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POVERTY TRAP AND EDUCATIONAL SHOCK: EVIDENCE FROM MISSIONARY FIELDS

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Poverty Trap and Educational Shock: Evidence from Missionary Fields

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Abstract

Low growth equilibria with low investment in human capital generally tend to persist till an external shock affects the economy. In this paper we use data on Christian missions to proxy a long-lasting educational shock in Africa. We estimate the effect of this shock on the quality of children which we proxy using the rate of underweight children. Consistent with the economic theory we find that the quality of children significantly rises with the exposure to this shock and this indirect effect accounts to almost 4 percent in terms of GDP for districts with the maximal exposure

Keywords: Poverty Trap, Christian Missions, Education, Development

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1 Introduction

The fertility rate has often been considered as one of the main sources of poor development in several Developing countries (Barro and Becker, 1989). To explain the persistence of the high fertility rate across Developing countries part of the growth literature has focused on human capital (Galor and Weil, 1996, 2000; Morand, 1999; Barro and Becker, 1986) and the interaction between low education, low returns on human capital, and high fertility which then generates multiple equilibria (Becker, et al. 1990; Moav, 2005). Because some of these equilibria are inefficient, countries remain trapped in a situation in which low education leads parents to invest more in the *"quantity"* rather than in the *"quality"* of children confining the country in a low-education and high fertility trap and therefore stagnation. In order to escape from such a trap, either a technological shock (Galor and Weil, 2000; Galor and Moav, 2002) or an educational shock (Moav, 2005) are considered crucial. While technological shocks affect returns on education, pushing individuals to accumulate more human capital, the educational shock works through the trade-off between the *"quantity"* and *"quality"* of children. Low educated parents have a comparative advantage for *"quantity"* of children (rather than *"quality"*) and because of that an equilibrium with low *"quality"* of children is still sustainable, even though the returns on human capital are relatively high (Moav, 2005). Therefore, to escape from such a trap a shock which increases the overall level of education of parents needs to occur.

Part of the evidence seems to confirm the idea that the persistence of inefficient equilibria is one of the main reasons for the high fertility rate in Africa (Shapiro and Tombashe, 2003, Shapiro, 2011). Yet, although the rate of education in Africa is the lowest across several Developing countries, there are regions (within the same country) where the level of education is well above the country's average. This variation within African countries occurs because the level of education in Africa significantly varies with the exposure to Christian missionaries in the 20th century (Acemoglu, Gallego, Robinson, 2014; Woodberry, 2004; Gallego and Woodberry, 2010; Nunn, 2012; Wietzke, 2012) and this effect persists even after changes in educational policies implemented by countries after independence. For example, Wietzke (2012) evaluates the effect of a massive post-colonial school investment program in Madagascar in the 1960s and finds almost no changes in the level of intergenerational persistence in school outcomes households that had access to schooling in the colonial period (Christian schools) and others that did not. Okoye and Pongou (2014) find a similar effect for Nigeria. After conducting several robustness checks, they find a strong persistence of the effect of Christian missions in Nigeria on education. This effect is mainly due to the intergenerational transmission of education and to the fact that the variation in education infrastructure in current Nigeria resembles quite closely the distribution of the mission fields.

Given the comparative advantage of uneducated parents for the *"quantity"* of children over the *"quality"* (Moav, 2005), one would expect that the variation in the prevalence of *"quality"* children in Africa would also vary with proxies for the exposure to missionary-fields in the colonial period. For this reason we rely on the empirical and the historical evidence on Christian missions and education, in order to investigate a potential effect of early colonial missionaries on the rate of underweight children below 5, which we use as a measure of the *"quality"* of children. The reason for focusing on the prevalence of underweight children in order to estimate the effect of such an educational shock on human capital is related to the fact that child birth-weight represents one of the best proxies for the *"quality"* of children, given that it seriously affects mental health, behavioral development, timing of school entry, and educational attainment (Chang et al., 2002; Glewwe and Jacoby, 1993; Glewwe et al., 2001; Weinreb et al., 2002), with consequent implications in terms of human capital accumulation and the possibility of escaping from a poverty trap (Almond, 2006; Currie and Moretti, 2003, 2007; Almond, Edlund and Palme, 2009; Oreopoulos, Stabile, Walld and Roos, 2008). In addition, the measure is closely related to fertility, capturing the *"quantity/quality"* trade-off.

The empirical challenge in evaluating such an effect at a district/province level relates to the fact that education, fertility and therefore the *"quality"* of children largely depend on group-specific preferences. In order to control for such a bias we match regions which share similar anthropological, social, cultural and pre-colonial institutional features, which in the context of Africa largely depend on tribal affiliation. Assuming that preferences (aggregated at a district level) are uniformly distributed within the same ethnic tribe, we can exploit the regional variation in the exposure to missions within ethnic tribes in order to flush out group-specific factors which may affect estimates. In practical terms, this means matching regions on the basis of unobservable characteristics and for this reason the estimator can be compared to a sort of matching estimator, where individuals are matched on observable/unobservable characteristics (Angrist and Pischke, 2008). The problem with this estimator is that relies on the randomness of Christian missions with all consequent implications in terms of consistency of the estimator in case missions were driven by unobservable deterministic factors. For this reason in order to be completely sure of the consistency of the estimator we also use an IV estimator in order to compare estimates.

Consistent with the hypothesis, we find that the rate of underweight children (our proxy of *"quality"* of children) significantly varies with measures of the intensity of the exposure to Christian missions in the colonial period and the effect is robust to a series of robustness checks including IV estimates of the effect. Using the latter estimator we find that moving from a district with the minimal exposure to Christian missions to one with maximal exposure decreases the rate of underweight child by almost 7.5 percent. In terms of GDP this effect consists to a change in income per capita almost equal to 3.75 percent, given that a one percent change in the rate of underweight children decreases GDP by almost 0.5 percent.

The negative effect of the Christian missions on underweight children is likely to be entirely related to the educational effect of early Christian missions (as suggested by the above literature). Actually, in the worst case scenario the educational effect is likely to be biased downward because of the negative effect of Christian religions on contraception (Blunch, 2008; Iyer, 2002). This conjecture is confirmed by further empirical investigation in which we use additional controls for religion in order to exclude this channel and by IV estimates of the effect.

The paper contributes to several strands of the literature. Focusing on one of the most important educational shocks in the history of Africa the paper provides evidence of the persistence of equilibria in which low education affects fertility and the *"quality"* of children and from which is impossible to escape in the absence of external shocks. From this point of view the paper is quite closely related to Duflo and Breierova (2004) who look at the impact of primary school construction programs in Indonesia between $1973-1974$ and $1978-1979$ on parents' education and therefore on child mortality. Chou et al. (2010) consider the change in compulsory education in Taiwan in 1968 to estimate the effect of mother's or father's schooling on infant birth outcomes[1]. However so far there is no much evidence for African countries, for which the literature has focused mainly on the effect of conflicts and diseases on birth-weight and child mortality (i.e. Kiros and Hogan, 2001; Sofeu, et al., 2014).

The paper is also related to that part of the unified growth literature which provides a micro-foundation for the fundamental links between economic and demographic variables (i.e. Galor and Weil, 2000; Doepke, 2004; Galor and Moav, 2002; Lucas, 2002; Strulik and Weisdorf, 2008; Cervellati and Sunde, 2005, 2007). In particular, Strulik (2008) and Strulik and Weisdorf (2008), assume that parents care not only about surviving offspring but also about their nutritional status and that an exogenous decrease in child mortality leads to lower fertility because more children survive. This effect leads parents to nourish their children better (a *quantity-quality* substitution effect) capturing the complex interaction

[1]See Currie (2009) for a general overview on poverty trap, socioeconomic status of parents, childrens health, and childrens future socioeconomic outcomes for industrialized countries.

between technological progress, mortality, fertility and income per capita in the process from stagnation to growth. Consistent with this model we assume that the exogenous shock related to Christian missions decreases child mortality and fertility affecting investment in human capital and therefore economic growth.

Finally the paper also contributes to the literature on the effect of Christian Missions in Africa (Acemoglu, Gallego and Robinson, 2014; Nunn, 2010, 2012; Woodberry, 2004; Gallego and Woodberry, 2010; Wietzke, 2012) showing the importance of missionary-fields in Africa in terms of child health, human capital accumulation (Ampaabeng and Tan, 2013; Belli, 1975; Cunha et al., 2010; Kim et al., 2010) and therefore economic growth.

