Sex and the Mission: The Conflicting Effects of Early Christian Investments on sub-Saharan Africa's HIV Epidemic

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Abstract

How does history affect HIV/AIDS prevalence in sub-Saharan Africa? This article studies the long-term historical determinants of prevalence at the subnational level, with a specific focus on the role played by historical missionary activities. On the one hand, missionaries were the first to invest in modern medicine in a number of countries, and these early health investments can have long-term positive effects. On the other hand, the impact of missionary activity is also negative effect through its effect on behaviors regarding sexual health and negative perception of condom use. The contemporary Christian response on abstinence and monogamy. Using contemporary individual-level data, we show that regions close to historical mission settlements are more likely to have a high HIV prevalence today. Among regions historically close to missionary settlements, proximity to a health investment is associated with lower prevalence rates and the negative effect can be explained by negative perceptions of condom use.

Keywords: Historical Persistence; Missions; Health Investments; HIV/AIDS; Sexual Behavior; Abstinence.
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All errors remain our own.

1 Introduction

How does history affect HIV/AIDS prevalence in sub-Saharan Africa? Prevalence is very high in this region of the world. It also varies strongly from one country to the other (Figure 1). In 2012, countries like Mali and Senegal had an estimated prevalence rate of around 1%; at the other extreme, this rate was above 16% in Namibia and South Africa. Many reasons have been avanced to explain these differences, from sexual behavior and epidemic timing to education and exports. This paper investigates the role played by long-term historical determinants. More precisely, we focus on the role played by early missionary investments.

The history of modern medicine in sub-Saharan Africa is closely linked to the development of missionary activity. Missionaries have been but the first and only ones to invest in modern medicine until the middle of the twentieth century (Vaughan, 1991, Ch.3). According to the World Missionary Atlas (Beach and Fahs, 1925), there were 150 missionary physicians in Africa in 1925 and more than 235 nurses working with nearly 500 trained native nurses in 116 hospitals and 366 dispensaries. We investigate whether these early health investments have long-term effects, and in particular whether they affect the propagation of the HIV/AIDS epidemic.

Health investments are not the only way through which missionary activity may affect the propagation of the HIV/AIDS epidemic nowadays, however. In particular, the Christian influence had affected the contemporary curricula of HIV/AIDS prevention taught in sub-Saharan African schools, with an exclusive focus on abstinence and monogamy to the detriment of the mention of the importance of using condoms (Duflo, Dupas, and Kremer, 2015). These restrictive messages may explain why the curricula is not associated with lower prevalence of sexually transmitted infections. According to Duflo, Dupas, and Kremer (2015), *"just over one third of sexually active unmarried 15-19 year old girls in Kenya had ever used a male condom as of 2008-2009"*. We thus disentangle this Christian influence effect from the effect of health investments – as well as of other missionary investments, in particular in education – on the prevalence of HIV/AIDS.

Using contemporary individual-level data from the Demographic and Health Survey (DHS), we show that regions close to historical mission settlements are more likely to have a high HIV prevalence today. Among regions historically close to missionary settlements (a hospital or a dispensary), proximity to a health investment is positively associated with lower prevalence rates, however.

Our econometric analysis attempts to move beyond two forms of selection. First, historical and geographical characteristics might have determined mission station location, preventing the comparison between regions close and far from these settlements. Protestant missionaries did choose to locate in geographically favored areas (Johnson, 1967; **?**). Second, Protestant stations invested in different activities such as printing, health and education. There may be endogenous selection of missions into these activities.

To address selection from missions' location, we follow Cage and Rueda (2016) and restrict our sample to regions near historical mission settlements. Because regions near Protestant missions shared similar geographic, institutional and cultural environments, this restriction isolates the specific effect of the investments from other possible long-term determinants of civic and social capital embedded in specific mission locations.

To address selection of missions into different investments, we first control for observable covariates. The set of observable covariates include geographic and historical characteristics as well as distance to historical mission stations that invested in health, educational facilities and printing presses. We then develop a matching strategy that aims at isolating the effect of proximity to a mission with a specific investment (printing press, school or hospital) from the effect of proximity to a mission with similar characteristics, but without this specific investment. The results are robust to this approach and of similar order of magnitude. Finally, we assess the bias due to unobservables using the sensitivity of the treatment to added controls.

Finally, beyond these selections issues, the main empirical challenge is to disentangle the effect of the health investments on the one hand from the one of the focus on abstinence on the other hand on the prevalence of HIV/AIDS nowadays. Medical activity was just one way to achieve what was the main goal of the missions in sub-Saharan Africa, namely to convert the local population to the Christian faith. This is particularly challenging because in sub-Saharan Africa, sexually transmitted infections were actually not treated in their medical nature, but mostly considered as "diseases of immorality" (Vaughan, 1991). The campaign to prevent syphilis in the 1920's in Uganda, for instance, focused heavily the stigmatization of the disease and conversion as the disease was perceived to result from the "dangerous" female African sexuality (Vaughan, 1991, Ch.6).

To disentangle these two effects, we investigate whether other missionary investments that missionaries used as vectors of conversion, like schools or the printing press, had any effect on the prevalence of the infection. Second, we use malaria as a counterfactual. Contrary to

HIV/AIDS, malaria is indeed not a sexually transmitted infection and its prevalence should not be affected by the abstinence-focused curriculum imposed by the Christian influence. But it is one of the most significant diseases in the world today in terms of its humanitarian burden. Finally, we focus on individual's sexual behavior and investigate the extent to which it is affected by the Christian influence.

[Figure 1 about here.]

[Figure 2 about here.]

Related literature There is a growing literature within economics on the HIV/AIDS epidemic in sub-Saharan Africa. A number of papers aim at understanding differences in prevalence. Oster (2005) shows theoretically that differences within Africa can be attributed to differences in sexual behavior (e.g. the number of sexual partners), male circumcision, and epidemic timing. Oster (2012) provides empirical evidence of a positive relationship between exports and new HIV infections. In this paper, we control extensively for those determinants that have been highlighted in the existing literature. In particular, we combine our data on HIV/AIDS prevalence with data on African roads and investigate at the micro-level the effect of road density of HIV/AIDS prevalence.

We contribute to this literature by investigating the role played by historical determinants. Bertocchi and Dimico (2015) also study the long-term determinants of the high rates of HIV infection in sub-Saharan Africa. Their focus is on family structure and sexual behavior as shaped by the demographic shock following the transatlantic slave trade. On the contrary, we focus on the long-term impact of missionary investments. To the extent of our knowledge, Mantovanelli (2015) is the only paper also considering the impact of missionary activites on HIV/AIDS and to highlight the importance of their impact on moral values and culture. However his focus is on missions' location and he does not take into account the different investments performed by the missions. In particular, he does not capture the positive long-term impact of missions through the early health investments.

