section 4, and explore explanations for our findings in Section 5. Section 6 discusses ways in which future health service delivery may be affected by the arrival of antiretroviral therapy (ART), and notes ways in which the design of AIDS care should take into account the fact that persons living in regions most affected by AIDS may not have been receiving adequate medical care for the past 20 years.

2. Demographic and Health Survey Data

Demographic and Health Surveys are large, nationally representative household-based surveys run at approximately four to five year intervals in low and middle income countries. Their focus is primarily on population, health and nutrition. Women in the household aged 15 to 49 are asked about their fertility histories, including information on prenatal care, delivery assistance and children's immunizations. In some survey waves, information on antenatal care is available for a woman's most recent birth, and in others it is collected for all births that occurred within a particular time window (within the past three years for some surveys, within the past five years for others). Appendix Table 1 provides a guide to survey years. Information on these surveys is also available on line at http://www.measuredhs.com/aboutdhs/.

We analyze data from 25 DHS surveys conducted between 1988 and 2006 in eight countries in sub-Saharan Africa. We have chosen three West African countries where HIV prevalence rates are relatively low – Burkina Faso, Cameroon, and Ghana – and five countries in

East and Southern Africa where rates are higher – Kenya, Malawi, Tanzania, Zambia, and Zimbabwe. We selected these countries because they have conducted three or four DHS surveys since 1988, and because their latest round of DHS data collection included HIV testing. We do not use the 1988 survey from Ghana and the 1991-92 survey from Tanzania, because the geo-coding of within-country regions changed between these and later surveys.

Table 1 reports on the DHS data we use, including survey years, the birth years of children covered in each survey year, and the number of observations in each survey.[1] For each birth year from 1988 to 2003, we have observations from at least six of the eight countries we are studying, with two exceptions. (For children born in 1988, there are no data from Ghana, Tanzania, or Zimbabwe, and for children born in 1994, there are no data from Cameroon, Zambia or Kenya.)

Our analysis will focus on the association between health service delivery on one hand, and HIV prevalence rates on the other. The DHS data do not allow us to match HIV results to individuals in each survey, but do allow us to match HIV prevalence at the *region* level. All countries are divided into regions that can be consistently identified across survey years. Countries vary in the number of regions (3 in Cameroon and in Malawi for example, 10 in Zimbabwe, 20 in Tanzania), and in total we analyze data from 75 regions.

Antenatal Care

Outcome measures for antenatal care and birth deliveries are presented in Table 2. The upper panel shows means for each country, taken over all DHS waves, on women's reports that they

[1] We exclude 86 cases where information on mother's education is missing and 3509 cases where information on the HIV prevalence in the region of birth is unknown for the child's birth year.

received any antenatal care (in the form of at least one antenatal visit). For women who report antenatal care, each is asked whether their urine and blood were tested, and whether measurements of their blood pressure and weight were taken. Over 90 percent of women surveyed in East and Southern Africa report some form of antenatal care, true for 60 to 90 percent of women in West Africa. Conditional on reporting prenatal care, more than 90 percent of women report they were weighed, and the vast majority report their blood pressure was taken. Blood tests and urine analysis are much less likely to be reported in some countries (Malawi, Tanzania, Zambia) than in others (Cameroon, Ghana).

Figure 1 shows a marked decline in the tests and measurements taken during antenatal visits, by country and birth year, particularly for tests involving bodily fluids. Results for urine and blood tests during antenatal care, shown in the upper panel of Figure 1, suggest that use of these tests declined in all parts of Africa. In Malawi, for example, the percentage of women reporting that their blood was tested as part of their prenatal care declined from 54 percent in 1995, to 32 percent in 2003. In Burkina Faso, this percentage dropped from 62 percent in 1998 to 32 percent in 2003. Reports that blood pressure was taken during an antenatal visit held constant in West Africa, but fell in East and Southern Africa, as can be seen in the bottom left panel of Figure 1. In Kenya, for example, reports of blood pressure being taken fell from 88 percent in 1998 to 80 percent in 2003, and in Tanzania from 75 percent in 2000 to 62 percent in 2003. The only measure that held relatively steady over this period is an inexpensive measure that takes little clinic time: being weighed during a prenatal visit is constant, at close to 100 percent, in all countries over this period. (Note that the graphing scales used are different for different procedures.)

Birth deliveries

Outcome measures for birth deliveries are presented in the bottom panel of Table 2. In almost all countries under study, approximately half of all births are attended by a trained professional. Approximately a third of all births occurred in public clinics, and ten percent in private clinics.

That these patterns have been changing over time can be seen in Figure 2, which presents delivery details, by country and year, for all countries in our study. The top left graph presents trends in whether the birth was attended by a trained professional, and the top right on whether the birth occurred in a clinic (public or private). Many countries have seen a decline in the presence of a trained professional at the delivery. In Burkina Faso, this has fallen from 66 percent in 1988 to 55 percent in 2003. In Malawi, attendance fell from 72 percent to 55 percent. An exception here is Zimbabwe, where reports of birth attendance by a trained professional declined very little over this period.

In general, delivery in a clinic setting has declined in these countries, largely driven by a decline in public clinic deliveries (presented in the bottom left panel of Figure 2). In Cameroon, delivery in a public clinic fell from 53 to 42 percent over this period, and in Kenya from 45 to 27 percent. Again Zimbabwe is an outlier, where delivery in public clinics was high throughout this period.

Childhood immunizations

The rates of childhood immunization against polio, measles, BCG, and DPT are reported by country in Table 3. DHS evidence on vaccinations is categorized as: no vaccine; mother reports vaccine (no card); vaccine recorded on card (no date); and vaccine is dated on card. There are many ways to categorize these reports. Our interest is in children missing vaccines, and for this

reason we code variables equal to '1' if the child is reported – either by the mother or on the health card – not to be vaccinated , and equal to '0' if the mother reports the vaccine, or evidence of the vaccine is recorded on the child's health card. Table 3 shows that approximately half of all children were reported not to have had a polio vaccine shortly after birth, but that this lack of vaccination falls to between 10 to and 20 percent of children at older ages. Between a quarter and a third of all children are not vaccinated against measles, and between 10 and 20 percent have not received BCG vaccines. Non-vaccination rates are generally higher in West African countries.

HIV prevalence

The HIV prevalence rates we use in our analysis were calculated using HIV test results from the most recent DHS surveys—2002 for Zambia, 2003 for Burkina Faso, Ghana and Kenya, 2004 for Cameroon, Malawi and Tanzania, and 2006 for Zimbabwe. This information is available at the country-region level. Differences in prevalence between countries, and between regions within countries, can be seen in Figure 3, where weighted averages of HIV prevalence are presented by region. HIV prevalence varies a great deal both across countries, and across regions within countries. The lowest prevalence rates are in Burkina Faso and Ghana, with values in all regions under 5 percent. There is substantial regional variation in HIV rates in the higher-HIV countries of Kenya, Malawi, Tanzania, and Zambia, whereas rates are uniformly high (15 percent or more) in Zimbabwe. We turn, in Section 3, to the methods we will use to examine whether health services for pregnant women and children deteriorated in regions in which HIV prevalence grew most quickly.

3. Methods

Our key concern is whether higher HIV prevalence within regions is associated with lower quality health care for mothers and their children. As noted above, we do not observe HIV prevalence over multiple years, but only in the year in which the most recent survey was conducted. We follow two general strategies for estimating the relationship between prevalence and health care. Our first strategy is to impute prevalence in each of the years in which children's births are observed, assuming that HIV prevalence has increased linearly since 1980. We then regress each health care measure on this measure of prevalence as well as other controls variables, including indicators for year of birth and country/region fixed effects. Our second strategy is to regress each health care measure on a set of interactions between the child's year of birth and the measure of HIV prevalence in the most recent survey. This permits us to examine whether the evolution of health outcomes from the last 1980's to the early 21st century is different in regions with high HIV prevalence rates when compared to regions with low prevalence rates. As we show below, the second of these strategies is simply a less restrictive variant of the first.

The first step is to impute HIV prevalence in each year in which children's births are observed. Let $H_{r\tau}$ denote the prevalence of HIV measured in region r in year τ, where τ exceed 1980 and r denotes a country/region. The estimated prevalence of HIV in region r in year t, denoted h_{rt}, is assumed to be:

$$(1) \quad h_{rt} = H_{r\tau}\left[\frac{t-1980}{\tau-1980}\right].$$

We then estimate regressions of the following form for each of the health outcomes discussed above:

$$(2) \quad y_{irt} = \delta_r + \gamma_t + \beta h_{rt} + X_{irt}\theta + \varepsilon_{irt},$$

where y_{irt} is a health care measure associated with child i, either a measure of the quality of the care the child's mother received before or at the birth of the child, or a measure of the quality of care the child has received. In addition to the prevalence measure, equation (2) contains a set of region fixed effects (δ_r), which capture time invariant features of the region, including determinants of quality of care that do not change over time. As seen in Figures 1 and 2, there are pronounced differences in the levels of the measures we examine, even though many have similar trends. We also include a set of birth year effects (γ_t), which capture changes over time that are common to all regions, and a set of controls for characteristics of the mother and child (X_{irt}). These controls include the mother's years of education, her age in years, the child's age in months (or, if the child has died, the age in months the child would have been at the time of the survey had he or she lived), an indicator for the child's sex, and an indicator for whether the household lives in an urban area. The parameter of interest, β, provides an estimate of how changes in HIV prevalence in a region influence health care outcomes.