In terms of identification of the effect the paper is closely related to Michalopoulos and Papaioannou (2012, 2014), who match partitioned group in order to control for potential ethno-omitted variable biases. For example, matrilineal groups in Africa generally have a higher level of education because of more frequent inter-vivos transfers (i.e. La Ferrara 2007; Machimu and Minde 2010) which is likely to bias results if correlated with missionary fields. However, while Michalopoulos and Papaioannou (2012, 2014) exploit the variation between partitioned groups belonging to the same tribe, the present paper exploits the variation between districts within the same ethnic group. Therefore, we rely on the randomness of Christian missions rather than focusing on the random drawing of borders due to the Scramble for Africa. Of course, one may argue that missionary fields may not be completely random. Other confounding variables unrelated to preferences may also be important (i.e. provision of local public goods) to explain the variation in the rate of underweight children. For this reason an IV estimator is also used in order to rule out these forms of biases.

The paper is organised as follows. In the next Section, we review the literature on Christian missions, poverty trap and the *"quality-quantity"* trade-off. In Section 3 we present a simple theoretical model in order to show empirical issues related to the estimation of the effect of education (and therefore Christian missions) on investment in children. In Section 4 we present the data that are used below to estimate the model and in Section 5 we show the results comparing the cross-district analysis with the within-group analysis and IV estimates. In Section 6 we estimate the effect of underweight children on development in order to have an idea of the indirect effect of Christian missions on GDP per capita. The paper ends with a short concluding Section.

2 Related Literature

Despite effects of colonialism in Africa are still largely debated with empirical evidence pointing at conflicting results (i.e. Heldring and Robinson, 2012) there are almost no doubts about the importance of Christian missionaries for the evolution of a mass education culture in Africa. On the eve of independence missionaries had still almost the monopoly over education in Africa. Colonial rulers realized the importance of education as a mean for the development of a western kind of society. However they were also conscious about the sheering cost of ruling schools. For this reason colonial governments preferred spending *"their limited funds in subsidizing, inspecting, and improving the schools already operated by the Christian missions instead of founding rival and far more expensive systems of state education"* (Oliver and Fage 1979, pp. 214-215). It is not surprising therefore that recent empirical evidence points at a strong association between measures of early mission-fields and education. Nunn (2012) uses data on mission-fields from Roome (1924) which he merges with data on location of ethnic groups from Murdock (1967) and individual data from the Afrobarometer in order to look at a potential lasting effect of the exposure to Christian missions (proxied by the number of missions per 1,000km of land area) in terms of educational outcome. Gallego and Woodberry (2010) use several sources about the presence of missionary-fields in 180 provinces included in 17 African countries and they also find a significant effect of proxies for the presence of a missionary-field (a dummy, and the number of missionaries per 1,000 people) on education. Wietzke (2012) uses the change in educational policy in Madagascar in 1960s (after the independence) in order to evaluate the effect of such a policy controlling for missionary-education in the colonial period and he finds a strong persistence in education among households exposed to missionary-education in the colonial period. The importance of missionary-fields have also been evaluated in terms of conversion to Christianity (Nunn, 2010), democracy (Shah and Woodberry, 2004), and technological spillovers (Cage and Ruenda, 2013).

The importance of a direct effect of education in terms of productivity and growth has been widely documented (Lucas, 1988; Barro and Lee, 2001; Cohen and Soto, 2007). However in Developing countries there is a second and most powerful indirect channel through which education can affect economic growth. This second channel is through the effect of parents' education on fertility and child *"quality"* (Breierova and Duflo, 2004; Duflo et al., 2012; Lynch, 2003; Chou et al., 2010; Becker, 1960, 1974; Becker and Lewis, 1973; Becker and Tomes, 1976; Barro and Becker, 1989) which then may have a long-lasting impact on human capital accumulation (Almond, 2001; Alderman et al., 2001; Handa and Peterman, 2007; Oreopoulos et al., 2008; Currie et al., 2010; Cunha and

Heckman, 2006). Part of the literature on education has focused more directly on the trade-off between *"quality"* and *"quantity"*, trying to provide empirical evidence at support of this theory. While empirical evidence for the US and Latin America seems to support the presence of such a trade-off between *"quality"* and *"quantity"* of children (Hanushek, 1992; Patrinos and Pascharopoulos, 1997), the link between *"quantity"* and *"quality"* seems to be only marginally significant (or oppostie to the expected) for most African countries (Montgomery et al., 1995; Chernichovsky, 1985). According to Levison (1991), the relationship for some of these countries may be different from the expected effect because of decreasing returns of household production.

The paper is also closely related to the literature on the demographic transition and factors which may have determined such a transition. Galor and Weil (2000) assume that a change in the rate of technological progress increases the rate of return of human capital, shifting preferences from *"quantity"* to *"quality"*. Galor and Moav (2002) develop a unified evolutionary growth model in which stagnation and the consequent natural selection have an important bearing on determining human capital accumulation. Becker et al. (1990) develop a representative agent model which generates multiple equilibria due to the different returns on education which depends on the general level of education within the society. Doepke (2005) also develops a unified growth theory to evaluate the effect of education policies on fertility. Strulik (2008) and Strulik and Weisdorf (2008) model the interaction between investment in nutrition/health, childrens chances of survival and fertility.

The literature on the effect of colonialism in Africa, persistence of pre-colonial institutions and long-term development is also related to the paper (Bertocchi and Canova, 2003; Acemoglu, et al., 2003; Heldrig and Robinson, 2012). Michalopoulos and Papaioannou, (2012, 2013, 2014) show a persistent effect of measures of pre-colonial state organization on economic development. At the same time current institutions do not seem to matter. This is because the partition of ethnic groups following the Scramble for Africa generated a number of small groups which lack political representation and thus affect regional development (Dimico, 2014). Gennaioli and Rainer (2006) find a significant cross-country relationship between pre-colonial centralization and measures of institutional development. Huillery (2009) finds a persistent effect of investment in education in the colonial period and education today. Banerjee and Iyer (2005) study the impact of a colonial land-tenure system in India, while Iyer (2004) compares economic outcomes in India across areas under the direct colonial rule of British administrators with areas under indirect colonial rule.

3 Empirical Issues

In this section we use a simple model of investment in children's health developed by Strulik (2008)[2] to highlight empirical issues which need to be considered before estimating the effect of education (in our case proxied by Christian missions) on the *"quantity/quality"* of children. The model serves only to motivate empirical implications and differs from Strulik (2008) only with respect to assumptions needed to show the empirical bias.

3.1 Theoretical Predictions

Consider a representative family i belonging to group g with a utility function which depends on consumption c, child health/nutrition expenditure h, and family size $\tilde{n}$. The parents are endowed with a given level of education $e_{i,g}$ which is assumed as given (i.e. parents can no longer affect the level of their education). Newly-born children have a survival probability $\delta_{i,g}$ which depends on parental education and therefore $\delta_{i,g} = \rho e_{i,g}$; where ρ is a scale factor. The probability of each child surviving is increasing with the education of its parents ($\frac{\partial \delta_{i,g}}{\partial e_{i,g}} > 0$) and captures a sort of empirical regularity in Developing countries according to which child mortality is significantly affected by parents education and other socio-economic characteristics. For example, Filmer and Pritchet (1999) find that four more years of education for parents compared to the country's average decreases mortality by almost 39 percent[3]. Parents can affect the survival probability of each child by investing in its health/nutrition. Therefore the survival probability of children adjusted for investment in health/nutrition becomes:

$$\pi_n = \delta_{i,g} + (1 - \delta_{i,g})vh_{i,g} = \rho e_{i,g} + (1 - \rho e_{i,g})vh_{i,g} \tag{1}$$

where $h_{i,g}$ is the family expenditure on child health/nutrition which will be endogenously determined and $v > 0$ is a productive parameter which translates health expenditure in a probability. The survival function increases in h (i.e. $\frac{\partial \pi_n}{\partial h_{i,g}} > 0$) but with diminishing returns (i.e. $\frac{\partial^2 \pi_n}{\partial^2 h_{i,g}} < 0$) such that any additional units of health/nutrition are more effective when the exogenous survival probability ($\delta_{i,g}$) is relatively low. Families care about family size, $\tilde{n}$, which in turn depends on the number of children, n, and on the survival

[2] Strulik (2004, 2005) also develops similar models.