Our paper is also related to the randomized experiments in the literature that highlight the limits of HIV prevention education focused on abstinence until marriage to reduce the HIV/AIDS prevalence (Dupas, 2011; Duflo, Dupas, and Kremer, 2015).[1] Consistently with

[1] See also Baird et al. (2012) who find that in Malawi, monthly cash transfers to the families of out-of-school girls significantly reduced HIV infection rates after 18 months.

the findings of this literature, we show that the Christian influence – independently from the health investments – has a long-term negative impact on prevalence. Moreover, we document the role played by the use of condoms.[2]

More generally, there is a growing literature on HIV prevention. **?** review the impact of media exposure. Banerjee, La Ferrara and Orozco (2015) have implemented a randomized control trial to estimate the impact of a TV show on risky sexual behavior, gender norms and domestic violence in Nigeria.

Finally, our article is more broadly related to the literature on the long-term effects of history. The early work of Protestant missionaries has been largely associated with improving development in the long-term, through an increase in social capital (Woodberry, 2012; Cage and Rueda, 2016), human capital (Gallego and Woodberry, 2010; Valencia-Caicedo, 2014), or gender equality (Nunn, 2014). Here, we consider both Protestant and Catholic missionaries and show that missionaries have both a negative and positive impact on long-term health.

The rest of the paper is organized as follows. Section 2 presents a brief historical background on missionary activity in sub-Saharan Africa, the early investments in modern medicine and the focus of a number of religious groups on abstinence until marriage. Section 3 describes the data and presents summary statistics. In Section 4, we provide empirical evidence on the long-term impact of missionary activity on HIV/AIDS prevalence nowadays, and disentangle between the positive effect of health investments and the negative effect of the focus on abstinence. Section 5 discusses our results and presents a number of robustness checks. Section 6 concludes.

2 Historical background

2.1 Missions and early health investments

The history of modern medicine in sub-Saharan Africa is closely linked to the development of missionary activity. Missionaries were the first and only ones to provide this form of healthcare until the middle of the twentieth century (Vaughan, 1991, Ch.3). Missionary work was often conducted by doctors or nurses; David Livingstone, who is probably the best known figure in the history of African missionaries, was a doctor himself. From the end of the nineteen

[2] Thornton (2008) finds that when people learn they are HIV positive they increase their purchase of condoms, by only by about one condom.

century to the early twentieth century, there was a rapid increase in the activity of medical work among missionaries. The Edinburgh Medical Missionary Association was founded in 1841, and in 1891 the Church Mission Society established a new "Medical Committee" that was specifically in charge of managing the medical work of the society.

The early Christian provision of health care persisted after the colonization and is particularly influential in the design of health care in poor countries (Idler, 2014). In 1968 the Christian Medical Commission was established, it institutionalized the long-lasting tradition of Christian medical and healing work around the world. The importance of such institution is recognized by the World Health Organization that has designed the agenda on health care provision in poor countries in conjunction with the CMC and the organizations that replaced it after its dissolution in 1998 (Idler, 2014). According to Pr. Dan Kaseje's address for the WHO on the contribution of the CMC to health care in Africa, policies such as the essential drugs initiative in 1987 (or Bamako initiative), that aimed at "solving the problems in the financing of primary health care" and lead to the commitment of African health ministers to ensure a regular supply of drugs were put together by the WHO and the UNICEF following the guidelines of the CMC.[3]

2.2 The Christian influence and the focus on abstinence

Missions have invested in different activities in Africa, health, but also education or the printing press. The main role of the missions was to convert the local population to the Christian faith. Medical activity was just one way to achieve this goal, because the notion of healing the body and soul is so deeply rooted in the Christian dogma. The Gospel of Matthew 10:1 reads: *"Jesus called his twelve disciples to him and gave them authority to drive out impure spirits and to heal every disease and sickness'"*. Medical work, as this form of *"healing authority"*, was *"part of a programme of social and moral engineering through which Africa would be saved"* (Hardiman, 2006). Therefore, sexually transmitted diseases were not really treated in their medical nature, but mostly considered as "diseases of immorality" (Vaughan, 1991).

Religious groups favored prevention messages focusing on abstinence until marriage, rather than condom use. Primary school children are not supposed to be sexually active. The resulting curriculum, e.g. in Kenya, teaches the biology of AIDS and HIV transmission, care

[3]The notes of the speech can be found online. They provide many more examples of the projects that have been put together by the CMC and the WHO

for people living with AIDS, and prevention. The prevention component stresses abstinence until marriage, followed by faithfulness in marriage as the most effective way to prevent sexually transmitted infections, and teaches skills such as saying no and resisting peer pressure. The official textbook does not mention condoms or contraception.[4]

Yet, it has been shown in the literature that HIV curriculum stressing abstinence until marriage does not reduce pregnancy or STI (Dupas, 2011; Duflo, Dupas, and Kremer, 2015).

3 Data Sources and Description

3.1 Contemporary Data

3.1.1 Demographic and Health Survey

We use the Demographic and Health Survey (DHS) to estimate the HIV prevalence at the subnational level, and the contemporary characteristics of the regions of interest.

The DHS are standardized nationally representative surveys in developing countries. Women and men answer questions related to their anthropometrics, living conditions, health, sexual reproduction behaviors, and attitudes and beliefs towards different health outcomes, in particular towards the HIV epidemic.

Since the 2000s, the DHS also collect biomarker data on STDs. Biomarkers are objective physical or biologic measures of health conditions. Using field-friendly technologies, the DHS Program is able to collect biomarker data relating to a wide range of health conditions, including infectious and STIs, chronic illnesses (such as diabetes, micronutrient deficiencies), and exposure to environmental toxins.[5]

We use the DHS data for sub-Saharan African countries where both GPS information and biomarker data on HIV are provided. Figure 3 shows the locations of these clusters. There are a total of 13307 clusters distributed among 20 countries: Burkina Faso, Burundi, the Democratic Republic of Congo, Côte d'Ivoire, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Liberia, Lesotho, Mali, Malawi, Mozambique, Rwanda, Senegal, Swaziland, Uganda, Zambia, and Zimbabwe. The information is collected in several rounds, from 2003 to 2014. Unfor-

[4]*"The curriculum does not mention condoms and provides only limited scope for teachers to discuss protected sex in response to students' questions. It does not cover partner selection, and although they cover love relationships between same)age boys and girls, the official textbooks do not mention cross-generational relationships (and their associated risk)"* (Dupas, 2011).

[5]Dried blood spots (DBS) on filter paper are increasingly used for HIV testing. This method of specimen collection has eliminated the need for cold chain and/or refrigeration of specimens, reducing considerably the complexity of storage in the field and transport to the laboratory. For more information, visit the DHS website.

tunately, not all the countries are systematically surveyed so our resulting pseudo-panel is extremely unbalanced. As a result, our variable of interest is HIV prevalence (a stock), rather than incidence (the flow, number of new cases). As an illustration, consider the HIV prevalence at t, h_t, as the number of people aged 15 to 49 years old living with HIV or AIDS in a given region. Denote d_t the number of deaths from HIV/AIDS from $t-1$ to t; then the incidence in_t is

$$in_t = h_t - h_{t-1} + d_t$$

Normalizing by the population size to obtain rates, the incidence rates tells how likely it is to get the disease in a given region (or how fast the epidemic is moving), whereas prevalence rates indicate how widespread the disease is. Incidence rate requires yearly data on prevalence and mortality form HIV/AIDS. Previous research that focuses on incidence rates typically uses country-level estimates (Oster, 2010, 2012).