Equation (2) incorporates two assumptions: one, that HIV prevalence increased linearly from 1980 to the current time period, and two, that HIV prevalence has a linear effect on health care quality. These assumptions can be loosened, by estimating models of the following form:

$$(3) \quad y_{irt} = \delta_r^* + \gamma_t^* + \beta_t^* H_{r\tau} + \alpha^* X_{irt} + \varepsilon_{irt},$$

where all variables are defined as above, only the actual prevalence in year τ has replaced estimated prevalence in year t, and the coefficient on actual prevalence is permitted to vary by year. Because the prevalence measure does not vary over time within regions, and region fixed effects are included, the value of β_t^* must be set to zero for one of the years.

In what follows, we present estimates of (2) and (3). It is straightforward to see that (3) is a less restrictive version of (2). First, substitute (1) into (2) to obtain:

$$y_{irt} = \left[\delta_r - \beta \frac{H_{r\tau}1980}{\tau - 1980}\right] + \gamma_t + \left[\frac{\beta}{\tau - 1980}\right] H_{r\tau}t + X_{irt}\theta \ + \varepsilon_{irt}$$

which, if:

$$\delta_r^* = \left[\delta_r - \beta \frac{H_{r\tau}1980}{\tau - 1980}\right]$$

and

$$\beta^* = \frac{\beta}{\tau - 1980}$$

can be expressed as:

$$(4) \quad y_{irt} = \delta_r^* + \gamma_t^* + \beta^* H_{r\tau}t + \alpha^* X_{irt} + \varepsilon_{irt}.$$

In (4), the inclusion of an interaction term between the prevalence in year τ and the year of birth permits a linear trend in the outcome (over and above the year effects γ_t^*) that varies with HIV prevalence. The only difference between (4) and (3) is that, in (3), different time patterns in areas with high and low HIV prevalence are not restricted to a linear trend. In the results that follow, we test whether this linear restriction can be rejected.

To see how estimates of equation (3) should be interpreted, consider predicted values of the outcome at two time periods, 1 and 2. Ignoring the control variables X_{irt}, the difference in the predicted value of the outcome in region r will be:

$$(5) \quad \hat{y}_{r2} - \hat{y}_{r1} = (\hat{\gamma}_2^* - \hat{\gamma}_1^*) + (\hat{\beta}_2^* - \hat{\beta}_1^*) H_{r\tau}.$$

The year-to-year change in the outcome contains a component that is common to all regions, and another component that is scaled by the region's HIV prevalence in year τ.

One concern is that not all outcomes are observed in all countries in all years of birth. For example, the indicator that a child did not receive a polio vaccine at birth is available in Tanzania starting with children born in 1991, but is not observed in two other countries (Burkina Faso and

Ghana) until 1994, and is not available for all countries until 1997. To prevent the birth year effects from reflecting the experience of only a few countries, we "trim" the sample for each outcome, so that regressions exclude birth years that do not have observations from at least three countries. As a result of this trimming, estimates of models for specific antenatal care procedures cover the 1995-2003 period; and polio at birth covers the 1994 to 2003 period. All other estimates cover the 1988-2003 period.

4. Results

Table 4 presents estimates of equation (2), which measure the association between estimated HIV prevalence in the year of birth and antenatal care. We present the coefficient on HIV prevalence from OLS regressions for whether a woman reports having had prenatal care (column 1) and, conditional on reporting care, that she reports having had a urine test, blood pressure measured, a blood test, or her weight measured (columns 2 to 5). The first row presents estimates from equation (2) where, in addition to estimated HIV prevalence, the only other controls are birth year indicators. The second row presents estimates from regressions that also include country/region fixed effects, and mother and child characteristics.[2]

Women in regions with high HIV prevalence are significantly more likely to report prenatal care. Relative to living in a region with zero prevalence, women living in a region with 10 percent HIV prevalence are 15 percentage points more likely to report antenatal care (top panel, column 1). However, when we include country/region fixed effects, so that identification comes from change in HIV prevalence within a region over time, we find that higher HIV

[2] Estimates using probit models yield similar results.

prevalence is associated with a significantly lower probability of reporting antenatal care. This suggests that the high prevalence areas started from higher levels of prenatal care, and that HIV has taken a greater toll there on service delivery than in regions with low levels of HIV prevalence. Conditional on reporting antenatal care, women in regions with higher HIV prevalence are observed with lower probabilities of having urine and blood tests, and of reporting that their blood pressure was taken. Controlling for country/region fixed effects magnifies these differences, so that all four of the measures of quality of prenatal care are significantly lower over time within a region as HIV prevalence rises. For example, within a region where HIV prevalence increased by 10 percentage points between 1995 and 2003, a woman is 18 percentage points less likely on average to report that her blood pressure was taken during prenatal care if she was pregnant in 2003, relative a woman who was pregnant in 1995.

Table 5 presents results on the association between estimated HIV prevalence in the year of birth and the quality of birth deliveries. Specifically, we estimate the association of HIV prevalence with an indicator that the birth occurred in a clinic (column 1) and, conditional on a clinic delivery, whether the clinic was public (column 2). In addition, we estimate the association between HIV prevalence and a trained attendant being present at the birth (column 3). Again, the results are markedly different with and without country/region fixed effects. In the absence of fixed effects (row 1), we find delivery at a clinic is significantly more likely in regions with high HIV prevalence. However, over time within a region (row 2), we find only a small, marginally significant relationship between HIV prevalence and delivery at a clinic. Without fixed effects, conditional on being a clinic birth, delivery is are significantly less likely to be at a public clinic. However, this result is not robust to the inclusion of country/region fixed effects. Over time within a region, conditional on a clinic delivery, higher HIV prevalence is not significantly

associated with the probability of the clinic being public. A disturbing finding in Table 5 is that, within regions over time, those with higher HIV prevalence see a significant drop in the probability that a trained birth attendant was present for the delivery. On average, a region that experienced a 10 percentage point increase in the rate of HIV prevalence witnessed a 8 percentage point drop in the probability of a trained attendant at the birth.

Table 6 turns to children's health care outcomes, and presents estimates of the association between HIV prevalence and children not reported to have had a polio vaccine soon after birth (column 1), or to have ever been immunized against polio, measles, BCG and DPT (columns 2 to 5). With the exception of the polio vaccine at birth, high estimated HIV prevalence in the year of birth is significantly associated with ever having been immunized (row 1). However, within regions over time, children in regions of high HIV prevalence are significantly less likely to be vaccinated against any of these diseases. Relative to children born in a particular region with zero HIV prevalence in 1988, those born in the same region in 2003 would be almost 20 percentage points less likely to be immunized against polio, and 10 percentage points less likely to be immunized against measles, BCG or DPT if the prevalence rate had risen to 10 percent in 2003.

In summary, it appears that regions that are bearing the heaviest HIV burdens have become less able to care for pregnant women, provide trained attendants for birth deliveries, and immunize children.

These results are built on the assumptions that HIV prevalence has increased linearly over time, and that prevalence has a linear relationship with our health care measures of interest. Next, we relax these assumptions by estimating models of the form of equation (3), reproduced here for convenience:

$$(3)\quad y_{irt} = \delta_r^* + \gamma_t^* + \beta_t^* H_{r\tau} + \alpha^* X_{irt} + \varepsilon_{irt}.$$

Our estimates are shown graphically. Specifically, after estimating equation (3) for each health outcome, we predict what the value of the outcome would be in each birth year, for four HIV prevalence rates ($H_{r\tau}$ equal to 0, 5, 10 and 20 percent.) For these predictions, the region fixed effects δ_r^* are averaged across all regions, and values of X_{irt} are replaced by their grand sample means. We set 1997 to be the omitted birth-year category for both γ_t^* and β_t^*, so that predicted values are equal for all , by definition, in 1997 for all prevalence rates. It is important to keep in mind that, in the discussion of these estimates, "HIV prevalence" refers to $H_{r\tau}$, the actual prevalence in a region, measured using data from the most recent DHS survey.

Figure 4 shows results for the indicator of whether the mother received antenatal care. Consistent with the estimates of equation (2), the figure indicates that in low prevalence regions, the use of antenatal care increased over time—by approximately 10 percentage points from 1988 to 2003. However, this upward trend is less pronounced for higher prevalence rates. At 20 percent prevalence, antenatal care is relatively constant from 1988 to 1995, and then declines from over 90 percent to less than 85 percent. Test statistics from the regression underlying Figure 1 are shown in the first row of Table 7. These indicate that the hypothesis that the birth year effects γ_t^* are jointly insignificant can be rejected, as can the hypothesis that the birth year/HIV prevalence interactions β_t^* are jointly insignificant.

