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> *People living in human populations are heirs to a pool of socially transmitted information that affects how they make a living, how they communicate, and what they think is right and wrong.*
>
> (Boyd and Richerson, 2005, p. 3.)

Abstract

This paper uses a measure of the long-term impact of ancestral malaria burden, which dates from when official malaria data is not available to assess its impact on the cultural traits of ethnic groups in the pre-industrial Sub-Saharan Africa (SSA). There is causal evidence that the incidence of malaria in the ancestral homelands raises the probability of patrilineal inheritance rules and patriarchal local headman succession by about one-third percentual points. The results are not stranger since pregnant women and children under five years old are the most risk population of malaria. Thus, the scapegoating effect associated with women's responsibilities as caregivers outweighs the women's complementarities inside the group, unbalancing the gender roles. In the last section, using the information on people's ethnicity and exploiting the variation of immigrants between homelands, there are suggestive results that confirm that malaria suitability is a strong predictor of the gender's perception in politics.

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1. Introduction

Nowadays, the role of culture in economics has reached high relevance to understand the origin of gender roles. Culture could be rationalized as a *rule-of-thumbs* used in the uncertainty environments as a response to the high cost associated with the knowledge acquiring process (Boyd and Richerson, 2005). By this definition, culture is a bundle of heuristic practices that we learn from others in various forms of social learning (e.g., imitation, teaching). The environment mainly determines the optimality of practices learned from others. A review in gender roles literature refers to cultural practices, such as pre-industrial characteristics, agricultural technology, language, religion, and others (Giuliano, 2017), as a critical determinant of the natural place of women's today. However, little is know about the link between epidemics and gender roles. Specifically, malaria is an endemic epidemic from Sub-Saharan Africa, whose principal killed people are children under five years and pregnant women. This paper assesses the impact of malaria on pre-industrial cultural traits related to women's roles, using a novel measure of the historical malaria burden.

Epidemics influence culture through what we learn from others. Epidemics change the local environment affecting beliefs, skills, and values transmitted within people. There is economic evidence of that. For example, people blamed Jewish from poisoning wells and causing the black death in the middle age, which arose in Germany's antisemitism movement. Voigtländer and Voth (2012) gives evidence that the movement persists even 600 years later. Likewise, in their analysis of mortality rates in the Black Death, Jedwab et al. (2019) concludes that the scapegoating effect associated with Jewish people increases the persecution to them, but in cities where Jewish offered complementarities to the community, the persecution was less. Another critical epidemic in human history is AIDS. In ongoing work, Fernández et al. (2019) show that the AIDS epidemic was a shock that ensued a process of political mobilization that led to a cultural change toward the perception of gay people. Using a theoretical model and validating it with contemporary data on AIDS, Boucekkine et al. (2009) explains how epidemics change people's fertility decisions. In what respect to malaria, Cervellati et al. (2019) state that the higher intensity of malaria increase the number of ethnic groups partitions, leading to a more ethnolinguistic diversity today. In sum, epidemics are relevant for the role of culture in economics.

The main interest in malaria to understand women's roles is not blurred. Malaria is one of the most (if not the most) killer-disease in human history, "...two reasons for this are that, unlike plague, smallpox, and cholera, it [malaria] has collected its grim annual tribute continually since the earliest days of our species. In addition, its geographical reach is enormous" (Snowden, 2019). Every year malaria kills more than 400,000 people. According to the World Malaria Report 2019, in 2018 was 405.000 deaths by malaria, and Africa Region accounted for 94% (Global Malaria Programme, 2019). By the window of 1990-2017, Sub-Saharan African accounts on average by more than 80% of the total world deaths per year (GBD, 2018). However, why is malaria relevant for gender roles? Most populations at risk are pregnant women and children under five years old. In the former group, in 2018, about 11 million pregnancies would have been exposed to malaria

infection, delivering critical consequences such as maternal anemia, low birth weight, and severe anemia in children. The latter group, account for the 67% of all malaria deaths worldwide (Global Malaria Programme, 2019). The ethnic puzzle with these statistics is that given the caregiver roles of women, they are the first to realize the child's illness. Jones and Williams (2004) states that in cases of severe malaria, ethnics groups associated it with a supernatural or spiritual origin, so the treatment decision of women are under considerable social pressure. When the child dies, women received the blame for the fatal consequences. Therefore, they are a *scapegoat* of the real causes of the disease in children.