Prevalence rates are an imperfect measure of the risk of contracting the disease, but they capture the how the disease has accumulated. Because we are interested in historical determinants of the infection's spread, as opposed to public policies in reaction to it, measuring the stock of the disease is very informative as well.

3.1.2 Geographical data

Following Michalopoulos and Papaioannou (2013, 2014), we use light density data as a proxy for urbanization and regional GDP. To control for geographic characterisitcs at the town and mission-level, we use the *Global Agro-Ecological Zones* (GAEZ) data compiled by the Food and Agriculture Organization (FAO). From this source, we extract precipitation levels, number of growing days per year, malaria ecology, and terrain ruggedness for each location.

Finally, we also use data on malaria incidence over time to compare to our results for HIV prevalence. The raster maps of malaria incidence in Africa from 2000 to 2011 come from the Malaria Atlas Project (Bhatt et al., 2015, MAP). The MAP provides geographical information on malaria incidence, use of Insecticide Treated Nets and other preventive treatment. It is compiled using multiple data sources (among them, surveys conducted across millions of households) and it is extrapolated geographically using a spatio-temporal Bayesian geostatistical model across 27573 georeferenced population clusters.

The data of African roads comes from the NASA Socio Economic Data and Application Center. The data set combines the best available roads data by country into a global roads coverage, using the UN Spatial Data Infrastructure Transport (UNSDI-T) version 2 as a common data model. The date range for road network representations ranges from the 1980s to 2010 depending on the country. Udated data for 27 countries and 6 smaller geographic entities were assembled by Columbia University's Center for International Earth Science Information Network (CIESIN), with a focus largely on developing countries with the poorest data coverage (Socio-Economic Data and Application Center (SEDAC), 2016)

3.2 Historical Data

3.2.1 Missionary Investments

We originally compiled the data of missionary investments and their locations in a previous article (Cage and Rueda, 2016).

We construct the mission-level data from the *Geography and Atlas of Christian Missions* (Beach, 1903). We geocode the maps of sub-Saharan African regions from this atlas. The maps locate all the Protestant mission stations in 1903 (an example of these maps is provided in the online Appendix of Cage and Rueda (2016)).

As opposed to other available geographic datasets of Protestant missions (Nunn, 2014), ours contains detailed information for each mission settlement. In the *Geography and Atlas of Christian Missions*, each mission station is uniquely identified in a statistical appendix providing information on the mission's size (number of students, of missionaries, etc) and a detailed record of its activities and investments. For example, we know whether each mission had a printing press, a school, or a health facility. The exhaustive list of variables and a reproduction of one page of the statistical index are provided in the online Appendix to Cage and Rueda (2016). Our sample of sub-Saharan African missions includes a total of 723 Protestant missions out of which 27 were equipped with a printing press, 99 had a dispensary, 38 had a hospital, and 86 had a school (a high school or a boarding school, by default, most missionary stations conducted literacy work).Figure 4 shows the locations of the missions and their investments.

3.2.2 Additional Historical Controls

The *Ethnographic Atlas* (Murdock, 1967) provides precolonial characteristics at the ethnic group-level such as initial population density. Data on ethnic-level slave trade come from Nunn (2008). Georeferenced Data on historical population density is from the History Database of the Global Environment (HYDE), computed by the Dutch Environmental Assessment Agency. We geocode these data at the mission and DHS cluster levels.

3.3 Determinants of mission location and investments

Johnson (1967), Nunn (2014), and Cage and Rueda (2016) discuss extensively the determinants of missionary location. Because of potential selection in missionary location, our empirical analysis restricts the focus to regions near historical mission settlements. Moreover, our specifications always control for all the geographic and historical characteristics that may have influenced location choice, such as the malaria ecology, proximity to the coast, suitability for rainfed crops, and proximity to historical rail lines and explorer routes.

Before turning to the empirical analysis, we analyze the determinants of missionary investments. We compare missions depending on whether they invested in health facilities(Table 1) and whether they had a printing press (Table 2). We choose these two investments because they are those that we will discuss the most in the empirical analysis.

Table 1 compares the geographic and historical characteristics of missions that did invest in health with those that did not. Missions that invested in health facilities were not, on average, located in more geographically favored areas. None of the geographical indicators are significantly different between the two groups, except for malaria ecology which is higher for missions that worked in health. Table 2 shows that the same results hold for missions with a printing press.

Historical characteristics exhibit a different pattern. Missions working in health and those with a printing press have more favorable historical characteristics: they are closer to historical cities and explorer routes. All our specifications control for these characteristics.

[Table 1 about here.]

[Table 2 about here.]

[Figure 3 about here.]

[Figure 4 about here.]

4 Empirical Analysis

4.1 Specification

Equation 1 describes our preferred specification

$$
\begin{aligned}
y_{rct} = &\mathbf{Dis}'_{\mathbf{rc}}\beta + \mathbf{X}'_{\mathbf{rct}}\gamma_{\mathbf{1}} + \mathbf{W}'_{\mathbf{rc}}\gamma_{\mathbf{2}} \\
&+ \zeta_r + \eta_t + \theta_c + \varepsilon_{rct}.
\end{aligned} \tag{1}
$$

The outcome variable y_{rct} will typically be the average prevalence rate of HIV as estimated from the DHS biomarkers, in the DHS cluster r, in country c, and year t. In the reminder of the paper, we will call "towns" the DHS clusters. **Dis** is a vector with 4 distances from town r to the closest historical mission settlement, the closest missions with a health investment (a hospital or a dispensary), with a printing press, and with an education investment (a high or a boarding school).

The vector $\mathbf{X_{rct}}$ contains town-level controls from each round of the DHS. These are the share of women in town, of married couples, of houses with electricity, households owning a bike or a car, the average age, population density.

The vector $\mathbf{W_{rc}}$ contains geographical and historical-level controls for town r in country c. The geographical controls are distance to the capital city, distance to the coast, the average malaria ecology, ruggedness, elevation, number of growing days, and suitability for rainfed crops in the town.[6] The historical controls are distances to cities in 1400 and 1800, estimates of precolonial population density from HYDE, distance to colonial railways and to initial explorer routes (Nunn, 2008). Following Oster (2012), we include distance to the originating point of the epidemic as a control in all our regressions. The exact latitude and longitude of her analysis are not specified in her paper, so we use distance to Kinshasa, as it has been documented to be the most likely originating point of the HIV-1 virus (Faria et al., 2014).

Finally, ζ, η, and θ are town, year, and country fixed effects. All the regressions' standard errors are clustered at the closest mission level.

[6] These variables are constructed from GAEZ raster data. The constructions is explained with more details in the online Appendix

4.2 Results

Christian Missions and HIV Prevalence We first estimate the long-term effect of proximity to a mission station on the average HIV prevalence today. The results are reported in Table 3. The baseline correlation between HIV prevalence and proximity to a mission is negative, whether the mission is is Catholic or Protestant. This means that regions close to historical mission settlements are more likely to have a high HIV prevalence today. As we restrict the analysis to regions close to Protestant missions and we add the controls and fixed effects described in equation 1, the correlation between regions close to Protestant missions and HIV prevalence vanishes and looses statistical significance. The coefficient on distance to Catholic missions becomes statistically significant and is also negative. The results indicate that a one standard deviation increase in the distance to a Protestant mission or to a Catholic mission increases the HIV prevalence rate by around 5% of a standard deviation in both cases.