The last column in Table 7 shows the results of test of the hypothesis that the birth year/HIV prevalence interactions follow a linear trend—or, in other words, that the parameter restrictions imposed in equation (4) are valid. This hypothesis is also rejected. This is not surprising, given that the changes in antenatal care at different prevalence rates shown in Figure

1 do not begin to diverge until the mid-1990's. The rejection of the hypothesis of a linear trend could be due to two factors. First, it could be that the evolution of HIV prevalence was highly non-linear. Second, it could be that the adverse effects of HIV on antenatal care have increased since the mid-1990's. Without data on HIV prevalence over time, we cannot distinguish between these two factors.

Results for the procedures women receive during antenatal care are shown in Figure 5. Consistent with the results in Table 4, differences in all of these procedures are apparent across high and low HIV prevalence regions, with the largest differences observed for urine tests and blood pressure. The use of blood tests is predicted to decline for all HIV prevalence rates shown, although more so for high HIV regions. Unlike the results for antenatal care discussed above, the linearity restrictions cannot be rejected for three of the four measures. This may reflect the fact that we do not have data on these measures prior to 1995. Without this information, we cannot determine whether changes across birth years in the use of antenatal procedures were similar across high and low prevalence regions prior to the mid-1990s.

Results for delivery care, in Figure 6, indicate that the largest differences across higher and lower HIV prevalence regions occur for the presence of a trained birth attendant. At 20 percent prevalence, the presence of a trained birth attendant declines almost continuously, from over 65 percent in 1989 to less than 55 percent in 2003. At zero prevalence, the presence of a trained birth attendant declines from 1988 to 1993 before leveling off and then increasing after 1999. Consistent with the results in Table 5, the there are only small differences across high and low prevalence regions for the indicators for whether the mother delivered in a clinic, and whether clinic deliveries occurred in a public clinic. The graphs indicate that, regardless of HIV

prevalence, clinic deliveries first decline from 1988 to the mid-1990's, and then increase. There is a steady shift from public to private clinics over this period.

Results for children's vaccines are presented in Figures 7 and 8. In high HIV regions, mothers were increasingly likely to report that their child had not received a polio vaccine shortly after birth. For example, at 10 percent prevalence, the fraction of mothers who report no vaccine is estimated to have increased from 45 percent to 60 percent. In contrast, low HIV prevalence regions made gains in vaccinating children against polio shortly after birth. The figures for the other vaccines are quite noisy, with large year-to-year fluctuations. However, the general pattern is for high HIV regions to show increases in indicators that vaccines were not given relative to low HIV regions.

Overall, the estimates of the less restrictive models, using equation (3), are consistent with those reported in Tables 4-6: regions with high HIV prevalence rates experienced greater deterioration in antenatal care, and larger declines in the use of trained birth attendants and vaccinations, relative to low HIV regions. Estimates of the less restrictive models also allow us to date when health care quality began to diverge across higher and lower HIV regions. For both the use of antenatal care and the presence of a trained birth attendant, this divergence began in the mid-1990's. Our estimates for children's vaccines, although noisy, also date the divergence to this time.

5. Discussion

There are several possible, non-competing explanations for the deterioration of non-HIV related health services observed in high prevalence regions. AIDS may have affected access to care. AIDS may also have reduced the demand for non-HIV related health services through its effect

on households' incomes. Alternatively, AIDS may have had little effect on demand for care, or access to care, but have had a large effect on the quality of care available. We discuss these in turn.

Access to care

AIDS-related illnesses may have crowded out access to medical care between 1995 and 2003. This would have been prior to the arrival of antiretroviral therapy in nearly all regions, and it is possible that the high morbidity rates among those infected with HIV took an ever larger toll on access to care. High HIV burdens may have reduced funding for non-HIV-related medical issues, producing closures of clinics or reductions in the range of services offered. Alternatively, high HIV burdens could put upward pressure on user fees charged for non-HIV related services.

The DHS surveys provide some information on the problems women experienced with access to services. Specifically, in the most recent surveys for all countries we examine except Kenya, mothers are asked about problems they face accessing medical care. Specifically, they are asked which of the following items were "a big problem with access to medical care": (1) not knowing where to go for care; (2) the distance required to get to care; (3) the lack of money to pay for medical care; and (4) the lack of transportation to get to a facility. If HIV burdens were responsible for forcing women to travel farther, or spend more to attend clinics, we would expect to see a difference in responses among women in West Africa, where HIV rates are low, and those in East and Southern Africa, where rates are high.

Tabulations of responses to these questions are in Table 8. For each outcome, we find a uniform pattern across countries. Approximately 10 to 20 percent of women report not knowing where to go for medical care; 40 percent report that distance is a problem; 60 percent say money

is an issue; and 40 percent say transportation is a problem. However, there is no divide between high and low HIV countries. We also ran regressions of each of these variables on HIV prevalence in the region, and a set of country dummies, and found no evidence that mothers living in high-prevalence regions within countries reported worse access to care.

This result—that access to care measures are similar across low- and high-HIV countries and regions within countries—provides suggestive but not conclusive evidence that HIV has not altered access to care. It is possible that high-HIV countries (or regions within countries) had better access to care prior to the HIV crisis, and that they have experienced more rapid deteriorations in these measures of access. Indeed, our results on health care use presented earlier indicate that, without controlling for region fixed effects, health care measures often look better in high-HIV regions. However, once fixed effects are included—so we are essentially looking at changes over time within region—we see a negative association between HIV prevalence and health care. The same could be true for access to care. As more rounds of DHS data are collected, it will be possible to examine within-region changes in access measures.

Demand for health services

Households in high-HIV regions may have become poorer, because of lost income due to illness, increases in funeral expenses, or greater demands on household resources that result from having to care for orphans. Lower wealth could, in turn, be responsible for the deterioration in health care in high HIV regions. If so, we would expect that the estimated associations between regional prevalence and health care will become smaller, in absolute value, when we control for household wealth.

The DHS surveys do not contain measures of financial wealth. However, they do collect information on household assets – ownership of bicycles, refrigerators, and radios, for example. We construct a measure of household assets equal to the sum of indicators for the ownership of a radio, television, refrigerator, bicycle, motorcycle and car. We first examine whether asset ownership declined with HIV prevalence within regions. To test whether the HIV-prevalence effect might be working through household resources, we re-ran equation (2), including a control for the number of assets. We also estimated variants that included indicators for ownership of each of the six assets separately.

Our results do not support the hypothesis that declines in wealth (as measured by assets) in high-HIV regions account for the deterioration in the quality of health care. It is not the case that the asset index declined significantly over time in high HIV-regions. Using a sample of mothers (rather than births), we regressed the asset index on a set of survey year dummies, country/region dummies, the mother's age, education, an indicator for urban status, and estimated HIV prevalence in the survey year. The coefficient on HIV prevalence was positive (0.919) rather than negative, although not significantly different from zero. Estimates of (2) with and without wealth indicators are in Table 9. The samples are somewhat smaller than those used previously, since some waves of data did not contain comparable asset information. However, in all cases, the addition of asset information has only small effects on the coefficient on HIV prevalence.

Quality of health services

Our parametric and semi-parametric results suggest that it is not access to health services, but the quality of services available, that is responsible for the decline in care we observe in our data.

Women continue to attend antenatal care clinics in very high numbers, but are receiving significantly fewer diagnostic tests during their visits. They report delivering children in clinics, but are significantly less likely to have a trained attendant at the delivery. These declines in quality could be due to diversions of funds for supplies and trained medical professionals to care for HIV patients. Whether the arrival of ART improves the quality of non-HIV related health services – either directly, through provision of resources for medical care more broadly – or indirectly, through a reduction in morbidity among HIV positive patients – is an important issue requiring attention.

6. Conclusions

The next round of DHS data sets will be in the field after the arrival of ART in many regions. When these data sets become available, we plan to assess whether ART improves the quality of care received by pregnant women and children, or whether it further crowds out care for non-AIDS-related medical care.

In the interim, care providers should take into account the fact that medical care in high prevalence regions has not been adequate since the mid-1990s, which may affect the diseases they face (measles, BCG, DPT) and the conditions they encounter (high under age 5 mortality) as they prepare to provide services.