The analysis of ancestral malaria impact on cultural traits relies on the novel measure develop by Depetris-Chauvin and Weil (2018). Malaria left a genetic imprint on people, which lets to approximate the historical burden on people. Carrying only one allele of the sickle cell disease gives a biological advantage to the individual in order to do not get malaria. In the case of having the two alleles, it is impossible to survive to adulthood. Modeling the equilibrium of the genetic distribution of the sickle cell disease gives a measure of the ancient impact of malaria. The economic interpretation of the variable is direct; it represents the probability of dying from malaria or sickle cell disease, conditional on dying for something else. Other indexes like Kiszewski et al. (2004) do not have an economic interpretation, challenging to establish succinct implications.

The identifying problem in the ancestral impact of malaria emerges from the measurement error associated with the ancestral malaria burden. The measure imposes the cost of dying by sickle cell disease. Likewise, in the historical analysis, there is the reverse causality problem, and in a not minor way, there is a substantial unobserved heterogeneity related to the women's complementarities within the homeland that down-biases the estimations. To overcome these problems, section 2 presents an instrumental variable approach using the temperature constraints of *Plasmodium's parasite* as an instrument. The orthogonality condition imposes that the instrument does not correlate with the human activity in the homeland, a plausible assumption as long as the Gething et al. (2011)'s index uses temperature data from dates in which human activity cannot modify the global temperature. The main causal results of the current work shows that increasing one standard deviation the historical treatment of malaria leads to an increase of 0.33 p.p. in the probability of patrilineal succession of the local headman; the inheritance rules of land are 0.18 p.p. more patrilineal, while the succession of movable goods follows the patrilineal heir with a 0.36 p.p. of likelihood. As a response to the survival pressure exerted by the diseases, homelands are 0.3 p.p. more likely to practice polygamy. Concerning labor division, the main type of agriculture of the homelands is extensive, so the body-requirements do not inhibit the women's participation. This fact supports that an increase in one standard deviation in the ancestral malaria burden raises the female labor force participation in agriculture at 0.36 p.p., so there is evidence that in highly malarious zones, women offer significant complementarities to farm work.

Regarding the persistence of the ancestral malaria burden on the contemporaneous times, the Afrobarometer survey 3 performs a particular question of the perception of gender political participation. The main challenge is to relate each individual's ethnic group to their ancestral

homeland, where the historical treatment of malaria occurs. Nunn and Wantchekon (2011) uses this dataset and gives the advantage that most observations are associated with their ancestral homeland. The main results state that the suitability of malaria is a strong predictor of males as better political leaders than women, while the ancestral burden of the local environment or the local suitability to malaria have a weak or even a null effect in the reduced form estimates.

The relationship between the *scapegoating effect* and the economic outcomes was first studied by Oster (2004). The author analyzes how witchcraft trials are an example of violence and scapegoating prompted by impoverishing economic conditions. However, the main explanation of the above results follow from Jedwab et al. (2019)'s conceptual framework. The disutility associated with the higher children mortality raises the *scapegoating effect* on females, making them weaker regarding males. Nevertheless, this negative perception in the homeland may be outweighed by the complementarities that women offer in their caregiver role and the type of economic activities in the homeland. In that case, whether the farm production that women do or the caregiver role in treating the illness is greater than the disutility associated with the high mortality caused by malaria, their relative importance in the group increases. In the opposite case, the responsibility associated with them for the death of children decreases their relative importance in the group, generating an unequal division of inheritance norms.

The more likelihood of polygamy and female labor force participation in agriculture have its explanation on the Boucekkine et al. (2009) theoretical framework. Epidemic diseases introduces a behavioral change regarding fertility decision. At the heart of their Boucekkine et al. (2009)'s insights, an increment on child mortality increases the number of births that parents need to achieve their desired number offsprings. So as males have more than one woman, this behavior increases the possibility of a higher fertility. On the other side, under natural conditions, males and females have the same probability of becoming ill. Thus, a higher impact of historical malaria translates into a potential reduction of labor supply, which increases the female labor force participation in activities where women may offer high complementarity (i.e., those that do not require body-strength). This last statement is the case for the current dataset, where the agriculture is mainly extensive, so it requires a lower body-strength than the intensive practice.