[3] Caldwel (1982, 1990) and Hobcraft (1993) also find a significant effect of female education on health status.

function $0 < \pi_n < 1$. Preferences for consumption, health and the number of children are summarized by the following quasi-linear utility function:

$$U(c_{i,g}, h_{i,g}, n_{i,g}) = c_{i,g} + \beta_g ln h_{i,g} + \gamma_g ln \pi_n n_{i,g} \tag{2}$$

where β_g and γ_g are assumed to be group- specific (i.e. depending on culture)[4], $c_{i,g}$ represents family consumption, $\pi_n n_{i,g}$ is the number of surviving children and $h_{i,g}$ is expenditure on health. We assume that $\gamma_g > 0$ in order to ensure a positive survival function (π_n) and $\gamma_g > \beta_g$.

Adults supply one unit of labour and receive labour income $y_{i,g}$. Normalizing the price of goods to one implies that the budget constraint is

$$y_{i,g} = c_{i,g} + p n_{i,g} h_{i,g} \tag{3}$$

where $p n_{i,g} h_{i,g}$ is total health expenditure.

Maximization of (2) subject to (3) and (1) provides the following first order conditions for an interior solution

$$\frac{\partial U(.)}{\partial c_{i,g}} \rightarrow 1 = \lambda \tag{4}$$

$$\frac{\partial U(.)}{\partial n_{i,g}} \rightarrow \frac{\gamma_g}{n_{i,g}} = p h_{i,g} \tag{5}$$

$$\frac{\partial U(.)}{\partial h_{i,g}} \rightarrow \frac{\beta_g}{h_{i,g}} + \frac{\gamma_g v(1 - \rho e_{i,g})}{\pi_n} = p n_{i,g} \tag{6}$$

Conditions (5) and (6) represent a sort of Beckerian trade-off between the *"quality"* and *"quantity"* of children, given that an increase in the number of children increases the marginal cost of the *"quality"* of children, while a higher expenditure on health/nutrition ($h_{i,g}$) leads to an increase in the marginal cost of children.

From FOCs we obtain the solution:

[4]The assumption that preferences are group-specific is made for consistency with the empirical model.

$$h_{i,g} = \frac{(\gamma_g - \beta_g)\rho e_{i,g}}{\beta_g v(1 - \rho e_{i,g})} \quad (7)$$

$$n_{i,g} = \frac{\gamma_g \beta_g v(1 - \rho e_{i,g})}{p(\gamma_g - \beta_g)\rho e_{i,g}} \quad (8)$$

Equations (7) and (8) imply that the investment in *"quality"* ($h_{i,g}$) should increase with education. On the other hand a higher level of education should lead to a decrease in the *"quantity"* of children ($n_{i,g}$) keeping the preferences for *"quantity"* and *"quality"* of children (γ_g and β_g), the effectiveness of health expenditure (v) and unit cost for children (p) constant.

Defining the rate of mortality as $(1 - \pi_n)$ and combining Equation (1) and (7) we get that:

$$(1 - \pi_n) = (\frac{\beta_g - \gamma_g \rho e_{i,g}}{\beta_g}) \quad (9)$$

and mortality declines with education.

Therefore, given the evidence on the effect of Christian missions on education, we should expect that regions with a higher exposure to mission fields would be associated with a lower level of child mortality than regions which have not been exposed. This effect is related to the fact that regions closer to former missions are more likely to have a higher level of education which then increases the investment in the *"quality"* ($h_{i,g}$) rather than the *"quantity"* of children ($n_{i,g}$). However, the rate of mortality also depends on group preferences for *"quality"* and *"quantity"* which are likely to bias the effect of missionaries/education on mortality. For example, preferences for more children (i.e. an increase in β_g) are likely to bias upward the rate of mortality while preferences for *"quality"* (i.e. an increase in γ_g) are likely to bias downward the effect. As a consequence a failure to control for these preferences for *"quality"* and *"quantity"* of children will bias the effect of education (and therefore of Christian missions) on mortality and therefore also on our proxy for underweight children.

3.2 Empirical Mehodology

Given the predictions above, we initially use a simple cross-section model where the rate of underweight children depends on the exposure to Christian missions (our proxy for education) and other control variables. The model can be written as follows:

$$Y_{r,c} = \sum_{c=1}^{C} \delta_c.1_{C_i=c} + \beta_1 Int\_Miss_{r,c} + \beta_2 Dist\_Miss_{r,c} + \beta_3 Miss_{r,c} + \beta_4 Kids_{r,c} + \beta_5 X_{r,c} + \epsilon_{r,c} \tag{10}$$

where $Y_{r,c}$ represents the ratio of underweight children below 5 within region r and country c; $\sum_{c=1}^{C} \delta_c.1_{Ci=c}$ is a set of country dummies which should control for differences in public health expenditure; $Int\_Miss_{r,c}$, $dist\_Miss_{r,c}$ and $Miss_{r,c}$ are proxies for the intensity of the exposure to Christian missions, the mean distance from the closest mission, and a dummy for whether within the administrative region there has been any mission; $Kids_{r,c}$ is the number of children below 5 which is used as a proxy of fertility; $X_{r,c}$ is a set of control variables; and $\epsilon_{r,c}$ is the error term.

The set of control variable $X_{r,c}$ includes population density from the Gridded Population of the World (GPW); the distance from the coast obtained from the NASA Ocean Biology Processing Group; the distance from the capital computed using geographical data from CEPII; a proxy for mountain slope computed using DEM data from GeoNetwork; the presence of inland water basins, soil nutrients, soil workability, climate constraints, net primary production (as a measure of vegetation) and median annual precipitation, which are collected from the FAO GAEZ; population density in 1800, which we use as a proxy of pre-colonial development; a proxy of malaria ecology[5] measured by the climatic suitability to malaria from the Malaria Atlas Project; and finally the level of ethnic fractionalization within the region which is computed using data on the area of each group as a share of the total area within the region. The Data Appendix reports sources and a brief description of these variables.

The problem with the model above is that preferences for education, number of children and thus for the *"quality"* and *"quantity"* of children are likely to be group-specific (β_g and γ_g in the previous section). For example, polygyny and matrilineal groups in Africa have specific social preferences which affect the number and the investment in children. If these preferences are in some way correlated with the presence of Christian missions then we are likely to have an omitted variable bias. Therefore, in order to control for such group specific preferences, we match regions within groups which are likely to share the same preferences for education and number of children. Therefore the model to be estimated can be written as:

[5] Malaria ecology is measured using a biological model which incorporates the impact of temperature on 1) vector lifespan and 2) the duration of P. falciparum sporogeny

$$Y_{e,r,c} = \sum_{c=1}^{C} \delta_c.1_{C_i=c} + \sum_{e=1}^{E} \delta_e.1_{E_i=e} + \beta_1 Int\_Miss_{e,r,c} + \beta_2 Dist\_Miss_{e,r,c} + \beta_3 Miss_{r,c} + \epsilon_{e,r,c} \tag{11}$$

where the dependent variable is now the rate of children underweight in region r, group e, and country c. Both, $\sum_{e=1}^{E} \delta_e.1_{Ei=e}$ and $\sum_{c=1}^{C} \delta_c.1_{Ci=c}$ are key to the identification, given that they allow us to focus on the variation within the country c and within ethnic tribe e allowing a match of comparable regions which will enable us to deal with biases related to group-specific preferences. Same controls (i.e. $X_{r,c}$ and $Kids_{r,c}$) are used to control for geographical factors and to caputre the trade-off.

Although the model above should allow us to control for the preference bias underlined in Equation (9), there are still two potential issues with this estimator. The first relates to the randomness of Christian missions, which may affect estimates if correlated for example with measures of pre-colonial development. The second issue is the presence of other confounding variables which we may have been omitted from the model. For this reason, in order to deal with these other issues we also use an IV estimator in which we use instruments in order to provide some exogeneity to our measure of Christian missions.