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Appendix Table 1

	Most Recent Birth Only	All Births, Last Five Years	All Births, Last Three Years
Antenatal care	BF4,CM4, GH4, KE4, MW4, MW3, TZ4, TZ2, ZM4, ZW5, ZW4	BF3,BF2, CM2, GH3, KE2, MW2, TZ1, TZ, ZM3, ZM2	CM3, GH2, KE3, ZW3
Antenatal procedures	CM4, BF4, GH4, KE4, MW4, MW3, TZ4, ZM4, ZW5, ZW4	GH3	
Polio vaccine shortly after birth		BF4(alive only), BF3(alive only), CM4 (alive only), GH4(alive only), GH3 (alive only), KE4 (alive only), MW4(alive only), MW3 (alive only), TZ4 (alive only), TZ2 (alive only), TZ1 (alive only), ZM4 (alive only)	CM3 (alive only), KE3(alive only)
Vaccines other than polio shortly after birth		BF4(alive only), B3(alive only), BF2(all), CM4(alive only), CM2(all), GH4 (alive only), GH3(alive only), GH1 (alive only), KE4(alive only), KE2(all), KE1(alive only), MW4 (alive only), MW3 (alive only), MW2 (all), TZ4 (alive only), TZ2 (alive only), TZ1 (alive only), TZ (all), ZM4 (alive only), ZM3 (alive only), ZM2 (all), ZW5 (alive only), ZW4 (alive only), ZW2(alive only)	CM3 (alive only), GH2(all), KE3(alive only), ZW3 (alive only),
Trained birth attendant		BF4, BF3, BF2, CM4, CM2, GH4, GH3, GH1, KE4, KE2, KE1,MW4, MW3, MW2, TZ4, TZ2, TZ1, TZ, ZM4, ZM3, ZM2, ZW5, ZW4, ZW2	CM3, GH2, KE3, ZW3
Place of delivery		BF4, BF3, BF2, CM4, CM2, GH4, GH3, KE4, KE2, KE1, MW4, MW3, MW2, TZ4, TZ2, TZ1, TZ, ZM4, ZM3, ZM2, ZW5, ZW4, ZW2	CM3, GH2, KE3, ZW3

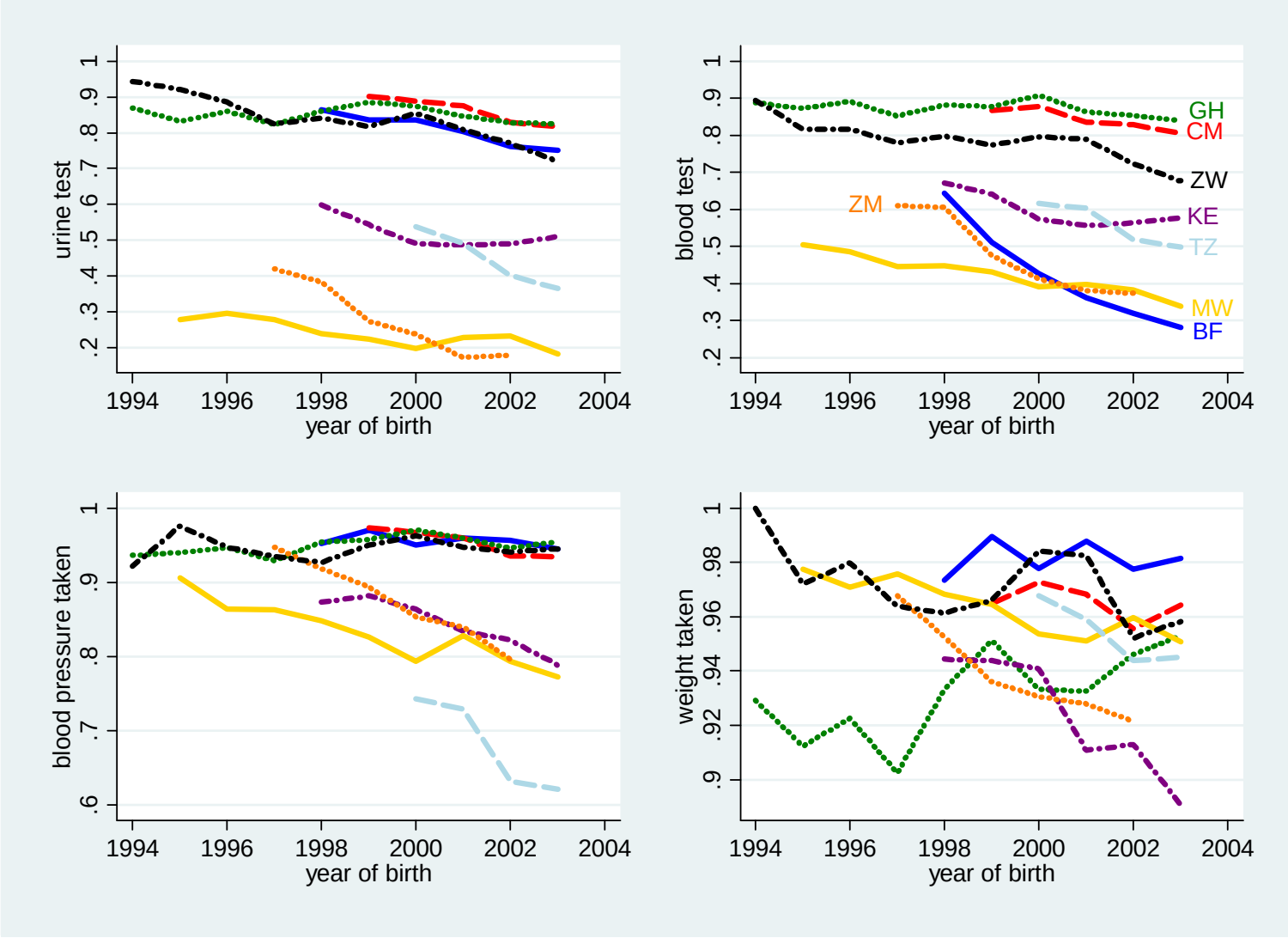

Figure 1. Prenatal care: urine tests, blood tests, blood pressure taken and weight taken, by country and birth year

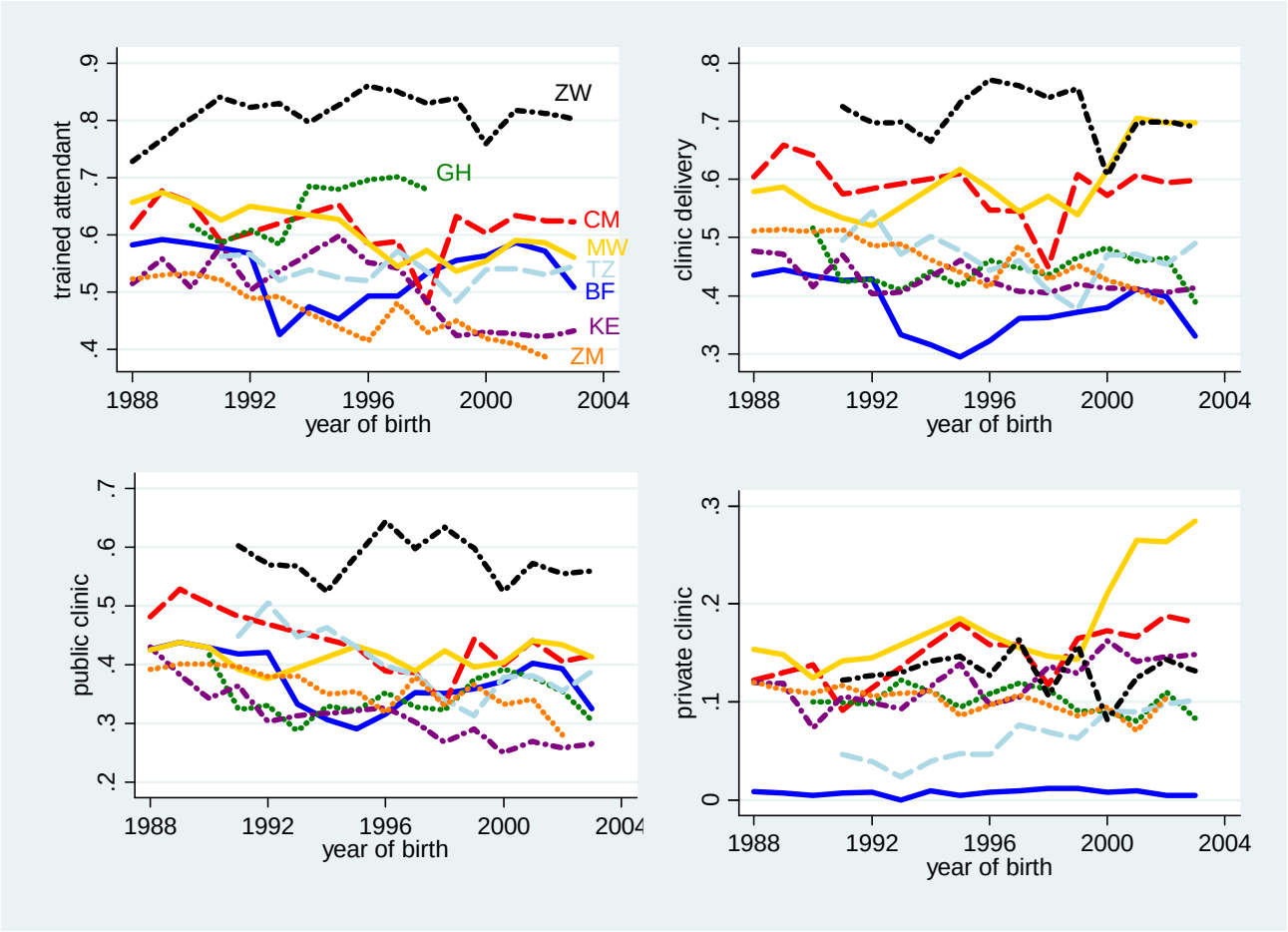

Figure 2. Birth deliveries: Attended by a trained professional, delivery in a clinic, delivery in a public clinic and delivery in a private clinic, by country and year of birth.