In addition to the *scapegoating effect*, that undermines women's roles. The adverse consequences of the disease restrict women's work outside the home. Symptoms such as fever, sweating, anemia, and convulsions impact the body's physical requirement to develop daily tasks, so they have less time to engage in outside-home activities when the disease is severe. Lado (1992) states that in the major rural areas in Africa, women have the primary responsibility of health and nutrition in their families. They provide the first-line health care, the responsibility of the home environment and good habits of hygiene and sanitation (Lado, 1992). These responsibilities are not usual on men, who have lower constraints to develop their activities. This differentiated division of work, mainly the constraints associated with women's tasks under the epidemic disease, generates different norms and social values that weaken the position of women inside the cultural group.

The historical results should not be confused with which ones found in the analysis of cul-

tural persistence. The cultural traits analyzed in the former talk about women's abilities within the ethnic group; therefore, women as a group with high malaria involvement are weaker than males, generating gender inequality in the inheritance rules. On the other hand, in the persistence analysis, the variable studied refers to an evaluative judgment of the women's capabilities regarding males. The evidence is only suggestive, and only consider the perception in respect of political leadership, which is quite different from the effective leadership that individuals have in the community.

The evolutionary process through which past social customs, beliefs, norms, values affect the current perception of women is consistent with Boyd and Richerson (2005) and Rogers (1988). Under these models, the evolution of gender roles evolves through the natural selection process. Therefore, zones with the historical incidence of malaria will have a different conception about the role of women inside the home. Alesina et al. (2013) relates three arguments of why culture persists. First, institutions, laws, and policies reinforce cultural practices, so unequal gender roles are institutionalizing. Second, unequal gender roles play a complementarity role with industrial structure. Thus, economic activities or political rules stimulate male political participation to the female political role's detriment. Third, cultural beliefs are inherently sticky. The net benefit associated with the rules-of-thumb in the information acquisition process make to persists cultural practices. Applying homeland-fixed effects makes it possible to take constant external factors or complementarities in the culture analysis. Specifically, using movers-people, it is possible to compare people's responses to different historical malaria burden, keeping constant external elements of the environment.

This paper relates with the role of culture in the economy. For example, Fernández and Fogli (2009) use the labor participation of ancestors to explain the number of hours worked by people today. Guiso et al. (2009) analyzes whether cultural features between European countries could bias international trade, their results suggest that lower bilateral trust leads to less trade between countries, less portfolio investment, and less direct investment; Gorodnichenko and Roland (2017) argue that more individualistic cultures lead to more significant innovation due to the social status rewards associated with innovation in that culture. Therefore, the increasing number of analyses that use culture and economics let assert that: culture matters. The rest of the paper is as follows. Section 2 presents the ancestral impact of malaria on some cultural traits relates to women's status in the ethnic group. Section 3 shows the contemporary effect of the ancestral malaria burden on the perception of gender's political participation. Section 4 concludes.

2. The Ancestral impact of Malaria

2.1. Data

This section analyses whether ethnic groups historically affected by malaria have different cultural traits regarding women's roles. The lack of data on the historical impact of the disease

was overcome by Depetris-Chauvin and Weil (2018). The genetic imprint left by malaria, let to approximate the historical burden. Carrying one allele of sickle cell disease gives protection against malaria, but the two alleles left the individual with lower chances to reach adulthood (Depetris-Chauvin and Weil, 2018). Therefore, malaria increases the biological pressure in the historical process of natural selection that affects the equilibrium rates of sickle cell in the population. Modeling the equilibrium of the genetic distribution of sickle cell in the population makes it possible to know the historical malaria burden. Other measures as malaria ecology have two key troubles. First, they do not have a direct economic interpretation in a regression framework. Depetris-Chauvin and Weil (2018)'s measure represents the *fraction of children expected to die from malaria or sickle cell disease, conditional on not dying of something else*. Second, these measures correlate with a bundle of environmental characteristics that may directly impact the social norms, values, and economic activities developed by pre-industrial tribes. Thus, omitting bias problem may arise. However, the measure imposes a cost because it captures the mortality by sickle cell disease. The database is the same used by Depetris-Chauvin and Weil (2018), complementing it with supplementary ethnic information of pre-industrial societies retrieved from *The Ethnographic Atlas* (Murdock, 1967). This dataset includes variables on pre-industrial characteristics of 1,265 tribes[1] around the world. The big challenge in data construction is to merge the homeland location (Murdock, 1959) to the ethnographic characteristics (Murdock, 1967). Even though George Murdock constructed the two sources of cultural information, there is no perfect match between Ethnographic Atlas and Murdock's Map. However, the authors followed the algorithm developed by Fenske (2013), which left a total of 520 ethnic groups with ethnographic information.