4 Data

4.1 Administrative Regions and Ethnic Groups

The data on administrative regions within a country included in a given ethnic group constitutes the first piece of information we need in order to carry out our analysis. For this reason, common to most of the recent research on development in Africa (Michalopoulos and Papaioannou, 2011, 2013, 2014), we use data on ethnic groups from the Ethnographic Atlas (Murdock 1959; 1967), which provides coordinates and maps for almost 843 African societies in each of 412 cultural clusters. The Ethnographic Atlas is then spatially joined with subnational maps of third level administrative boundaries (provinces or districts, depending on the administrative organization of the state) available from GADM. The result of such a merge is a sample of 5316 subnational administrative regions within 830 ethnic groups[6].

Figure 1 shows the regional distribution within both countries and ethnic groups in

[6]Among the 843 groups reported in Murdock (1959) there are 8 uninhabited areas, which are dropped. Another 5 groups are unusable because of missing values.

Africa. Blue lines represent administrative boundaries while red lines represent ethnic tribal boundaries. In order to have a better idea of the identification strategy, Figure 2 shows the distribution of administrative regions within ethnic groups in Madagascar. The figure shows that several administrative regions are included (blue lines) within each ethnic group (red lines) which provide enough variation for the analysis. This regional variation within ethnic groups will allow us to exploit the variance in the rate of underweight children across districts, controlling for the social, institutional, anthropological and cultural features which can affect both the educational and the fertility choice. This should minimize the biases coming from different preferences.

Figure 1: Administrative Regions within Ethnic Groups

Figure 2: Madagascar: Administrative Regions within Ethnic Group

4.2 Mission Fields

Data on missionary-fields are obtained from Nunn (2010), who collected data from the *"Ethnographic Survey of Africa: Showing the Tribes and Languages; also the Stations of Missionary Societies"* published by William Roome (1924). For each missionary-field the Ethnographic Survey provides coordinates which, when spatially joined with the country-ethnic-region map above, give an idea of the number of missions in each region.

In order to obtain a measure of the intensity of the exposure for each region, we use a kernel interpolation with barriers[7] (a sort of home range analysis) where barriers are represented by administrative regions in order to capture the cross-district variation of the effect. The geographical distribution of Christian missions together with the resulting interpolation is shown in Figure 3. Dark blue areas represent regions with the highest exposure to Christian missions while yellowish areas represent regions with the lowest exposure. Finally, regions which have not been exposed at all to Christian missions are shown as white areas.

The interpolation permits us to capture spillover effects on neighbouring regions, which in this case are likely to be highly important, given that districts within regions which have

[7]The proxy for the intensity of the exposure to Christian Missions is different from Nunn (2012) who uses the number of missions per 1,000 km.

been highly exposed to Christian missions are also likely to benefit from the exposure (even when the districts themselves have no missions of their own). The intensity of spillover effects will depend on the distance from the closest mission and on the number of missions in the surrounding administrative areas. In contrast, regions with sparse missions are unlikely to be affected by spillovers and hence surrounding administrative regions will scarcely be affected. The importance of spillover is particularly evident for East Africa, where the number of missions is relatively high, causing large spillover effects. In South-West Africa (i.e. Namibia, Botswana), however, the number of missions is not very high and thus there are no huge spillover effects (yellowish areas).

Figure 3: Interpolation of Christian Missions in Africa

In Figure 4 we show again the interpolation of Christian missions in a single country (Madagascar again) in order to give a better idea of the variation. The highest concentration of Christian missions in Madagascar is in the east and central parts of the island and for this reason the regions in this area are those with the highest exposure in an absolute sense (shown in dark blue). However, even across these regions there is a quite large variation between regions which have been treated and regions which have not been treated. This variation in the intensity (and between treated and untreated regions) permits us to identify the effect.

Figure 4: Interpolation of Christian Missions in Madagascar

4.3 Underweight Children

The Global Subnational Prevalence of Child Malnutrition from the Center for International Earth Science Information Network (CIESIN) is the source of data that we use for the prevalence of underweight child under the age of five. The data are provided at a 2.5 arc-minutes resolution and consist of estimates of the percentage of children with weight-for-age z-scores that are more than two standard deviations below the median of the NCHS/CDC/WHO International Reference Population.

Figure 5 shows the distribution of underweight children in Africa. Darker areas represent regions with the lowest level of underweight children while lighter areas represent regions with higher levels of underweight children (with the maximal level equal to 547 per thousand). On average the rate of underweight children for the entire continent is equal to 252.41 (per thousand) with a standard deviation equal to 115.8. If we restrict our analysis to Madagascar, again the figure shows that the island is one of the countries with the highest rate of underweight children even though it has been massively exposed to Christian missions. However, even for this case, there is some regional variation within the country which permits us to exploit this dimension.

Figure 6: Prevalence of Underweight Children in Africa

5 Descriptive Statistics and Results

5.1 Descriptive Statistics and Cross-District Analysis

Table 1 provides descriptive statistics for some of the variables in our sample. The average rate of underweight children is 255.41 (per thousand). The average number of children below 5 per 1,000 square metres is 0.13 while population density per $10km^2$ is around 20. The intensity of the exposure to Christian missions is 0.72 (standardized and scaled on a 0-1 range) and almost 16 percent of the regions in the sample have been exposed to at least one mission. The average district is relatively ethno-homogenous, with an index of ethnic fractionalization equal to 0.1 (almost homogenous).

Table 1: Descriptive Statistics

The effect of Christian missions on the rate of underweight children is reported in Table 2 where the effect is estimated by exploiting the variation across districts. In Model 1 we regress the rate of underweight children under 5 on the dummy for whether in the district there has been at least one mission, the distance from the mean mission, and controls for population density in 2000 and the number of children below 5 per surface area. The dummy for the presence of Christian missions in the 20th century turns out to be significant at a 5 percent level with a coefficient equal to -0.039, which denotes that the average rate of underweight children decreases by almost 0.014 per a one standard deviation in the dummy for whether in the region there has been at least one Christian mission. In Model 2 we enter our proxy for the intensity of the exposure to Christian missions together with the dummy for the presence of missions and the former completely dominates over the latter. The proxy for the intensity of the exposure to Christian missions is significant at a 1 percent level, while the dummy for whether there is at least one mission in the region is not significant, denoting that the exposure to missions is much more important than the simple presence of missions. Part of the reason why the exposure dominates over the dummy relates to the importance of spillover effects which are captured by the former but not by the latter. Hence it is possible to have districts without missions but with a positive exposure because of spillover effects from neighbouring regions. At the mean, a one standard deviation in the intensity of the exposure decreases the rate of children underweight by almost 13 children per thousand. The distance from the mission now also turns out to be significant at a 5 percent level, increasing the rate of children underweight by almost 10 children (per thousand) per a one standard deviation.

In Model 3 we control for the level of fractionalization within the region and the dummy for Christian missions is marginally significant at a 10 percent level while the proxy for the intensity of the exposure and the distance from the mission are still both significant at a 5 percent level at least. Finally in Model 4 we enter the full set of geographical controls, proxies for pre-colonial development and country dummies. Despite these additional controls the intensity of the exposure to Christian missions still keeps its significance. In the full model (Model 4) the rate of children underweight decreases by almost 0.34 percent when we move from a region with maximal exposure to a region with minimal exposure.

Table 2: Cross-District Analysis

5.2 Within-Groups Results

As discussed in Section 3, the rate of underweight children is likely to be affected by group-specific preferences for education and number of children, which then will bias results if preferences are not taken consideration. Table 3 provides some basic evidence of differences across groups in terms of fertility. Among 391 ethnic groups clustered by marriage composition[8] it seems that polygyny groups are the ones with the highest fertility rate, followed by non-sororal, monogamous and sororal groups respectively. Other differences are likely to depend on whether groups are matrilineal or not, whether husband and wife live in the same house, clan structure, residence with kin, small vs. large extended families, etc. These sorts of difference are highly likely to be the result of different preferences, which in turn will bias results.

[8]Data from Murdock (1959)

Table 3: Descriptive Statistics: Fertility and Marriage Composition

In order to control for this source of bias in the following models we match regions which from an anthropological, social and institutional point of view share the same features. This is done by exploiting the variation within a single ethnic tribe instead of the cross-district variation. The assumption that preferences (aggregated at a district level) across districts within an ethnic tribe are constant is crucial to the identification strategy.