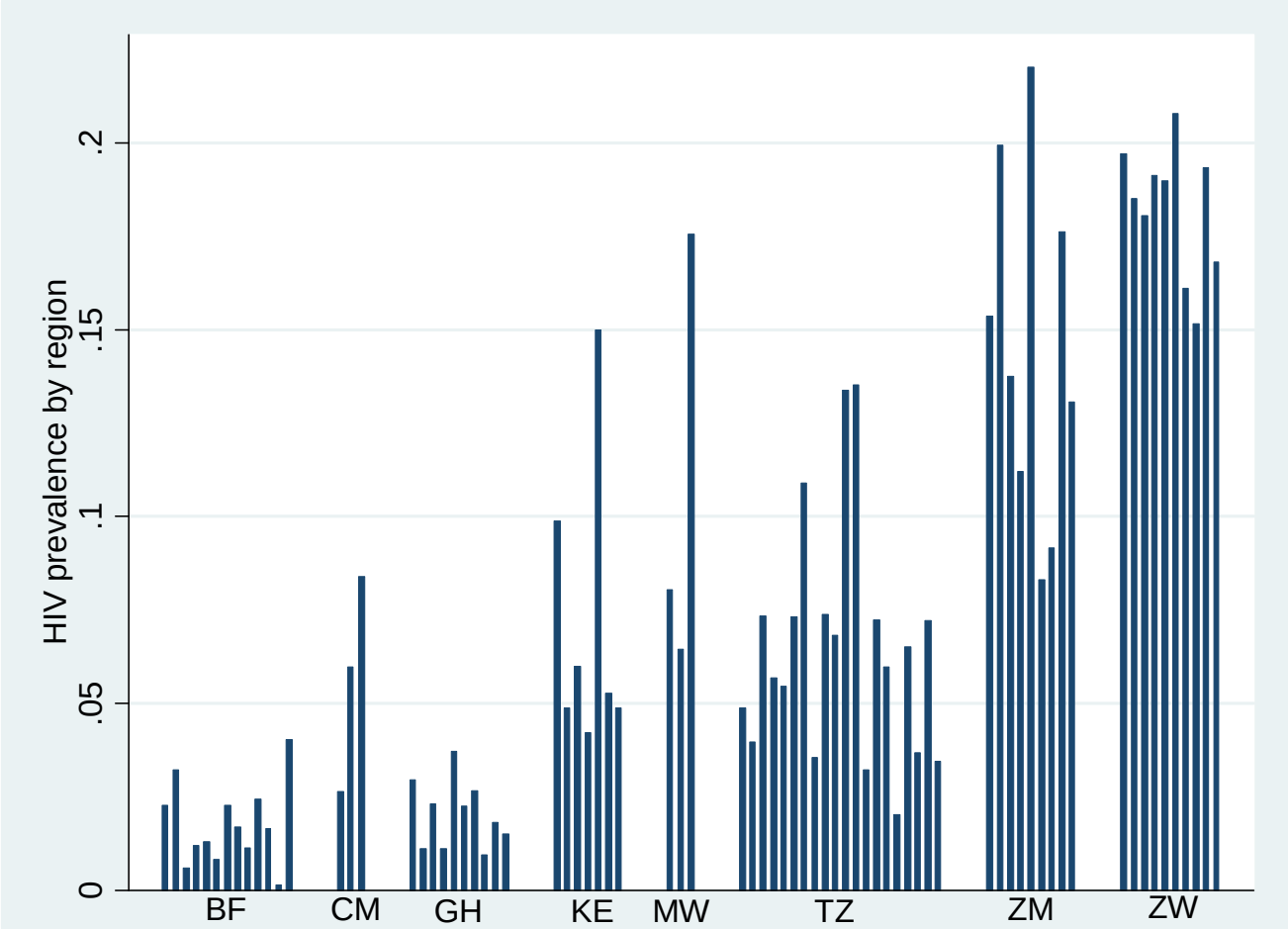

Figure 3. Regional HIV prevalence rates by country

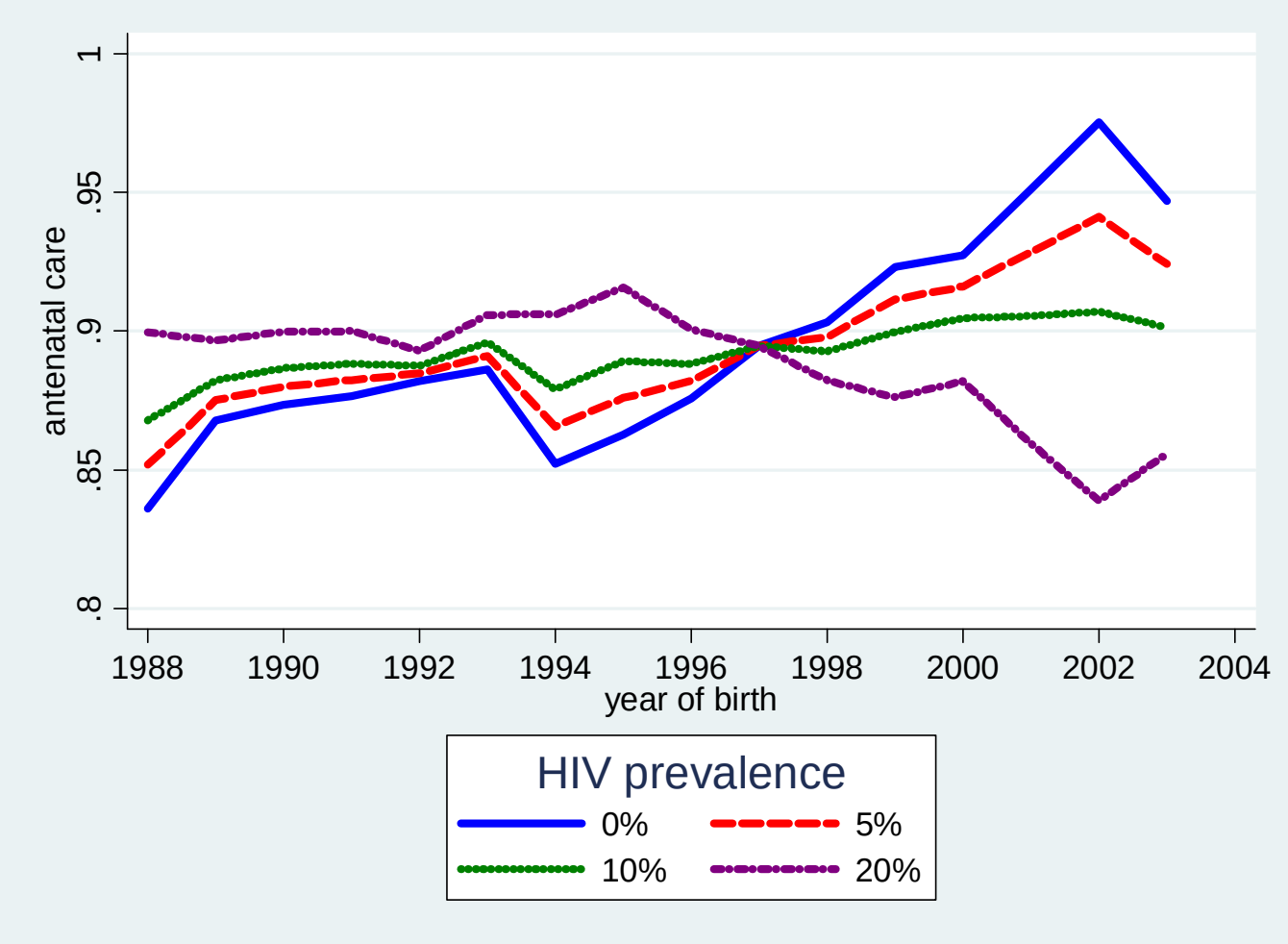

Figure 4. Predicted changes in antenatal care, by HIV prevalence

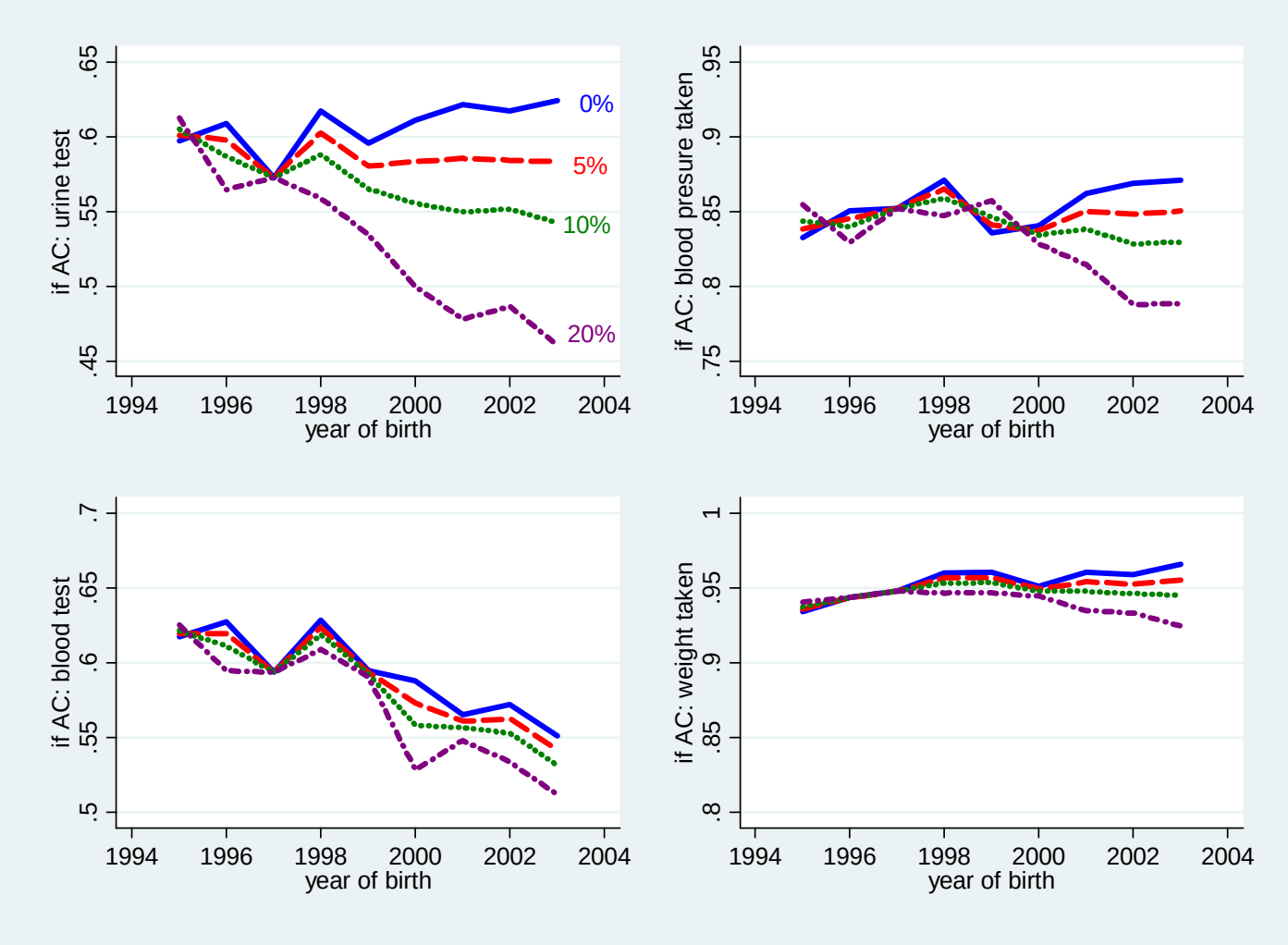

Figure 5. Predicted changes in antenatal procedures among those who receive antenatal care, by HIV prevalence