Figure 1 shows the map with the distribution of the measure of ancestral malaria burden over homelands matched. The Fenske (2013)'s algorithm left more than 300 groups of the Murdock's map without a representation in the *Atlas Ethnographic*. This potential selection bias could be a problem if the excluded groups are potentially different in the treatment of malaria. However, the analysis discussed by Depetris-Chauvin and Weil (2018) shows that although it is not possible to determine if the excluded ethnic groups are different in characteristics, at least in terms of the ancestral treatment of malaria, there are no statistically significant differences. Table 13 show some summary statistics of the variables related to women's roles in pre-industrial ethnic groups.

2.2. Historical impact of malaria

This section turns to the primary inquiry, the impact of malaria on pre-industrial cultural traits relates to women's roles. The empirical strategy is as follows:

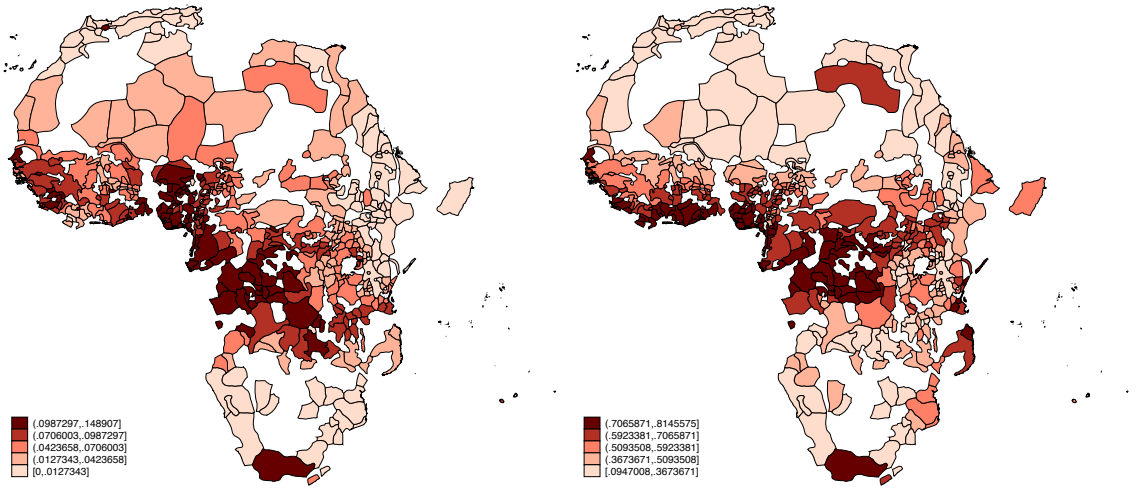
$$y_{e,r} = \mu \text{Malaria Burden}_e + \mathbf{\Omega G}_e + \mathbf{\Phi W}_e + \mathbf{\Lambda C}_e + \delta_r + \varepsilon_{e,r} \tag{1}$$

[1]More than 95% of ethnic features dated from 1850 to 1950

Figure 1: Ancestral malaria burden and *Plasmodium suitability*

(a) Malaria Burden

(b) Plasmodium Suitability



Notes. Panel A shows the distribution of the ancestral malaria burden across all homeland considered in the analysis. Panel B shows the mean of the *Plasmodium falciparum* and *Plasmodium vivax* suitability across all homelands in the analysis.

where y is a relevant characteristic adopted by the ethnic group e whose homeland's land belongs mostly to the geographical region r. Some geographical, access to water and climate controls at the homeland level are included in $\mathbf{G}$, $\mathbf{W}$ and $\mathbf{C}$, respectively. Region fixed effects, δ_R, take into account geographical differences across the Africa continent. The relevant coefficient is μ, and it measures the historical impact of malaria on the acquisition of a particular cultural trait.[2]