As detailed in the introduction, Christian missions have mostly been associated with positive long-term effects on economic development. Therefore, the rest of the article examines the possible channels explaining the counterintuitive result from table 3, according to which proximity to Christian missions is associated with higher HIV prevalence.

[Table 3 about here.]

Missionary Investments and HIV Prevalence In Table 4, we investigate the long-term effect of missionary investments on HIV prevalence today. Controlling for distance to investments and restricting the analysis to missions close to protestant missions eliminates the baseline correlations of table 3 between distance to any mission and HIV prevalence.

Column (1) in table 4 shows that distance to missionary investments has conflicting effects on HIV prevalence. On the one hand, a one standard-deviation increase in distance to the printing press increases HIV prevalence by around 7.9% of a standard deviation. On the other hand, a one standard-deviation increase in distance to a missionary health facility decreases HIV prevalence by around 7.3% of a standard deviation. Finally, distance to education has no statistically significant effect on HIV prevalence today.

Proximity to health investments likely captures the supply of medical services today, as medical care and health care on the field is still largely supplied or coordinated by Christian institutions today. The observed relation is then likely driven by the better coverage of health care in regions close to historical mission settlements. In the section specifically addressing endogeneity, we make sure that the effect is not driven by selection on the location of health investments within the missions.

Cage and Rueda (2016) point out the long-term consequences of the printing press for outcomes that are positively associated with development, such as media consumption and social capital. How can we make sense of the negative long-term relationship between the printing press and HIV prevalence?

Duflo, Dupas, and Kremer (2015) analyze the complex relationship between education costs, sex-education programs, and HIV prevalence. They show that when no information on how and why to use condoms is taught, education has little preventive power on HIV contamination. Moreover, since most HIV prevention programs in sub-Saharan African schools are designed or coordinated by local Christian actors, it is not rare that their content emphasizes on abstinence and having a single partner, without teaching anything about condoms at all. Since the printing press was an important tool of conversion to Christianity, we test whether the negative relationship observed is linked to Christian-specific catalysts to the spread of the epidemic.

In column (2), we control for media consumption (newspaper readership) and literacy, as these are important tools for information diffusion. Consistently with Duflo, Dupas, and Kremer (2015), we find no that access the means of information in itself does not change HIV prevalence. Halperin and Epstein (2007) identify two important determinants of the HIV epidemic: the number of sexual partners (increases contagion risk) and male circumcision (decreases contagion risk). Both of them can be correlated with Christianity, as neither circumcision, multiple partners before marriage, or polygamy are encouraged in the Christian tradition. Column (3) reports the results when male circumcision and number of partners are added as controls (these variables are not present in all the rounds of the DHS, hence the decrease in the number of observations). We do observe a negative correlation between the number of partners (resp. share of male who are circumcised) and HIV prevalence. Adding these controls reduces the statistical significance of the coefficient associated with distance to the printing press, but the magnitude remains unchanged. The coefficient on distance to catholic missions remains statistically significant.

We further investigate whether the observed negative relationship between proximity to the printing press and HIV prevalence can be explained by attitudes and behaviors regarding condom use among Christian populations. We thus look at respondents' reported religion, attitudes, and beliefs about condom use and HIV that are consistently reported in the DHS. Columns (4) and (5) show the results of regression 1 when controlling for the share of individuals who are Christian, those who disapprove of contraception use ("against contraception"), and the share of those who think that condoms do not protect against HIV ("condoms do not protect").[7] The coefficients associated to the aforementioned variables all have the expected signs. Adding these variable to the regression makes the effect of distance to the printing press almost nil and insignificant, while the one of distance to a health facility is now greater and more statistically significant. Results in column (4) suggest that within regions located close to missions, a one standard-deviation increase in distance to a historical health facility increases HIV prevalence by about 11.3% of a standard deviation.

Most of the controls added in the regression reported from columns (2) to (5) do not have statistically significant effects on HIV prevalence. We thus run an F-test on the joint statistical significance of these variables. The obtained F-statistic is 2.29 (p-value=0.02), so we reject the null hypothesis of joint insignificance at the 5% level.

Because we do not have information on Catholic investments, we check that the results are not driven by regions close to them. In column (5), we run the same regression than in column (4), but restricting it to a sample of towns close to Protestant missions (less than 200 km, as in the other regressions), but far to Catholic (more than 200 km). The results are robust to this restriction.

[Table 4 about here.]

5 Robustness checks and Discussion

The results from the previous section suggest that missionary investments had opposing effects on HIV prevalence today. This section investigates the robustness of these results.

Road Density As proved by Oster (2012), proximity to trade routes, and in particular to roads is a strong predictor of HIV incidence at the cross-country level. The aim of this robustness check is twofold. First, we want to test the accuracy of our HIV prevalence measures by reproducing Oster's result. Second, we test whether our results are robust to the inclusion of road density as a control.

[7]The variables and procedures used in the construction of all the additional controls are carefully explained in the online Appendix

To construct road density at the town level, we use data from the NASA's Socio-Economic Data and Application center. They provide a geographic dataset with all the roads reported from country's data and other data sources (Socio-Economic Data and Application Center (SEDAC), 2016). We keep all the primary to tertiary roads in the sample for which the existence is not claimed to be "dubious". We then draw a 50 kmx50 km grid on the map and compute the average length of roads in each grid. We define road density as the average length on each grid, divided by the grid's surface.[8]

Columns (1) and (2) in table 5 report the results. Column (1) shows that there is indeed a positive relationship between road density and HIV prevalence in town. These results are reassuring regarding the quality of the HIV prevalence estimates. Column (2) reports the results of running the same regression as in column (4) of table 4, adding road density as a control. Our results remain unchanged, but the coefficient on road density looses its statistical significance. This does not mean that Oster's results are invalidated. Adding all the controls on distance to missionary investments means that we are comparing similar and developed areas, in which the presence of a road network might make no difference for the risk of infection.

[Figure 5 about here.]

Malaria Incidence We also investigate the extent to which proximity to historical mission locations and investments affect malaria. Malaria is a particularly interesting counterfactual in our framework. While malaria – contrary to HIV/AIDS – is not a sexually transmitted infection, it is one of the most significant diseases in the world today in terms of its humanitarian burden. Depetris-Chauvin and Weil (2013), studying the long-term effects of malaria on economic development in Africa, find that in the more afflicted regions, malaria lowered the probability of surviving to adulthood by about ten percentage points (on the impact of malaria on growth and development see also: Cutler et al., 2010; Weil, 2010).[9] Malaria is a leading cause of death for children and the cause of numerous lost work hours for adults nowadays (Cohen, Dupas, and Schaner, 2015).