Results from matching regions into ethnic groups are reported in Table 4. Both the coefficient and standard errors on the variable proxying the intensity of Christian missions decrease quite significantly. However the variable for the exposure to missions is still significant at a 5 percent level. In the most complete model (Model 3), we control for the number of children per Km^2, the ethnic fractionalization within the region, regional GDP in 2000, population density in 2000 and in 1800, a proxy for malaria ecology and a full set of geographical controls which includes the distance from the sea, the point-distance of the administrative area from the capital, mean elevation and inland water basins. The coefficient for this model is equal to 0.02, meaning that the difference in the rate of underweight children between an area with maximal exposure (i.e. Christian Mission Intensity =1) and an area with the minimal exposure (i.e. Christian Mission Intensity =0) is equal to almost 0.2 percent.

Table 4: Within Tribes Analysis

Given that fertility preferences may be locally distributed, in Table 5 we use a Spatial HAC estimator[9] (Conley, 2008) in order to correct standard errors for spatial correlation. We use three different distance thresholds. In Model 1 we use a 100km distance threshold, which then is increased to 200km in Model 2 and to 300km in Model 3. When we control for spatial autocorrelation, standard errors decrease quite significantly and the effect of Christian missions becomes significant at a 1 percent level (Model 1). In the following models (Model 2 and Model 3) we increase the distance threshold but standard errors are hardly affected.

Table 5: Conley Robust Standard Errors

[9]The ado file provided by Hsiang (2010) is the one that we use to run the command.

Finally in order to exclude a potential effect of religion on the dependent variable in Table 6 we also control for the share of Roman Catholics, Protestants, Animists and Muslims. Data on religion by ethnic groups are collected from the Joshua Project[10]. We enter these four controls together with other geographical, demographic and economic proxies, as in previous tables. In Model 1 we find that a larger share of Christians (Roman Catholics and Protestant) tends to be associated with a higher rate of underweight children, while the share of Muslims is negatively associated with the share of underweight children. The positive effect on the share of Christians is likely to be related to the fact that Christian religions are normally associated with a higher risk of underweight children due to restrictions on the use of contraceptive and birth control methods (i.e. Iyer, 2002). However the coefficient of the intensity of exposure to Christian missions is hardly affected and its effect is still significant at a 1 percent level. In Model 2 we interact the four proxies for religion with the intensity of Christian missions in the 20th century in order to test for a differential effect for regions in which people may have been converted to the Christian religion following the exposure to early missions. When we enter these interactions, proxies for religions become insignificant with the exception of the one for the share of Muslins for which the overall coefficient drops to 0.00024. In addition, the coefficient on the intensity of the exposure to early missions in Model 2 increases from -0.02 to almost -0.021.

Table 6: Controlling for Religion

6 IV Estimates

Even though controlling for ethnic fixed effects should allow us to control for preferences, it is still not possible to rule out other confounding variables which may affect results. For this reason in this section we use an IV estimator controlling for country and ethnic fixed effects to estimate the consistent effect of Christian missions. In order to provide some sort of exogeneity to our measure for the intensity of the exposure to Christian missions we use a proxy for rugged terrain which is obtained using the terrain analysis plug-in in QGIS 2.01. According to Nunn and Puga (2012), rugged terrain in Africa mattered

[10]The Joshua project provides point spatial data. Point data are transformed in polygons using a Voronoi transformation. Therefore each point will be partitioned into convex polygons such that each polygon contains exactly one generating point and every point in a given polygon is closer to its generating point than to any other.

because it used to provide protection to ethnic groups[11] (which therefore were spatially located according to terrain ruggedness) and given that the aim of Christian missions was to convert ethnic groups in Africa then we should expect a positive relationship between rugged terrain and Christian missions. In addition, the fact that Nunn and Puga (2012) do not find any direct effect of rugged terrain on development (it has only an indirect effect through its protection of groups) rules out any sort of effect on underweight children through development.

First stage statistics and diagnostic tests in Table 7 confirm the relevance of the instrument. The proxy for rugged terrain has a significant and positive effect on the exposure of Christian missions (as expected). The Partial F-statistics larger than 10, which is normally used as a threshold for weak instruments. The relevance of instruments is also confirmed by the Cragg-Donald F-statistics which is larger than the Stock and Yogo critical values.

The second stage statistics confirm the significant effect of the exposure to Christian missions on the rate of underweight children. In addition the estimated effect of Christian missions increases quite significantly, with the rate of underweight children decreasing by almost 7.5 percent when we move from a region with the maximal to a region with the minimal exposure. This effect is quite substantial if compared to the 4 percent decrease in the rate of underweight children achieved in the last 20 years, during which the cutting of the rate of child mortality has been one of the main goals of UN Millennium Development Goal.

Table 7: IV Estimates

7 Implications in Terms of Development

Finally in order to have an idea of the implications of the exposure to Christian missions in terms of development in this section we estimate the effect of the rate of underweight children on GDP using an IV estimator to get a clue of the indirect effect of Christian missions on development (through underweight child).

In order to proxy development at province/district level we use estimates about total economic activity from Nighttime Lights satellite imagery provided by the NOAA/NGDC

[11] Nunn and Puga (2012) argue that rugged terrain used to provide protection from slave raids. However their measure of the effect of the slave trade is at an ethnic level and this effect is therefore ruled out by ethnic-fixed effects.

(Ghosh, Powell, Elvidge, Baugh, Sutton and Anderson, 2010). The exposure to Christian missions and our proxy for terrain ruggedness represent instruments for the rate of underweight children. As argued above, terrain ruggedness does not have any significant direct effect on development. Same for the exposure to Christian missions which according to the existing literature may have an effect on development only through education[12]

First stage statistics and diagnostic tests in Table 8 confirm again the relevance of instruments. In addition the fact that Hansen J-statistics does not reject the null of exact identification (p-value=0.25) provides some basic but not definitive evidence of the exogeneity of the instruments. In the second stage statistics we find a significant and negative effect on development of the rate of underweight children, with the latter decreasing our proxy for GDP by almost 0.5 percent per a one percentage change. Given the 7.5 percent reduction in the rate of underweight children for regions with the maximal exposure to Christian missions estimated using the IV, we can infer that the indirect effect of Christian missions in terms of development is to increase GDP by almost 3.75 percent. Therefore considering the figures from the World Bank (2011) for the average GDP per capita for Sub-Saharan Africa, which estimates income per capita for this region as equal to $2,339 we can infer that the change in income for regions with the maximal exposure to be almost equal to $85 per year.

Table 8: Underweight Children and Development

8 Conclusions

Child malnutrition represents a pervasive problem in Developing countries with serious consequences in terms of economic development given its negative effects on mental health, behavioral development, timing of school entry and educational attainment. Same as for other economic indicators, Africa is the continent which performs the worst in terms of child malnutrition. Progress has also been rather slow with estimates from the Global Database on Child Malnutrition showing that in the period 1990-2010 there has been only a slight decrease in the rate of child malnutrition (from 22.7 percent to 17.9 percent) in Africa, despite a sharp decrease in other Developing countries. This trend is largely due to the low level of education in Africa, which confines countries in a poverty trap with low

[12]See Acemoglu, Gallego and Robinson (2014), who use Christian missions as the instrument for current education in order to estimate the effect of human capital on development.

quality and high quantity children. For this reason educational shocks may be necessary to reverse such a trend.

The paper shows that potential educational shocks (measured by the exposition to former Christian missions) are highly effective in decreasing the rate of child underweight in Africa. The effect is largely due to preferences for quality over quantity among more educated parents. This effect is estimated using a sort of matching estimator which allows us to neutralize the effect of group preferences for the quality and quantity of children.