Table 1 shows a correlation between malaria burden and patrilineality groups. The dependent variable refers to the patrilineality of the cultural group, and takes values one if the group is Patrilineal and 0 otherwise (e.g., Matrilineal, ambilineal, mixed). Patrilineality refers to the group lineage and inheritance rules.[3] Kinship structure defines different relations of power inside the household. While in matrilineal societies, the authority figure could be a man, but the group membership of an individual becomes from its female ancestors, in patrilineal kinships, both authority and individual's kin group refer to males. To the women, the former group ensures more intra-household bargaining power, land access, additional support in their kin group, and a better exit options than the latter (Giuliano, 2017). Lowes (2018) documents that the survival of this kinship system is puzzling because it undermines male authority, and given that husband and wife have a strong allegiance to their tribe group, an integral unit of cooperation is less likely. The first column of Table 1 reveals a negative correlation between patrilineality and malaria burden. An increase of one standard deviation in the malaria burden reduces the probability of being patri-

[2]The specification model corresponds to a Linear Probability Model. Given that the main interest is not in prediction, to simplify the computational work required with the fixed effects, probability models such as Probit or Logit are not considered. See Angrist and Pischke (2009) for a further discussion.

[3]Do not confuse with the patriarchal or matriarchal meaning. These concepts indicate that males (patriarchal) or females (matriarchal) are the gender authority in the group (Lowes, 2018).

lineality on 0.065 percentual points (p.p.). Confounding factors may bias the estimations, so they are considered next.

Column 2 of Table 1 includes geographic controls. Geographical characteristics related to the homeland affect the prevalence of malaria, and the estimand may capture these differences. To account for that, column 2 includes a land suitability index, an ecological diversity index, and the mean of terrain elevation. The following paragraph comments and describes each one of these controls.

Livingstone (1958) and Wiesenfeld (1967) consider that the development of slash and burn agriculture in Africa increased the sunlit pools of water, improving the *Anopheles gambie* suitability,[4] and recent medical research asserts that the agricultural expansion correlates with more mosquito's suitability (Janko et al., 2018). Ramankutty et al. (2002) develop an index for land suitability using information on climate and soil constraints; it represents the probability of a grid cell (of 50km x 50km) to be cultivated. Another relevant omitted variable is the local environment diversity. Malaria has a higher prevalence in zones with less ecological diversity, which in turn has a lower population density. White (1983) classifies Africa vegetation into 18 major types, and Fenske (2014) uses the share of land of each homeland into each type of vegetation, to construct a fractionalization index of ecological diversity. Another important characteristic is the terrain elevation, different elevations of the homeland terrain can affect the life cycle of the mosquito, leading to a different transmission intensity. After include these controls, the point estimate decreases roughly 0.005 p.p., while the standard error remains stable.

The humidity conditions of the homeland affect the life cycle of the mosquito. Actually, in their egg and larval stages, mosquitoes do not resist dryness and require moist surfaces to survive. The third column adds two water controls. The first is the logarithm of the total area of water bodies accessible to the ethnic homeland (e.g., Lake Victoria in Uganda). The second is the logarithm of the distance from the centroid of the homeland to the nearest coast. The spread of malaria depends on population density, and zones with a shorter distance to the coastline are highly populated.[5] The absolute value of the point estimates goes up 0.006 p.p., while the standard error is virtually unaffected.

The relationship between malaria contagion and climate conditions is not linear. The relevant identification comes from the non-linearities associated between the mosquito life cycle and the

[4] *Anopheles gambie* is the principal vector of *P. falciparum*, the most severe parasite of plasmodium's family. Some biological analysis on the parasite *P. Falciparum* and Humans genes may correlate the date of the last common ancestor of malaria with the introduction of agricultural practices. For example, Volkman et al. (2001) use the genetic variability of *P. palciparum*, their results suggest that the date of the most common ancestor of *P. palciparum* dates from 3200 to 7000 years ago. They argue that this estimation coincides with the establishment of slash and burn agriculture in Africa less than 6000 years ago, facilitating the conditions for the mosquito vectors of P. falciparum, and the growing population may maintain the transmission. At the same time, Tishoff et al. (2001) analyze the genetic variation of glucose-6-phosphate dehydrogenase (G6PD), an essential enzyme to the metabolism of glucose, whose deficiency reduces the risk of contracting malaria. They established the origin of the mutation within 3820 to 11760 years ago. They concluded that the impact of malaria on humans is recent and coincident with the spread of agriculture in Africa.