Malaria can be prevented in a number of cheap ways, in particular different class of antimalarials, among which the artemisinin combination therapies (ACTs), the provision of insecticide-treated nets (ITNs) and indoor residual spraying (IRS, meaning the spraying of

[8]The normalization matters because the grid's size is smaller when cut by a coast

[9]On the long-term effects of other diseases in Africa, see Alsan (2015).

insecticide in house's walls). A natural way to ensure access for appropriate users while limiting over-treatment is to distribute subsidized health technologies like ACTs, IRS, and ITNs, through the public health system, where diagnostic tools and trained medical personnel can target technologies to patients with high returns (Cohen and Dupas, 2010; Cohen, Dupas, and Schaner, 2015). Cohen and Dupas (2010) show the effectiveness of public policy intervention to incentivize ITN use and the importance of peer-effects that encourage uptake.

In table 5, we present the results of estimating equation 1 using malaria incidence in 2015 as an outome. The estimates of malaria incidence come from the maps produced by the Malaria Atlas Project (Bhatt et al., 2015). Malaria prevalence pre-existed missionary location. On the one hand, missionaries may have avoided malaria to protect their own health, but on the other hand, in the quest of "healing" the most deprived populations, it may as well have positively affected it. In particular, table 1 shows that among missions, those with a health investment tend to have higher malaria ecology. Moreover, the mapping of malaria incidence has greatly changed over time, with the expanding use of technologies to prevent contagion (Bhatt et al., 2015). For the aforementioned reasons, we do not seek to interpret the coefficient on missionary investments and malaria incidence today.

However, given that malaria is not sexually transmissible, malaria should not be affected by Christian influence on sexual behaviors per se. Therefore, the inclusion of the controls on sexual behaviors and beliefs that are linked to Christianity should not affect the observed relationships, as opposed to what is observed in table 4 for HIV prevalence. Columns (3) and (4) in table 4 show the results. The inclusion of the controls proxying for Christian influence on sexual behaviors does not change the correlation between distance to investments and malaria incidence in 2015. An F-test on the joint-significance of the added controls returns a F-statistic of 1.01 (p-value=0.42)

[Table 5 about here.]

6 Conclusion

In this paper, we provide new empirical evidence on the long-term effects of missionary activities in sub-Saharan Africa on the prevalence of HIV/AIDS nowadays. We highligth two possible countervailing effects of missions. One the one hand, early missionary investments in health have a positive long-term impact on prevalence as of today. On the other hand, the impact of missionary activity is also negative effect through its effect on behaviors regarding sexual health and safety. By focusing on moral values and abstinence until marriage, and ignoring condoms, they increase the risk of HIV/AIDS within comparable regions.

While the focus of the existing literature have being mostly on missionary presence per se, to the exception of Cage and Rueda (2016), we highlight the importance of distinguishing the investments performed by the mission to the missionary presence and in particular the Christian influence. Through their investments in health, missions have a positive long-term effect on development, consistently with the existing literature, this positive effect is counter-balanced by the negative Christian influence on beliefs and the practice of safe sex methods. These results also have important policy implications in terms of optimal policy to reduce the incidence rates in the future.

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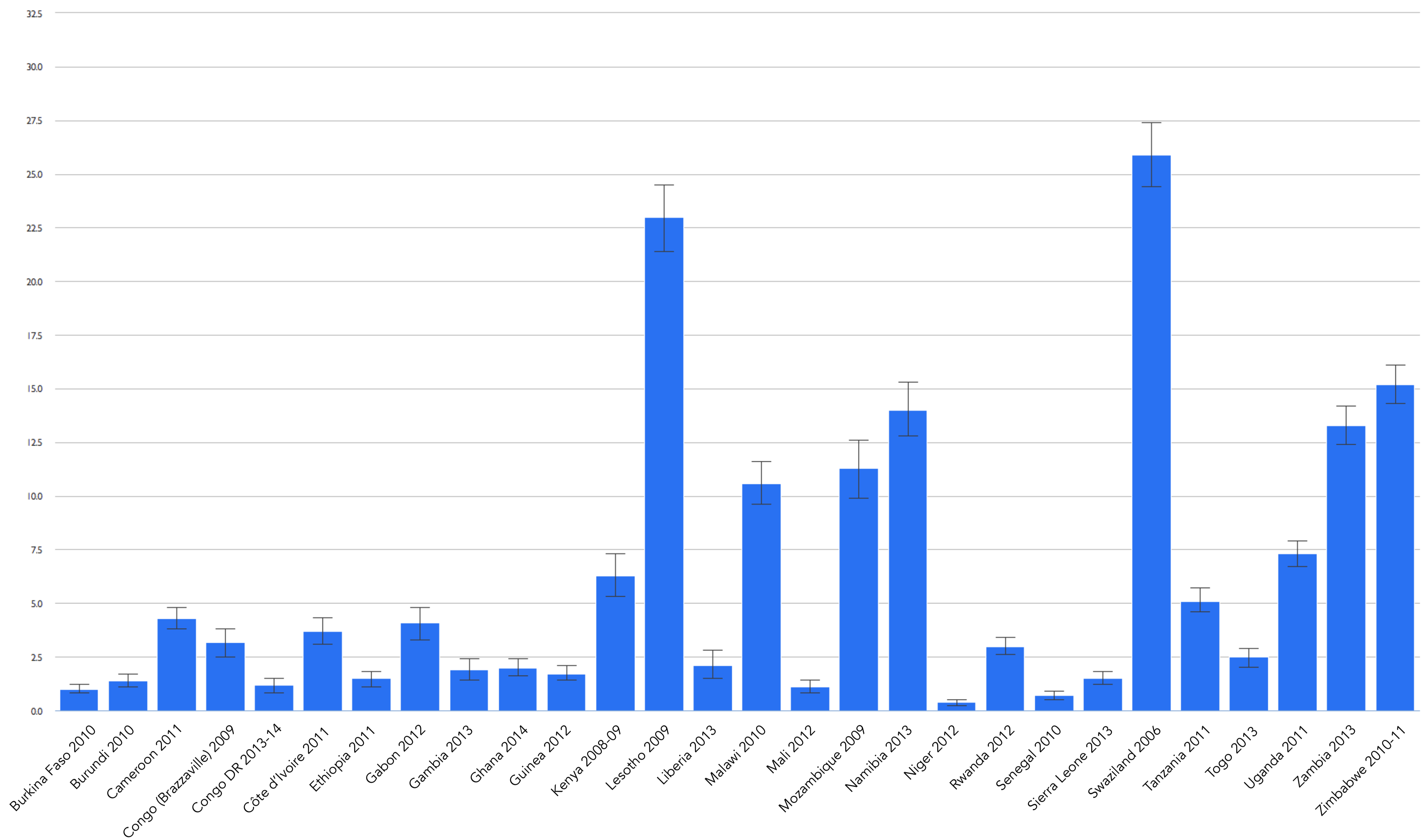

Figure 1: HIV prevalence rates by country

Notes: The figure shows the average prevalence rates from different sub-Saharan African countries. The estimates are those of the DHS using the most recent biomarker data for each country (extracted from statcompiler).