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FIGURES

Figure 1: Administrative Regions within Ethnic Groups

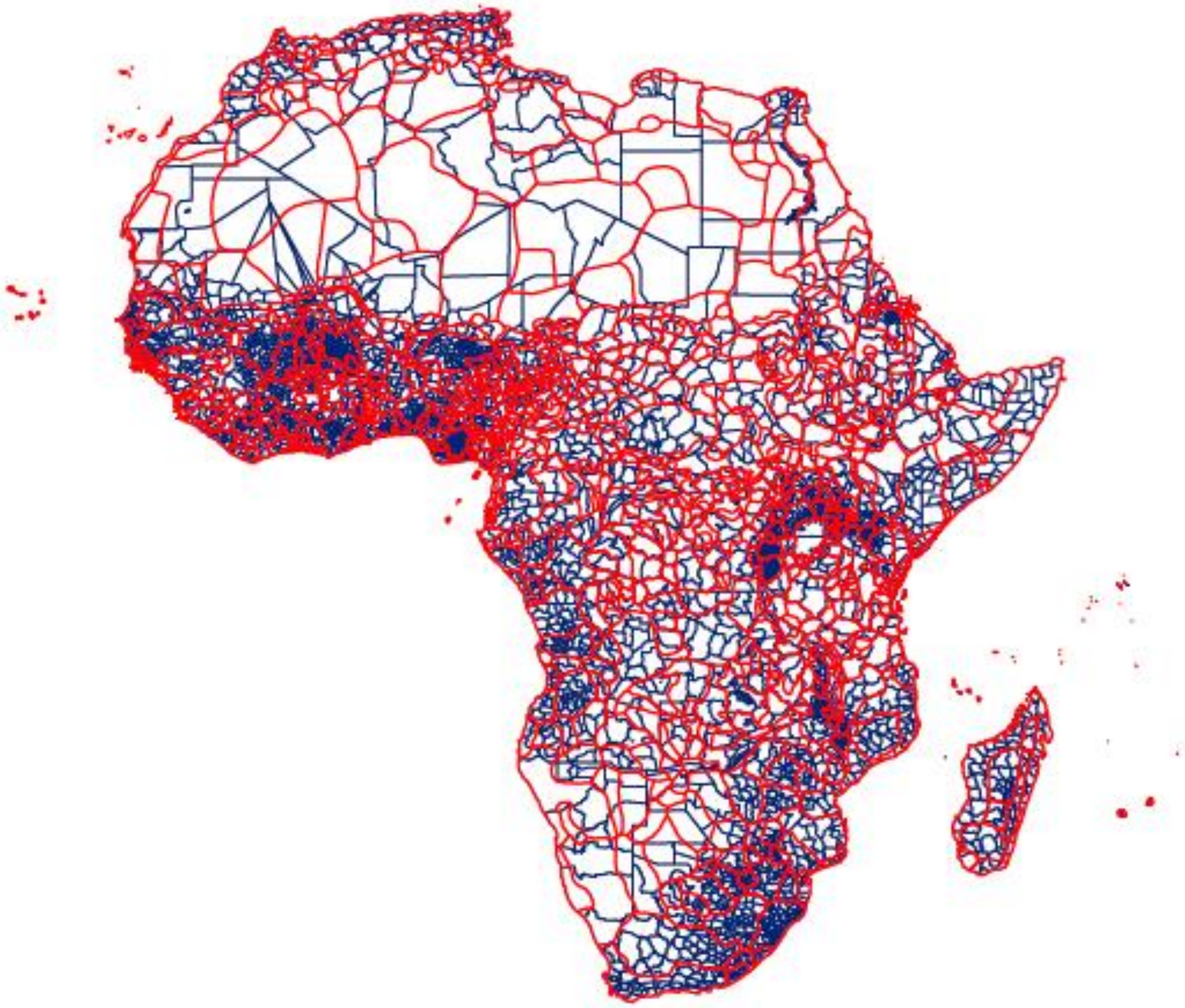


Figure 2: Madagascar: Administrative Regions within Ethnic Group

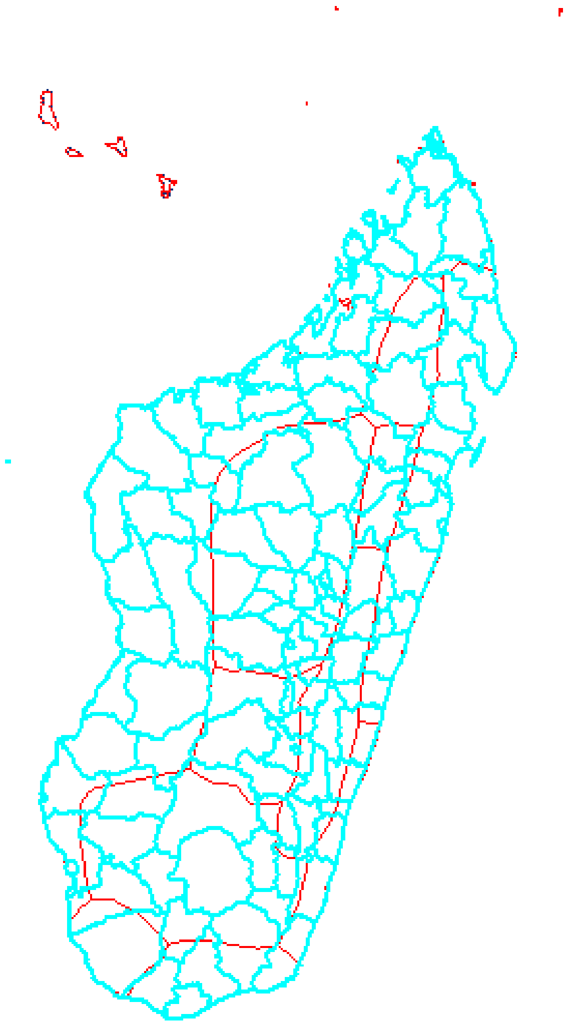


Figure 3: Interpolation and Distribution of Christian Missions in Africa

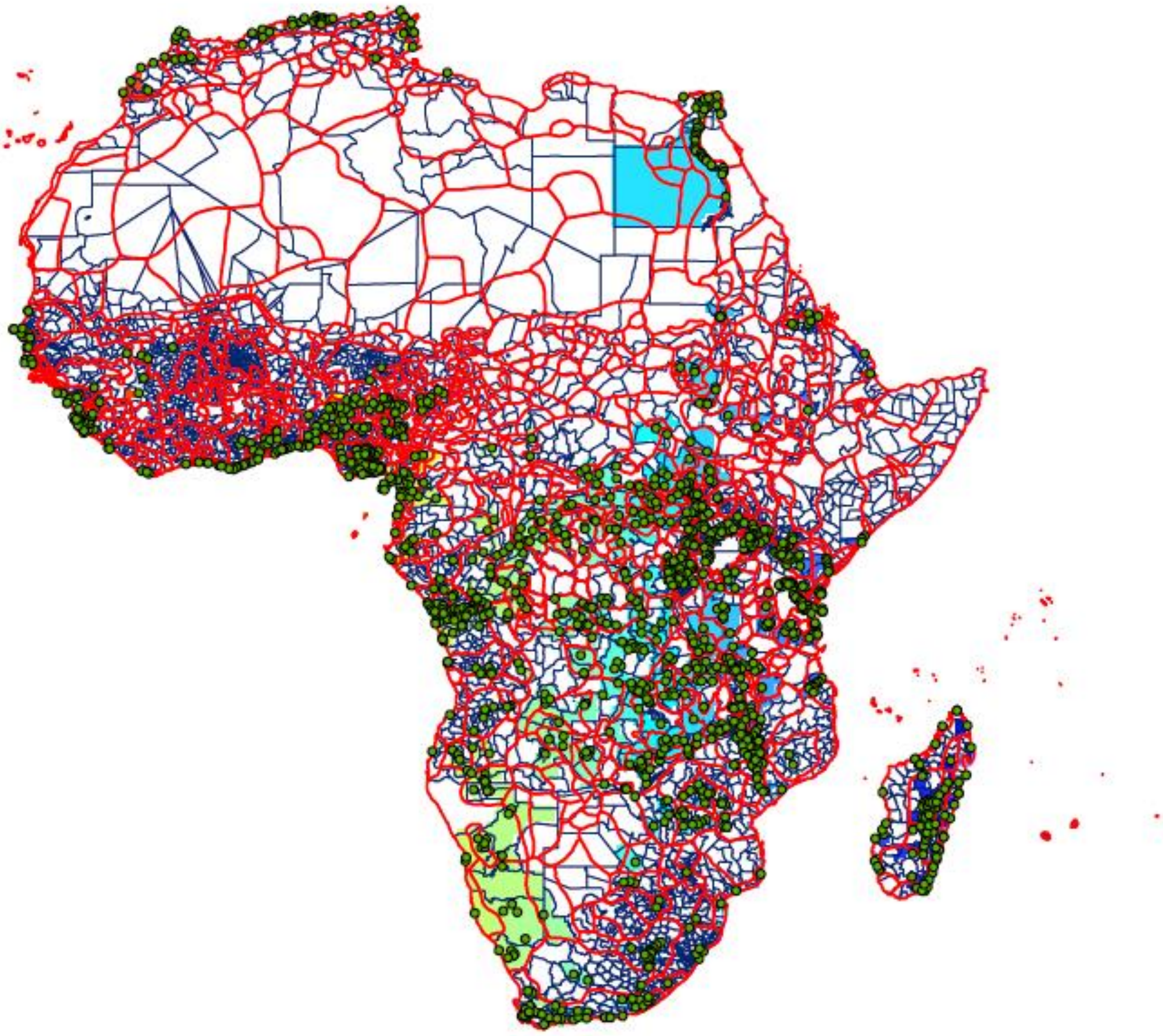


Figure 4: Interpolation of Christian Missions in Madagascar

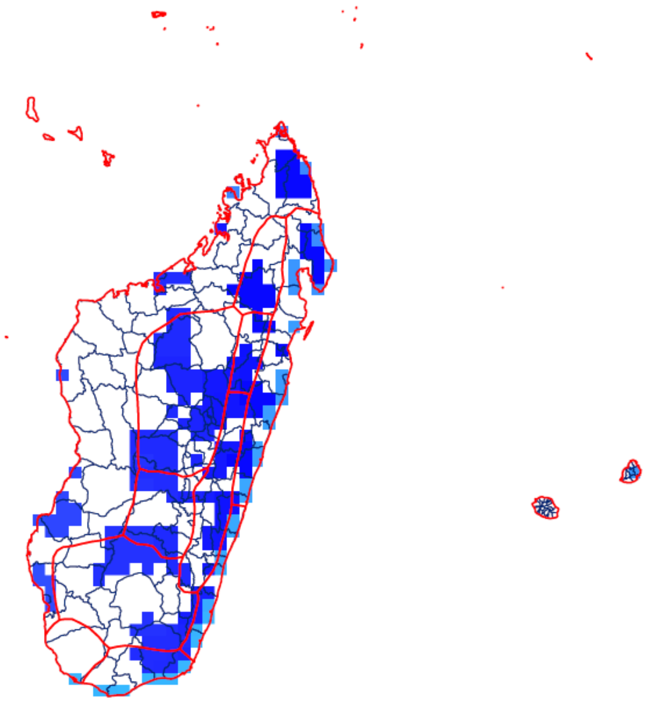
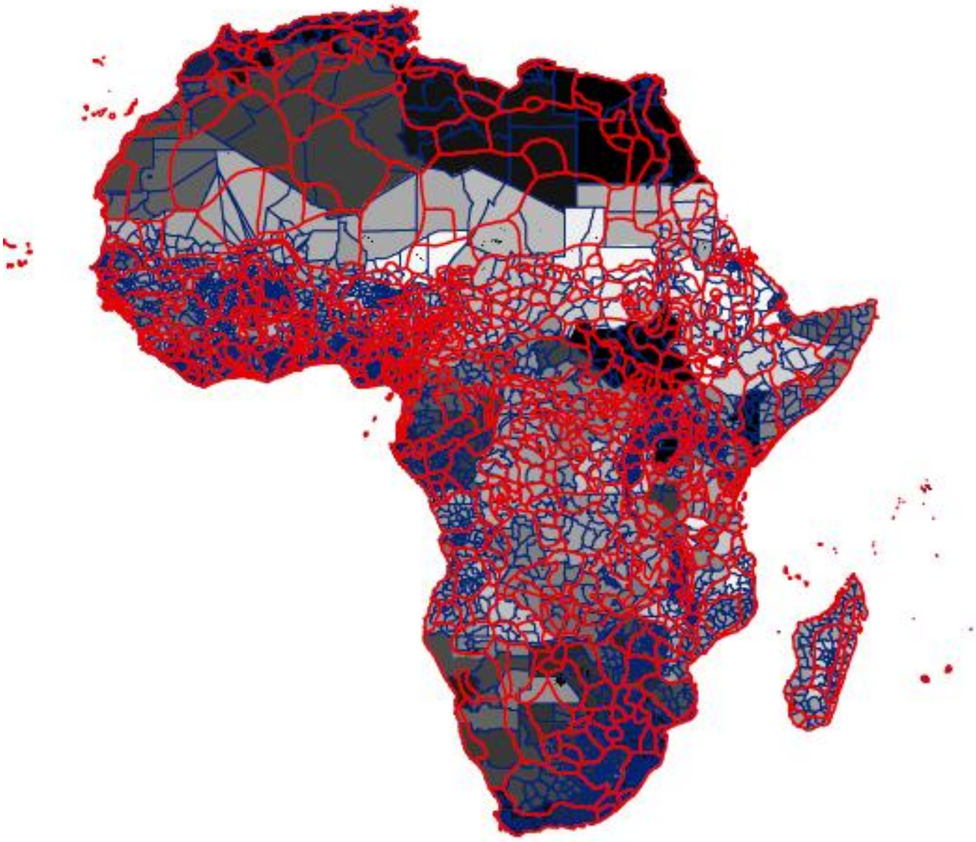


Figure 5: Prevalence of Children Underweight in Africa



TABLES

Table 1: Descriptive Statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Rate of Children Underweight	5023	0.255411	115.825	0.2430769	547
Intensity of Christian Missions	5317	0.727257	0.1528804	0	1
Christian Mission Dummy	5317	0.155726	0.3626304	0	1
Mean Mission Distance (Log(1+X))	5161	3.409695	0.9262329	0.1206838	4.695511
Children under 5/Region Surface Area	5067	0.013201	0.2162266	2.70E-10	13.07683
Population Density (Log(1+X))	5270	1.97355	0.2854578	0.000261	2.639057
Ethnic Regional Fractionalization	5317	0.10457	0.1862123	6.74E-07	1
Mountain Slope (Log(1+X))	5317	0.274395	0.2575915	0	1.980669
Distance from the Sea (Log(1+X))	5317	6.162189	0.7444312	0.5485775	7.577249
Distance from the Capital (Log(1+X))	5161	3.409695	0.9262329	0.1206838	4.695511
Malaria Ecology (Log(1+X))	5317	10.4622	0.7362311	2.484907	11.27771
Regional Mean GDP (Log(1+X))	5292	0.216968	0.5061685	0	4.833459
Net Primary Prod./Vegetation (Log (1+ X))	5317	1.911912	.3304168	0	2.197225