[5] These controls are taken from Depetris-Chauvin and Weil (2018)'s calculations.

homeland's climatic conditions, or else the real causal phenomenon would not be malaria, but weather conditions. The fourth column adds the mean and standard deviation of temperature for each ethnic homeland throughout 1901-2012 using the CRU TS3.21 dataset (National Center for Atmospheric Research Staff (Eds), 2014). Taking off from the direct temperature effect increases the point estimate until -0.056 p.p., while the precision of estimation is not much affected.

Africa continent has an area of more than 30 million square kilometers, so differences across geographical regions may not be taken account in the above controls. These differences might cause that very distant groups have different geographic characteristics, which may favor the acquisition of certain cultural practices that could bias the estimation. In order to compare homelands within the same geographical region, the last column adds a dummy for the five zones defined by the M-49 Classification of the United Nations.[6] The effect of compare homelands within the same region avoids some of the omitted heterogeneity not included in the environment. Therefore, it decreases the probability of being patrilineal in the last column by about 0.09 p.p.

Table 1: Malaria Burden and Patrilineality (OLS)

	Dep. Variable: Patrilineality				
	(1)	(2)	(3)	(4)	(5)
Malaria Burden	-0.0654^{***}	-0.0694^{***}	-0.0756^{***}	-0.0557^{**}	-0.0908^{***}
	(0.0196)	(0.0212)	(0.0217)	(0.0239)	(0.0293)
Geographic	N	Y	Y	Y	Y
Water	N	N	Y	Y	Y
Climate	N	N	N	Y	Y
ONU Regions	N	N	N	N	Y
Obs.	513	512	512	512	512
Adj. R2	0.0191	0.0157	0.0324	0.0439	0.0630

Notes. Malaria Burden has mean zero and one standard deviation. Geographic controls: mean value of land suitability index for agriculture (Ramankutty et al., 2002); Ecological diversity (Fenske, 2014); homeland's terrain mean elevation (taken from Depetris-Chauvin and Weil (2018)'s calculations). Water controls: log. of total area of water bodies -in sq km- and distance from centroid of each homeland to coastline(taken from Depetris-Chauvin and Weil (2018)'s calculations). Climate controls: Homeland's mean and standard deviation of temperature over 1901 - 2012 (National Center for Atmospheric Research Staff (Eds), 2014). ONU Regions: dummies for five ONU Mv49 regions (Northern-, Middle-, Eastern-, Western-, Southern-Africa) own calculation from digitalized version of Murdock Map. Robust Standard errors. $^{*}p < .10$,$^{**}p < .05$,$^{***}p < .01$.

After using a battery of plausibly exogenous control, increasing one standard deviation on the historical malaria burden is associated with a lower probability of patrilineal inheritance of at least 0.09 p.p. However, understanding what a less likely patrilineality means is complex. The kinship structure of an ethnic group refers to a bundle of things (Lowes, 2018). Table 2 uses other pre-industrial characteristics available in the *Ethnographic Atlas* that describe the natural position of women inside the ethnic group. The first column considers the inheritance succession to the local office of the headman. This variable takes the value of one if this succession occurs by patrilineal heir and zero to matrilineal or other forms of succession (e.g., informal consensus, election or formal consensus, social status). The point estimate β goes in line with the last patrilineality result; it

[6]Homelands are assigned to the geographical regions over which they have a greater area. The regions are: 1 - Northern Africa, 2-Middle Africa, 3-Eastern Africa, 4-Western Africa, and 5-Southern Africa.

is negative and strongly significant, indicating that increasing one standard deviation in malaria burden reduces the probability of patrilineal succession of the local headman office in 0.07 p.p. The second and third columns consider the inheritance rule for real property (i.e., land) and movable goods. These variables take the value of one for patrilineal inheritance and zero otherwise (e.g., matrilineal, absence of individual property rights). The former is not statistically different from zero, and the latter has a weaker significant effect of -0.05 p.p.