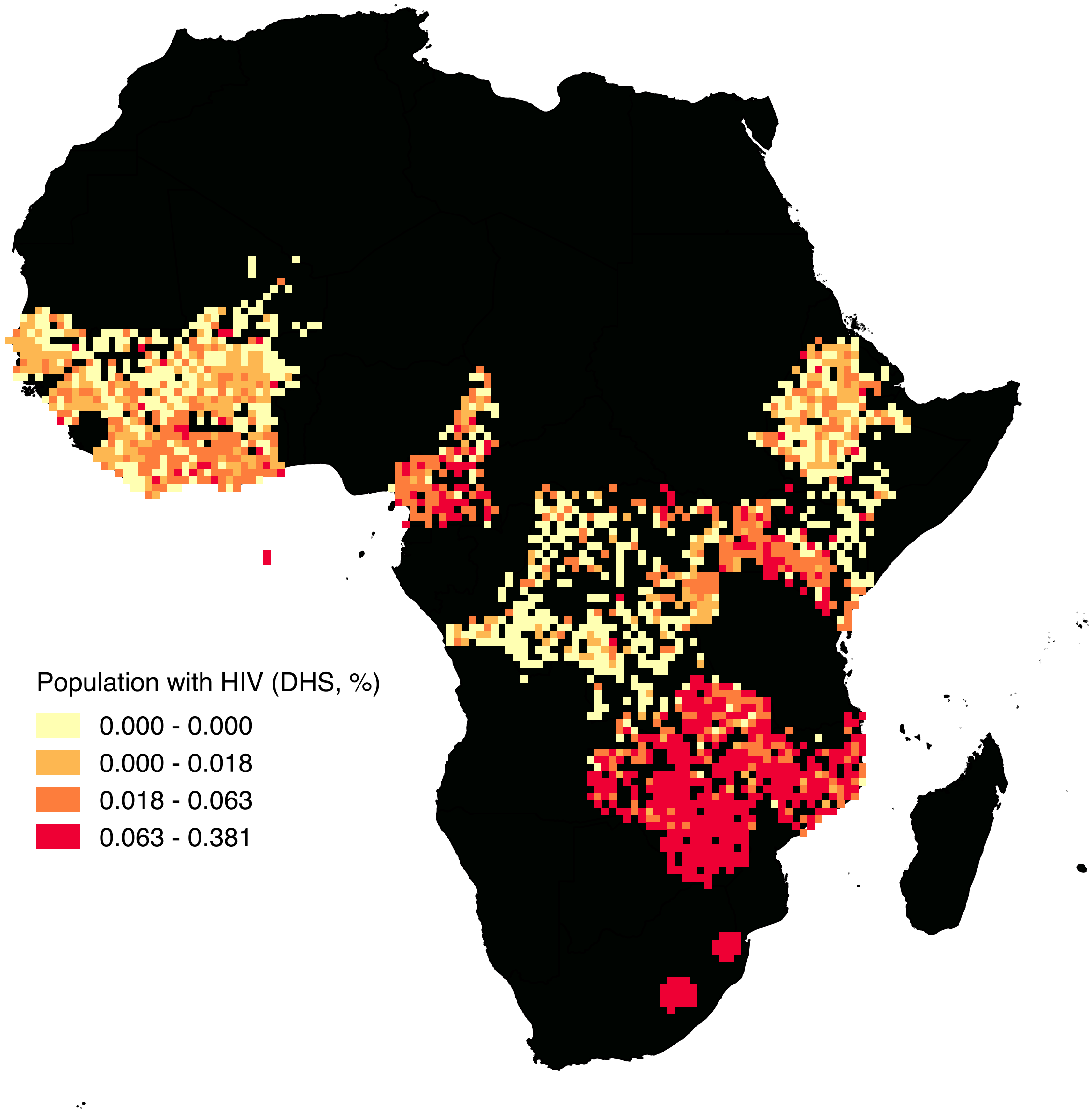

Figure 2: HIV prevalence estimates at the subnational level

Notes: The figure shows the average prevalence rates from DHS clusters, estimated by the authors using available biomarker data from 2003 to 2013. The figure hows the average estimated prevalence from all the DHS cluster in a 50x50 km grid.

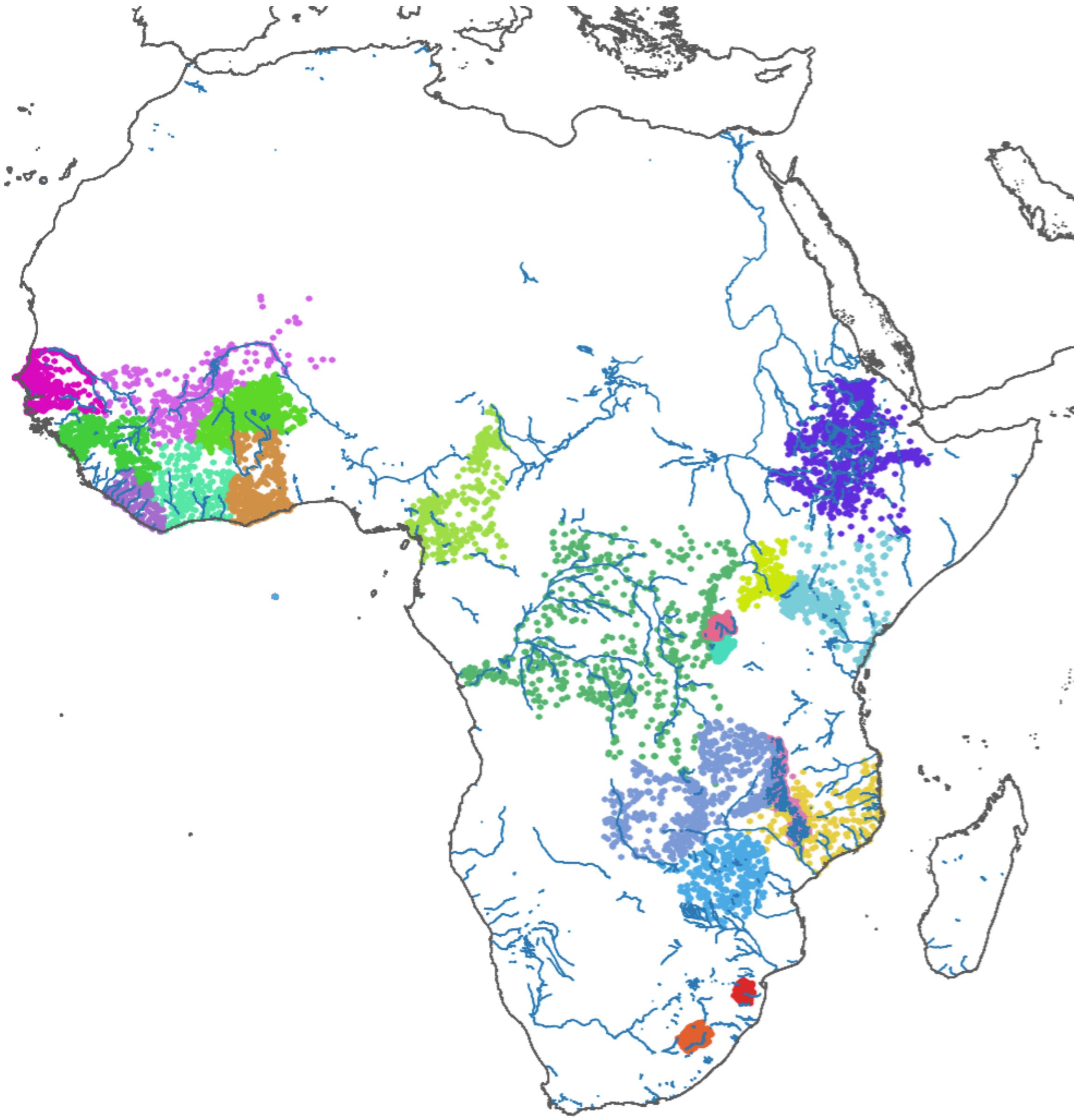

Figure 3: DHS locations

Notes: The figure shows the location of DHS clusters in sub-Saharan Africa that report both HIV biomarker data and GPS information. Each color represents a different country.