Soil Workability (Log (1+ X))	5317	.9238942	.3886632	0	2.079442
Soil Nutrient (Log (1+ X))	5317	.9961034	.3885072	0	2.079442
Annual Precipitation (Log (1+ X))	5286	6.749051	.8072717	.2411621	8.099251
Terrain Ruggedness (Log (1+ X))	5317	5.325377	1.779673	0	10.24863
Climate Constraint (Log (1+ X))	5242	3.198523	.186276	.620742	3.456469
Inland Water Basins/Rivers (Log (1+ X))	5317	.4628884	.9662099	0	4.61512

Table 2: Cross-Regional Analysis

Dependent Variable: Rate of Underweight Children below 5				
Estimation Method: OLS	***Model 1***	***Model 2***	***Model 3***	***Model 4***
Christian Mission Intensity (0-1 scale)		-0.0925***	-0.0929***	-0.0337**
		(0.0343)	(0.0338)	(0.0158)
Christian Mission Dummy	-0.0391**	-0.0273	-0.0278*	-0.00140
	(0.0173)	(0.0168)	(0.0166)	(0.00776)
Distance to the Mission	0.0895	0.122**	0.111**	0.0259
	(0.0553)	(0.0505)	(0.0483)	(0.0289)
Country Fixed Effects	No	No	No	Yes
Observations	4,990	4,990	4,990	4,836
R-squared	0.01	0.02	0.03	0.67

Ethnic and Country Clustered Standard errors in parentheses:*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Controls included are as follows:

- Model 1 and Model 2 include only Number of Children per Area and Population Density in 2000.
- Model 3 includes controls above + Regional Fractionalization
- Model 4 includes controls in Model 3 + Country Fixed Effects, Malaria Suitability, Regional GDP, Climate Constraint on agriculture, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability, Mountains Slope and Population density in 1800.