Another cultural trait closely related to the kinship system is the couple residence after marriage. In Patrilocal or virilocal societies, the partners reside near the husband's relatives so that wives will have a lower support in their ethnic group, a higher cost associate to return where their parents, and in case of marital dissolution, women's have a more considerable disadvantage (Alesina et al., 2019). The opposite is valid to matrilocal societies. There is a bargaining power that is unbalanced within the home and is more favorable to men (in the case of patrilocal or virilocal residence) or women (in the case of matrilocal societies). *The Ethnographic Atlas* defines nine categories to postmarital residence: (1) avunculocal; (2) ambilocal; (3) optionally uxorilocal or avunculocal; (4) optionally patrilocal; (5) matrilocal; (6) neolocal; (7) non common residence; (8) Patrilocal; (9) uxorilocal; (10) virilocal. The marital residence variable takes the value of one in case of (8) or (10), zero otherwise. The point estimates reflect a stronger allegiance to non-patrilocal or virilocal residence. Homelands are 0.12 p.p. less likely to adopt a marital residence near to the husband's relatives.

Table 2: Malaria Burden and Other pre-industrial measures of women's local status (OLS)

Dep. Variable:	Local Headman Succession	Land Succession	Movable Succession	Marital Residence	Bride Price	Polygamy	FLFP Agriculture
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Malaria Burden	−0.0704*	−0.0334	−0.0533*	−0.1168***	−0.0163	0.0378	0.0708***
	(0.0360)	(0.0312)	(0.0319)	(0.0249)	(0.0243)	(0.0241)	(0.0167)
Obs.	365	399	422	514	522	510	306
Adj. R2	0.0538	0.1715	0.1228	0.0664	0.0225	0.1662	0.2608

Notes. Malaria Burden has mean zero and one standard deviation. All specifications have the full set of control from column 5 Table 1. Robust Standard errors. $^{*}p < .10$,$^{**}p < .05$,$^{***}p < .01$.

Most of the features previously considered refer to wealth inheritance within the ethnic group. Nevertheless, the marriage's mode is important to understand the groups' valuation of female's work. Giuliano (2017) states that ethnic groups in which women have a high productivity are more likely to establish the bride price, while in societies where women have a low productivity, the bride's family is more likely to transfer a payment or service to the family of the bridegroom. According to that, if the women become more valuable within the group due to the disease, then ethnic groups with an intensive treatment of malaria will establish modes of marriage with a higher value towards women. The fifth column examines the last relationship. The Ethnographic Atlas classifies the mode of marriage between the following values: (1) bride price or wealth, to bride's family; (2) bride service, to bride's family; (3) token bride price; (4) gift exchange, reciprocal; (5) sister of female relative exchanged; (6) absence of consideration; (7) Dowry. Following Giuliano and Nunn (2018)'s codification, in the current dataset, Bride Price takes the value of one for the

first category, and zero otherwise. The preliminary correlation is almost zero and not statistically significant, suggesting that the females' valuation inside the group was not affected by the historical treatment of malaria.

The sixth column uses the polygamy practice as the dependent variable, following the decoding used by Fenske (2013). It is an indicator of whether the marital composition is preferentially sororal (inhabiting the same or separate dwelling) or non-sororal (inhabiting the same or separate dwelling), the excluded categories are monogamous, occasional polygyny and polyandrous families.[7] The epidemic disease implies a survival risk of the members of the ethnic groups, so homelands that faced a higher mortality from malaria should have a greater probability of polygamous practices. Although the association found is positive, the estimator is statistically not significant.

The final column is the Female Labor Force Participation (FLFP) in agriculture. The *Ethnographic Atlas* classifies the labor of women into the following categories: (1) males only; (2) males appreciably more; (3) differentiated but equal participation; (4) equal participation; (5) female appreciably more; (6) females only. In order to get an easier interpretation, the decoding is the same used by Giuliano and Nunn (aper), so all the FLFP considered in the current analysis takes values from 0 to 1: (1) 0 p.p.; (2) 0.25 p.p.; (3,4) 0.5 p.p.; (5) 0.75 p.p.; (6) 1 p.p. Categories (3) and (4) are nested because this distinction is irrelevant for the analysis. The point estimate reflects that increasing one standard deviation on malaria raises the FLFP in agriculture by 0.07p.p. This active role of women in agriculture may reflect the positive association between agriculture and *Anopheles gambiae* suitability. Indeed, it is more likely that places highly malarious require more labor input, so women have a relatively higher labor participation.