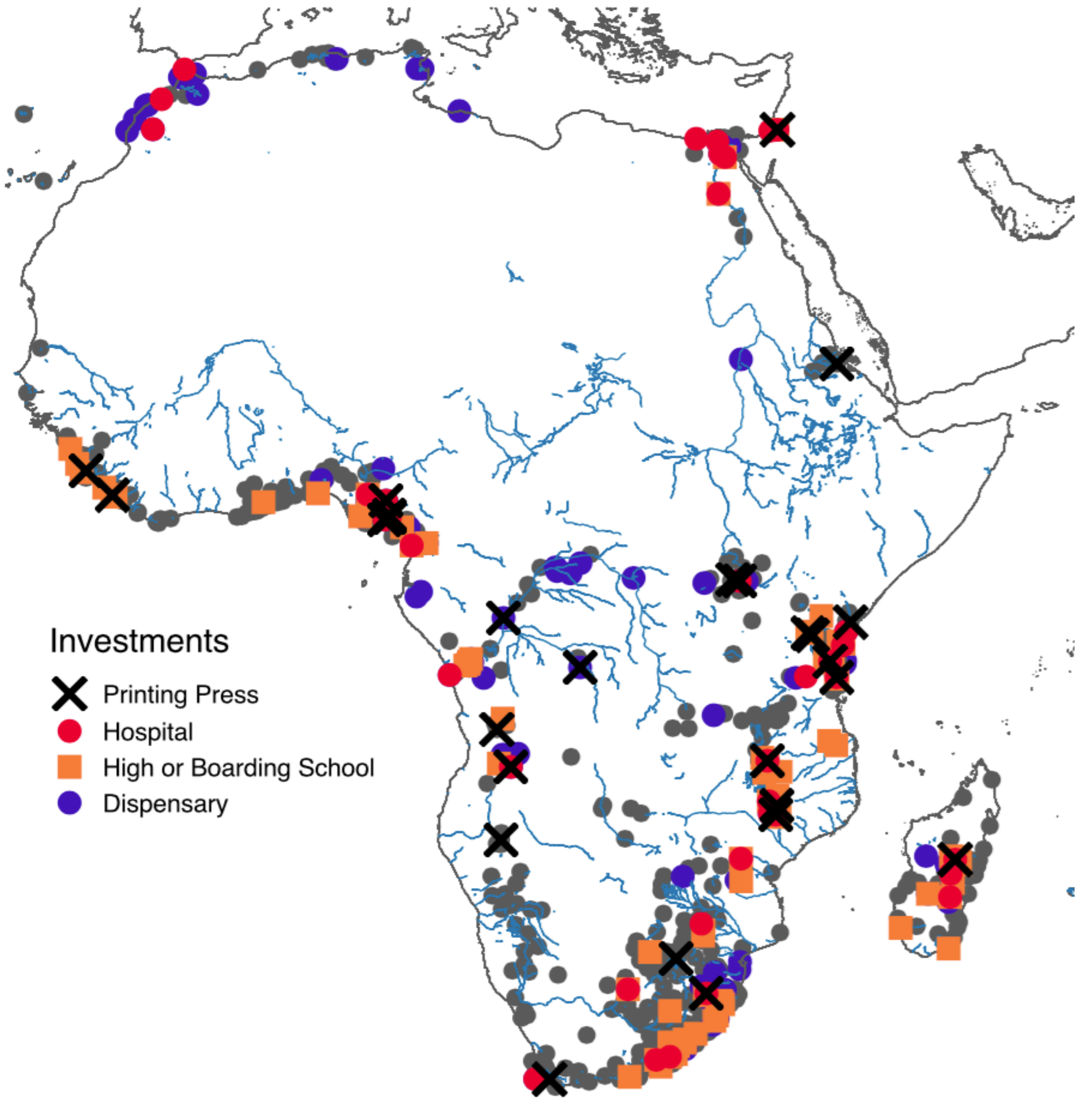

Figure 4: Missions and missionary investment locations

Notes: The figure shows the location of missions and our investment of interest: health investment, schools, and the printing press

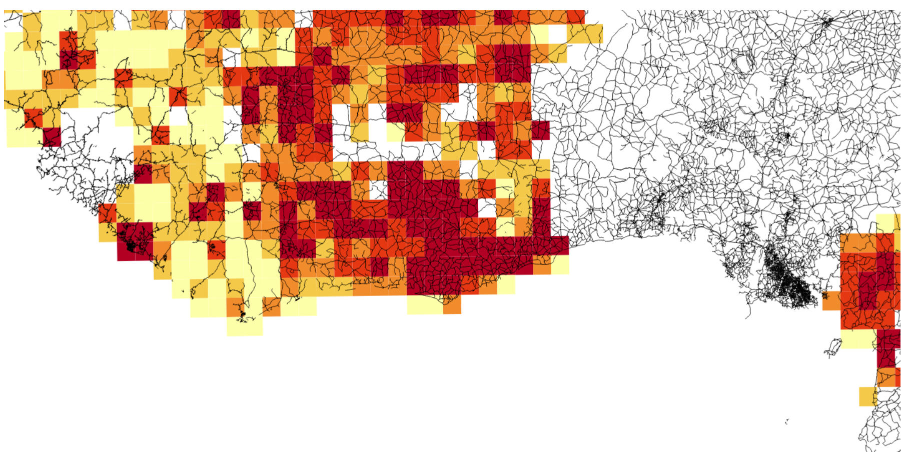

Figure 5: Road Density

Notes: The figure a part of the map of African roads from the SEDAC and the extracted road density measure at the grid level (in Western Africa). The colors indicate a range of road densities from low (light color) to high (dark color). The areas that are non gridded correspond to regions where no DHS town is located.

List of Tables

Table 1: Summary Statistics: Characteristics of Missions with Health Investments

	(1) No Investment	(2) Investment	(3) Diff
Geographical Characteristics			
Number of Growing Days (%)	53.674	51.990	1.684
			(2.711)
Suitability for Rainfed Crops	4.927	5.286	-0.359*
			(0.196)
Average Precipitation per Day (over year)	3.532	2.861	0.671
			(0.664)
Distance to 2000 city (100km)	2.735	2.511	0.224
			(0.205)
Distance to the Coast (100km)	2.335	2.288	0.047
			(0.293)
Malaria Ecology	4.910	8.032	-3.123***
			(0.825)
Historical Characteristics			
Slave Exports, per capita	0.067	0.100	-0.033
			(0.058)
Railway Contact	0.243	0.170	0.073
			(0.045)
Explorer Contact	0.138	0.208	-0.070*
			(0.038)
Initial Population Density / 100	10.442	19.676	-9.233**
			(4.373)
Distance to 1400 City (100km)	9.235	6.409	2.825***
			(0.500)
Distance to 1800 City (100km)	16.386	9.977	6.409***
			(1.011)
Observations	573	106	679

Notes: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The Table reports OLS estimates. The unit of observation is the town. The dependent variable is the average prevalence rate of malaria in town in 2015 (columns (1) and (2), and the decrease in malaria prevalence from 2010 to 2015 in town (columns (3) to (5)) Standard errors in parentheses are clustered at the closest mission level. Controls are described in the text.