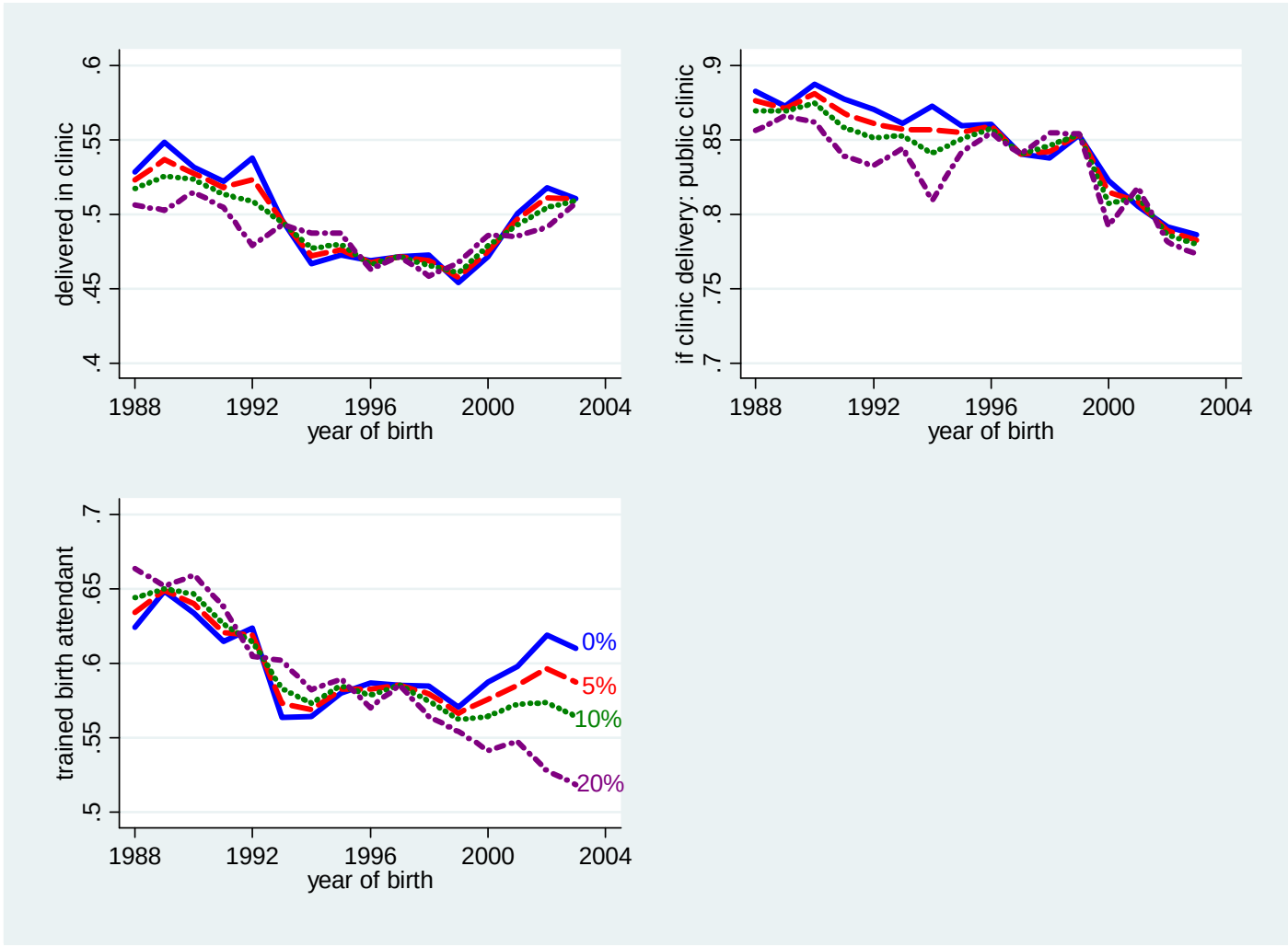

Figure 6. Predicted changes in delivery care, by HIV prevalence

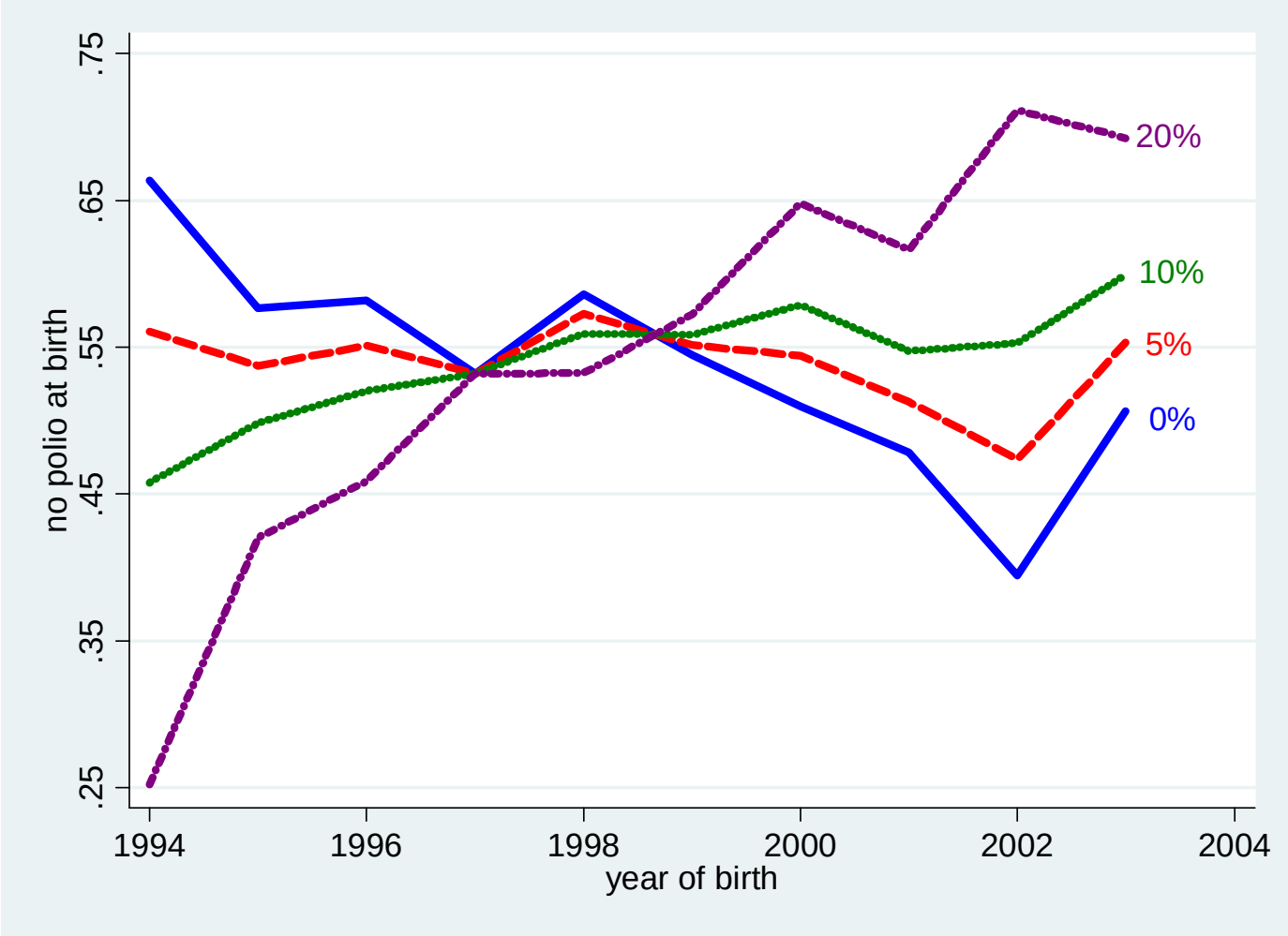

Figure 7. Predicted changes in the lack of a polio vaccine shortly after the child's birth, by HIV prevalence

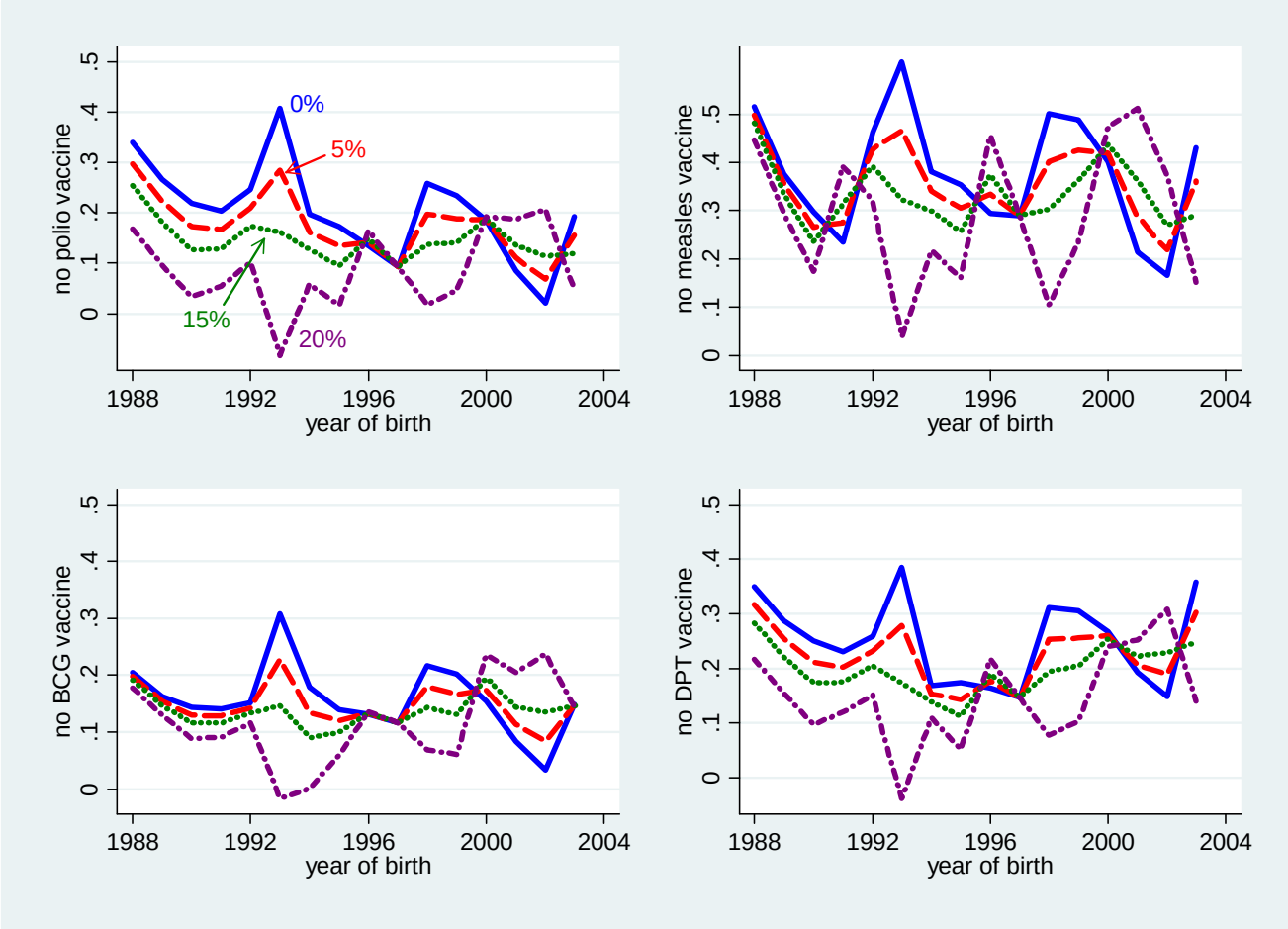

Figure 8. Predicted changes in the lack of a polio vaccine shortly after the child's birth, by HIV prevalence

Table 1. Demographic and Health Survey Datasets

	Burkina Faso	Cameroon	Ghana	Kenya	Malawi	Tanzania	Zambia	Zimbabwe
Survey year [Birth years] (obs)				1988-89 [1988-89] (1769)				
Survey year [Birth years] (obs)	1992-93 [1988-93] (5828)	1991 [1988-91] (2319)	1993-94 [1990-94] (2204)	1993 [1988-93] (6115)	1992 [1988-92] (4326)	1996 [1991-96] (6169)	1992 [1988-92] (5438)	1994 [1991-94] (2436)
Survey year [Birth years] (obs)	1998-99 [1994-99] (5950)	1998 [1995-98] (2317)	1998-1999 [1993-99] (3298)	1998 1995-98] (3531)	2000 [1995-2000] (11,926)	1999 [1994-99] (2406)	1996-97 [1991-96] (7246)	1999 [1994-99] (3640)
Survey year [Birth years] (obs)	2003 [1998-2003] (10,645)	2004 [1999-2003] (7378)	2003 [1998-2003] (3844)	2003 [1998-2003] (5495)	2004-05 [1999-2003] (8593)	2004-05 [1999-2003] (5499)	2001-02 [1996-2002] (6862)	2005-06 [2000-03] (3186)