Table 3: Descriptive Statistics - Fertility and Marriage Composition across Ethnic Groups

	Obs	***Mean***	***Std. Dev.***	***Min***	***Max***
Monogamous	5	199	38.18377	145	253
Polygyny	91	216.7473	36.11543	122	263
Sororal	43	189.907	14.98382	171	230
Non Sororal	252	203.8135	36.21044	118	266

The DHS is the source for data on fertility

Table 4: Within Tribes Analysis

Dependent Variable: Rate of Underweight Children below 5			
Estimation Method: OLS	Model 1	Model 2	Model 3
Christian Mission Intensity (0-1 scale)	-0.0259**	-0.0272**	-0.0200**
	(0.0129)	(0.0135)	(0.00989)
Christian Mission Dummy	-0.00336	0.00265	0.00355
	(0.00433)	(0.00511)	(0.00421)
Distance to the Mission	0.0212	0.00760	0.00478
	(0.0192)	(0.0184)	(0.0181)
Tribe Fixed Effects	Yes	Yes	Yes
Country-Fixed Effect	Yes	Yes	Yes
Observations	4,990	4,974	4,836
R-squared	0.85	0.85	0.86

Ethnic and Country Clustered Standard errors in parentheses:*** p<0.01, ** p<0.05, * p<0.1
Controls included are as follows:

- Model 1 includes only Number of Children per Area, Population Density in 2000 and Regional Fractionalization
- Model 2 includes controls above + Malaria Suitability, Regional GDP and Population Density in 1800.
- Model 3 includes controls in Model 3 + Climate Constraint, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability and Mountain Slope.

Table 5: Within Tribes Analysis Controlling for Spatial Autocorrelation

Dependent Variable: Rate of Underweight Children below 5			
Estimation Method: HAC Spatial OLS	Model 1	Model 2	Model 3
Christian Mission Intensity (0-1 scale)	-0.0200***	-0.0200***	-0.0200***
	(0.00654)	(0.00657)	(0.00667)
Christian Mission Dummy	0.00355	0.00355	0.00355
	(0.00297)	(0.00319)	(0.00306)
Distance to the Mission	0.00478	0.00478	0.00478
	(0.0139)	(0.0143)	(0.0144)
Tribe Fixed Effects	Yes	Yes	Yes
Country-Fixed Effect	Yes	Yes	yes
Observations	4,836	4,836	4,836
R-squared	0.98	0.98	0.98

Conley (2008) Spatial HAC errors in parentheses:*** p<0.01, ** p<0.05, * p<0.1
Controls included are the following: Number of Children per Area, Population Density in 2000, Regional Fractionalization, Malaria Suitability, Regional GDP, Population Density in 1800, Climate Constraint, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability and Mountain Slope.

Table 6: Controlling for Religion

Dependent Variable: Rate of Underweight Children below 5		
Estimation Method: OLS	***Model 1***	***Model 2***
Christian Mission Intensity (0-1 scale)	-0.0199***	-0.0215***
	(0.00656)	(0.00714)
Christian Mission Dummy	0.00363	0.00328
	(0.00294)	(0.00293)
Distance to the Mission	0.00354	0.00415
	(0.0138)	(0.0141)
Share of Roman Catholics	0.000272*	0.00022
	(0.00015)	(0.0003)
Share of Protestants	0.000513**	0.00091
	(0.00024)	(0.0008)
Share of Animists	-0.00024	-0.00054
	(0.00015)	(0.00041)
Share of Muslims	-0.00042*	-0.00086**
	(0.00024)	(0.0004)
Share of Roman C.*Mission Intensity		0.00007
		(0.0003)
Share of Protestants* Mission Intensity		-0.00056
		(0.0011)
Share of Animists*Mission Intensity		0.00044
		(0.00056)
Share of Muslims*Mission Intensity		0.00064*
		(0.00033)
Observations	4,836	4,836
R-squared	0.98	0.98

Conley (2008) Spatial HAC errors in parentheses:*** p<0.01, ** p<0.05, * p<0.1
Controls included are the following: Number of Children per Area, Population Density in 2000, Regional Fractionalization, Malaria Suitability, Regional GDP, Population Density in 1800, Climate Constraint, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability, and Mountain Slope.

Table 7: IV Estimates

Dependent Variable: Rate of Underweight Children below 5	
Estimation Method: IV	***Second Stage Stat.***
Christian Mission Intensity (0-1 scale)	-0.755***
	(0.228)
	First Stage Stat.
Rugged Terrain	0.1613***
	(0.047)
Anderson Canon LR-Stat.	29.000
Partial F-Stat.	11.77
Cragg Donald F-Stat.	28.991
Stock and Yogo crit. Val.	16.38
Observations	4,836
Root MSE	0.098

Country Clustered Standard errors in parentheses:*** p<0.01, ** p<0.05, * p<0.1

Controls included are the following: Country and Ethnic Fixed Effects, Number of Children per Area, Population Density in 2000, Regional Fractionalization, Malaria Suitability, Regional GDP, Population Density in 1800, Climate Constraint, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability and Mountain Slope.

Table 8: Underweight Children and Development

Dependent Variable: Log(1+Mean Economic Activity)	
Estimation Method: IV	***Second Stage Stat.***
Rate of Underweight Child (x1000)	-5.005**
	(2.189)
	First Stage Stat.
Christian Missions Intensity	-0.0114**
	(0.0053)
Rugged Terrain	0.1320***
	(0.0328)
Anderson Canon LR-Stat.	168.217
Cragg Donald F-Stat.	85.306
Stock and Yogo crit. Val.	19.93
Hansen J-statistics	0.2941
Observations	4836
Root MSE	0.3524

Country Clustered Standard errors in parentheses:*** p<0.01, ** p<0.05, * p<0.1

Controls included are the following: Country and Ethnic Fixed Effects, Number of Children per Area, Population Density in 2000, Regional Fractionalization, Malaria Suitability, Regional GDP, Population Density in 1800, Climate Constraint, Mean Annual Precipitation, Net Primary Productivity, Distance from the Capital, Distance from the Sea, Inland Water Basins and Rivers, Soil Nutrients, Soil Workability and Mountain Slope

Data Appendix

Data Source		
Variables	***Description***	***Source***
Rate of Underweight Child	Rate of Underweight Children in Thousands	SEDAC-CIESIN
Number of Children Under 5		SEDAC-CIESIN
Christian Missions	Map on Christian Missions from Roome (1924)	Nunn (2010)
Ethnic Boundaries	Maps on Ethnic Group	Murdock (1959,1967)
Administrative Boundaries	Third level Administrative Boundaries	Global Administrative Database (GADM)
Population Growth 1500-1860, Population 1500 and Population 1860	Historical Spatial Data on Population	HYDE – Historic Database of Global Environment from the Netherlands Environmental Assessment Agency.
Economic Activity	Satellite Imagery of light density from the National Geophysical Data Center (NOAA/NGDC)	Ghosh et al. (2010)
Population Density	Spatial Data on population density at a $1km^2$ level	Gridded Population of the World (GPW) - SEDAC
Group Share	Group Area/Country Area	
Mountain Slope	Digital Elevation Model	FAO-GeoNetwork
Inland Water Basins	Spatial Data on Rivers and inland Basins	FAO-GAEZ
Soil Nutrients	Spatial Data on Natural Soil Fertility	FAO-GAEZ
Soil Workability	Spatial Data on Factors which can limit agriculture	FAO-GAEZ
Climate Constraint	Spatial Data on Climatic Factors which affect Agriculture	FAO-GAEZ
Net Primary Production	Spatial Data on potential Vegetation depending on Soil Moisture and Temperature	FAO-GAEZ
Terrain Ruggedness	Computed using DEM Data and the Terrain Analysis Plugin in QGIS	
Distance from the Sea	Distance to the Nearest Coast	NASA Ocean Biology Processing Group
Distance from the Capital	Euclidean Distance from the Capital	CEPII (cepii.fr)
Population Density in 1800	History Database of the Global Environment	HYDE
Environmental Suitability to Malaria	$1km^2$ Spatial Data from a biological model which incorporates the effect of climate on 1) vector lifespan and 2) the duration of *P. falciparum* sporogeny.	Oxford Atlas Malaria Project
Religion	Share of Roman Catholics, Protestants, Animists and Muslims.	The Joshua Project