Table 2: Summary Statistics: Characteristics of Missions with the Printing Press Investments

	(1) No Investment	(2) Investment	(3) Diff
Geographical Characteristics			
Number of Growing Days (%)	53.123	60.049	-6.926
			(4.920)
Suitability for Rainfed Crops	4.992	4.750	0.242
			(0.356)
Average Precipitation per Day (over year)	3.413	3.791	-0.378
			(1.208)
Distance to 2000 city (100km)	2.702	2.655	0.047
			(0.374)
Distance to the Coast (100km)	2.310	2.747	-0.437
			(0.534)
Malaria Ecology	5.187	10.295	-5.108**
			(1.509)
Historical Characteristics			
Slave Exports, per capita	0.074	0.042	0.031
			(0.107)
Railway Contact	0.237	0.107	0.129
			(0.081)
Explorer Contact	0.143	0.286	-0.143**
			(0.069)
Initial Population Density / 100	11.803	13.760	-1.958
			(8.008)
Distance to 1400 City (100km)	8.872	6.969	1.903*
			(0.932)
Distance to 1800 City (100km)	15.587	10.704	4.883**
			(1.890)
Observations	651	28	679

Notes: * p<0.10, ** p<0.05, *** p<0.01. The Table reports OLS estimates. The unit of observation is the town. The dependent variable is the average prevalence rate of malaria in town in 2015 (columns (1) and (2), and the decrease in malaria prevalence from 2010 to 2015 in town (columns (3) to (5)) Standard errors in parentheses are clustered at the closest mission level. Controls are described in the text.

Table 3: Missions and HIV

	All	Mission at 200km		
	(1) b/se	(2) b/se	(3) b/se	(4) b/se
Distance to mission	-0.016***	-0.014***	-0.003	-0.004*
	(0.004)	(0.005)	(0.003)	(0.003)
Distance to catholic	-0.004	-0.005	-0.009**	-0.009***
	(0.006)	(0.008)	(0.004)	(0.003)
Observations	13,216	7,545	7,545	7,482
Country and Wave FE	No	No	Yes	Yes
Historical and Geo Controls	No	No	No	Yes
Clusters	215	207	207	207
R-sq	0.17	0.14	0.42	0.44

Notes: * p<0.10, ** p<0.05, *** p<0.01. The Table reports OLS estimates. The unit of observation is the town. The dependent variable is the average prevalence rate of HIV in town. Standard errors in parentheses are clustered at the closest mission level. Controls are described in the text.

Table 4: Missionary Investments and HIV

	(1) b/se	(2) b/se	(3) b/se	(4) b/se	(5) b/se
Distance to mission	-0.002	-0.002	-0.002	-0.003	-0.008*
	(0.003)	(0.003)	(0.003)	(0.002)	(0.004)
Distance to catholic	-0.007**	-0.007**	-0.007*	-0.001	-0.011
	(0.003)	(0.003)	(0.004)	(0.004)	(0.010)
Distance to printing	-0.009**	-0.008*	-0.004	-0.003	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)
Distance to education	-0.006	-0.006	-0.004	-0.005*	0.002
	(0.004)	(0.004)	(0.003)	(0.003)	(0.006)
Distance to health	0.008**	0.007**	0.010***	0.011***	0.015***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)
Reads news weekly		-0.019	-0.026	-0.026	-0.016
		(0.017)	(0.021)	(0.022)	(0.019)
High literacy		0.044***	0.038***	0.037***	0.035
		(0.014)	(0.013)	(0.013)	(0.022)
Male circumcision			-0.019	0.008	-0.026
			(0.019)	(0.014)	(0.020)
Number of sex partners			0.019*	0.010	0.016
			(0.011)	(0.010)	(0.015)
Age gap in couples			-0.001	-0.001	-0.001
			(0.001)	(0.001)	(0.001)
Againt Contraception				0.013	0.001
				(0.013)	(0.015)
Condoms do not protect				0.022	0.004
				(0.019)	(0.022)
Christian				-0.006	0.022
				(0.012)	(0.030)
Observations	7,482	7,482	4,524	4,172	2,054
Country and Wave FE	Yes	Yes	Yes	Yes	Yes
Historical and Geo Controls	Yes	Yes	Yes	Yes	Yes
Clusters	207	207	192	172	88
R-sq	0.44	0.44	0.47	0.49	0.51

Notes: * p<0.10, ** p<0.05, *** p<0.01. The Table reports OLS estimates. The unit of observation is the town. The dependent variable is the average prevalence rate of HIV in town. Standard errors in parentheses are clustered at the closest mission level. Controls are described in the text. All regressions restrict the analysis to regions at least 200 km close to missions. Columns (5) focuses on regions that are far from Catholic missions (more than 200km)

Table 5: Robustness Checks

	HIV Prevalence		Malaria Incidence	
	(1)	(2)	(3)	(4)
	b/se	b/se	b/se	b/se
Road Length per km2	0.140**	-0.006	0.161**	0.151*
	(0.058)	(0.043)	(0.077)	(0.083)
Distance to mission		-0.001	0.024***	0.025***
		(0.003)	(0.005)	(0.005)
Distance to catholic		-0.007	-0.012**	-0.013**
		(0.004)	(0.006)	(0.006)
Distance to printing		-0.004	0.019***	0.019**
		(0.004)	(0.007)	(0.007)
Distance to education		-0.004	0.006	0.007
		(0.003)	(0.006)	(0.006)
Distance to health		0.009***	-0.020***	-0.021***
		(0.003)	(0.007)	(0.007)
Number of sex partners		0.016		0.006
		(0.010)		(0.010)
Age gap in couples		-0.001		0.001
		(0.001)		(0.001)
Againt Contraception		0.011		-0.009
		(0.011)		(0.009)
Condoms do not protect		0.037**		-0.020*
		(0.019)		(0.011)
Christian		-0.007		0.019
		(0.011)		(0.013)
Observations	7,482	4,524	7,482	7,102
Country and Wave FE	Yes	Yes	Yes	Yes
Historical and Geo Controls	Yes	Yes	Yes	Yes
Clusters	207	192	207	207
R-sq	0.40	0.47	0.77	0.76

Notes: * p<0.10, ** p<0.05, *** p<0.01. The Table reports OLS estimates. The unit of observation is the town. The dependent variable is the average prevalence rate of HIV in town (columns (1) to (4)), and the average incidence rate of malaria in town in 2015 (columns (5) and (6)). All regressions restrict the analysis to regions at least 200 km close to missions. Standard errors in parentheses are clustered at the closest mission level. Controls are described in the text.