Number of regions	13	3	10	7	3	20	9	10

Table 2. Antenatal care and birth deliveries

	Burkina Faso	Cameroon	Ghana	Kenya	Malawi	Tanzania	Zambia	Zimbabwe
ANTENATAL CARE								
Any antenatal care (AC)	0.649	0.815	0.900	0.944	0.947	0.974	0.953	0.944
If AC: Urine test	0.789	0.843	0.847	0.503	0.223	0.416	0.248	0.812
If AC: Blood pressure	0.955	0.945	0.949	0.836	0.816	0.656	0.866	0.944
If AC: Blood test	0.360	0.829	0.871	0.579	0.407	0.535	0.444	0.763
If AC: Weight taken	0.982	0.963	0.930	0.919	0.961	0.950	0.935	0.966
BIRTH DELIVERIES								
Trained professional	0.545	0.618	0.649	0.502	0.581	0.536	0.471	0.823
Delivery at a clinic	0.381	0.591	0.442	0.426	0.604	0.471	0.467	0.713
Public clinic	0.373	0.429	0.340	0.323	0.413	0.405	0.365	0.579
Private clinic	0.008	0.162	0.102	0.120	0.191	0.066	0.102	0.134
Observations	22408	11964	9298	16830	24773	14009	19498	9240

Notes. Means are presented by country over all DHS waves. Means are weighted using sample weights. Observations are the maximum number observed for any variable listed for each country.

Table 3. Children's immunizations

	Burkina Faso	Cameroon	Ghana	Kenya	Malawi	Tanzania	Zambia	Zimbabwe
IMMUNIZATIONS								
No polio vaccine at birth	0.497	0.406	0.561	0.397	0.575	0.548	0.881	n.a.
No polio vaccine	0.249	0.172	0.162	0.117	0.101	0.081	0.118	0.222
No measles vaccine	0.462	0.444	0.371	0.338	0.252	0.242	0.306	0.345
No BCG vaccine	0.252	0.213	0.168	0.098	0.107	0.077	0.095	0.166
No DPT vaccine	0.297	0.256	0.180	0.117	0.099	0.239	0.132	0.230
Observations	20257	11002	8756	14429	22339	12578	17596	8578

Notes. Means are presented by country over all DHS waves. Means are weighted using sample weights. Birth years for 'no polio vaccine at birth' is for birth years 1994-2003. All other immunizations are for the period 1988-2003. Observations reported in the last row are the maximum number of observations by country for any of the vaccines listed.

Table 4. Antenatal care and HIV prevalence

		If had antenatal care:			
	Had antenatal care	Urine test	Blood pressure taken	Blood test	Weight taken
	[0.878]	[0.527]	[0.866]	[0.558]	[0.954]
Indicators for birth year included					
HIV prevalence in year of birth	1.464 (0.022)	–2.036 (0.045)	–0.423 (0.031)	–0.300 (0.046)	0.014 (0.019)
Indicators for birth year and country/region, and mother and child characteristics included					
HIV prevalence in year of birth	–1.256 (0.079)	–2.767 (0.372)	–1.785 (0.301)	–0.540 (0.411)	–0.719 (0.193)
Observations	100158	42209	42213	42214	42223
Range of birth years	1988-2003	1995-2003	1995-2003	1995-2003	1995-2003

Notes: Ordinary Least Squares estimates. The mean of the dependent variable, calculated using sample weights, is in square brackets. Standard errors are in parentheses. Mother and child characteristics include the mother's education in years, the mother's age in years, the child's age in months, an indicator for the child's sex, and an indicator of whether the family lived in an urban area.

Table 5. Care at delivery and HIV prevalence

	Delivered in a public or private clinic	If delivered in a clinic, clinic was public	Had a trained birth attendant
	[0.500]	[0.785]	[0.565]
Indicators for birth year included			
HIV prevalence in year of birth	1.651 (0.031)	–0.782 (0.035)	0.684 (0.031)
Indicators for birth year and country/region, and mother and child characteristics included			
HIV prevalence in year of birth	0.250 (0.113)	0.227 (0.139)	–0.833 (0.115)
Observations	125934	64215	124219
Range of birth years	1988-2003	1988-2003	1988-2003

Notes: Ordinary Least Squares estimates. The mean of the dependent variable, calculated using sample weights, is in square brackets. Standard errors are in parentheses. Mother and child characteristics include the mother's education in years, the mother's age in years, the child's age in months, an indicator for the child's sex, and an indicator of whether the family lived in an urban area.

Table 6. Child immunizations and HIV prevalence

	no polio vaccine at birth	no polio vaccine	no measles vaccine	no BCG vaccine	no DPT vaccine
	[0.537]	[0.149]	[0.340]	[0.145]	[0.189]
Indicators for birth year included					
HIV prevalence in year of birth	1.198 (0.040)	–0.370 (0.023)	–0.953 (0.030)	–0.669 (0.022)	–0.832 (0.025)
Indicators for birth year and country/region, and mother and child characteristics included					
HIV prevalence in year of birth	6.397 (0.333)	1.846 (0.089)	0.950 (0.109)	1.283 (0.087)	0.974 (0.097)
Observations	72233	115486	115000	115526	115461
Range of birth years	1994-2003	1988-2003	1988-2003	1988-2003	1988-2003

Notes: Ordinary Least Squares estimates. The mean of the dependent variable, calculated using sample weights, is in square brackets. Standard errors are in parentheses. Mother and child characteristics include the mother's education in years, the mother's age in years, the child's age in months, an indicator for the child's sex, and an indicator of whether the family lived in an urban area.

Table 7. Tests for models with HIV prevalence/birth year interactions

dependent variable:	Test: birth year effects jointly insignificant F (p-value)	Test: birth year/HIV prevalence interactions jointly insignificant F (p-value)	Test: birth year/HIV interactions follow linear trend F (p-value)
Had antenatal care (AC)	43.01 (0.000)	24.46 (0.000)	7.60 (0.000)
If AC: urine test	1.36 (0.210)	7.87 (0.000)	1.09 (0.269)
If AC: blood pressure	2.26 (0.021)	5.80 (0.000)	2.23 (0.029)
If AC: blood test	3.28 (0.001)	1.00 (0.431)	0.88 (0.525)
If AC: weight taken	1.58 (0.124)	2.06 (0.037)	0.46 (0.861)
Delivered in public or private clinic	12.01 (0.000)	1.82 (0.026)	1.70 (0.048)
If delivered in a clinic: clinic was public	8.34 (0.000)	1.07 (0.374)	0.950 (0.501)
Had trained birth attendant	7.15 (0.000)	5.40 (0.000)	1.72 (0.044)
No polio vaccine at birth	55.31 (0.000)	51.62 (0.000)	10.08 (0.000)
No polio vaccine	186.85 (0.000)	148.41 (0.000)	121.38 (0.000)
No measles vaccine	229.54 (0.000)	239.56 (0.000)	248.03 (0.000)
No BCG vaccine	80.11 (0.000)	96.16 (0.000)	82.68 (0.000)
No DPT vaccine	116.35 (0.000)	102.08 (0.000)	99.77 (0.000)

Note: Each row shows test statistics from a regression of the dependent variable on a set of mother and child controls, region/country controls, birth year indicators, and interactions between the birth year indicators and the HIV prevalence in the country/region from the most recent DHS survey (equation 3 in text). The results of these regressions are graphed in Figures 4-8.

Table 8. Problems accessing medical care

	Burkina Faso	Cameroon	Ghana	Malawi	Tanzania	Zambia	Zimbabwe
	2003	2004	2002	2004	2004	2002	2006
A big problem with access to medical care is:							
not knowing where to go	0.188	0.198	0.113	0.156	0.064	0.070	
distance	0.464	0.387	0.328	0.600	0.380	0.455	0.414
money	0.630	0.656	0.548	0.616	0.400	0.664	0.578
transportation	0.404	0.370	0.332	0.549	0.377	0.474	0.422
Observations	12476	10633	5689	11686	8115	7640	8894

Notes. Means are weighted using sample weights. Blank cells indicate the relevant question was not asked in the survey.

Table 9. HIV prevalence and health care, controlling for household wealth

dependent variable:	No wealth measures included	Wealth index included	Six indicators for asset ownership included
Had antenatal care (AC) (80151 obs)	–1.621 (0.097)	–1.614 (0.096)	–1.589 (0.097)
If AC: urine test (32736 obs)	–3.103 (0.540)	–3.033 (0.539)	–3.031 (0.540)
If AC: blood pressure (32739 obs)	–1.549 (0.426)	–1.520 (0.426)	–1.499 (0.427)
If AC: blood test (31600 obs)	–1.310 (0.585)	–1.250 (0.585)	–1.254 (0.586)
If AC: weight taken (31607 obs)	–0.906 (0.289)	–0.883 (0.289)	–0.860 (0.289)
Delivered in public or private clinic (101018 obs)	–0.273 (0.129)	–0.249 (0.129)	–0.278 (0.129)
If delivered in a clinic: clinic was public (50608 obs)	0.346 (0.158)	0.358 (0.158)	0.420 (0.159)
Had trained birth attendant (99313 obs)	–1.180 (0.130)	–1.180 (0.130)	–1.180 (0.130)
No polio vaccine at birth (59948 obs)	5.317 (0.451)	5.309 (0.450)	5.303 (0.450)
No polio vaccine (92331 obs)	2.461 (0.105)	2.455 (0.105)	2.431 (0.105)
No measles vaccine (91994 obs)	1.581 (0.129)	1.573 (0.128)	1.550 (0.129)
No BCG vaccine (92359 obs)	1.728 (0.104)	1.722 (0.104)	1.709 (0.104)
No DPT vaccine (92331 obs)	1.674 (0.116)	1.668 (0.116)	1.679 (0.116)

Note: Each row shows test statistics from a regression of the dependent variable on a set of mother and child controls, region/country controls, birth year indicators, and the estimated HIV prevalence in the year of the child's birth (equation 2 in text). The first column does not include wealth measures; the second includes the wealth index; and the third includes a set of indicators for ownership of each of the six assets (radio, television, refrigerator, bicycle, motorcycle and car).