2.2.1. Treats to validity: The Identification Problem

The last analysis, albeit preliminary, suggests that a higher intensity of malaria in the homeland attenuates the *status quo* of men: ethnic groups are less likely to be patrilineality; inheritance rules of property land and movable goods are less patrilineal; women probably resides near to their relatives' location, and females have an active role in agriculture. However, identifying the actual effect of malaria on pre-industrial groups' social structure is difficult without an exogenous variation. The empirical strategy (1) has some identification problems: measurement error, reverse causality, and omitted variable problem. The measurement error of malaria burden arises from the cost associated with the probability of dying from the sickle cell disease. Strictly speaking, the constructed measure is a good proxy but not an exact measure of the ancient impact caused by the epidemic. The reverse causality arises from the fact that some cultural practices - such as agriculture, endogamy - may exacerbate the ancestral malaria measure. In terms of the Granger's causality, the last statement implies that the cause (i.e., malaria burden) is a subproduct of the

[7] Polyandrous families refer to wives that have several husbands. Note that the polygamy indicator measures to the male's social status directly. Including polyandrous families as one in the variable, may confound the interpretation of the results.

consequences (i.e., a particular cultural trait). Indeed, the marriage between consanguineal people affects the frequency of genes that cause sickle cell disease, modifying the cost associated with the malaria measure and affecting the estimation of causal effects. Under this problem, the point estimates are hard to interpret and are far from being causal.

The latter threat to validity comes from the omitted variable. In all homelands where malaria was present in the past, were children and pregnant women the most population at risk. It implies that if women have a vital caregiver function associated with their biological role inside the group, they will be more constrained than men to develop other out-home activities. Nevertheless, how these constraints operate depends on women's within-group complementarities, and they differ across the entire Africa. The omitted heterogeneity associated with the complementarities that women supply inside the group down-biases the estimands, but in a non-constant intensity around all homelands. For example, a matrilineal kinship structure allows complementarities within the home (e.g., a lower intrahousehold cooperation (Lowes, 2018)) that are very different from those of patrilineal groups. The most significant number of matrilineality groups locates in south-central Africa, also called the "the matrilineality belt", in the current data are 50 homelands who are matrilineal and locates around that zone (i.e., Middle and Eastern Africa according to ONU regions). These groups have an average probability of dying from malaria or sickle cell that it is 1.64 times the mean value of all 150 homelands that are patrilineal and locates in the same regions. Therefore, the complementarities of women within-group are closely related to the intensity with which the epidemic affects its members.

2.3. Instrumental Variable Approach

An instrumental variable approach will be employed to solve the identification issues of the last. A key determinant in malaria transmission is the temperature suitability of the parasite; it may modulate the endemicity in some regions and prevents transmission in others. Gething et al. (2011) defined a dynamic biological model that incorporated a mechanism through which temperature affects the suitability of the *Plasmodium Falciparum* and *Plasmodium Vivax*, the two most killer parasites that cause human malaria. The index reflects the effects of temperature on the vectorial capacity; it is a relative measure of the number of infectious mosquitoes in an environment - with a particular temperature profile - given a constant engagement rate of adult mosquitoes. If the index takes the value of zero, it means that the local environment's temperature conditions preclude the vectorial capacity of malaria (i.e., there is high constraints to the prevalence of the parasite). In contrast with Kiszewski et al. (2004)'s index, the current measure does not rely on biological or seasonal characteristics associates to mosquitoes. This last statement is essential to accomplish with the orthogonality condition of the instrument, because human activities may accentuate the lifespan of the mosquito (McCann, 2011).

Using the temperature constraints on the malaria landscape as an exogenous variation to the malaria burden leads to estimate its historical impact on social norms related to men in the pre-

industrial world. The identification assumption (i.e., orthogonality restriction) of the instrument is that the Gething et al. (2011)'s index is unrelated to the human activities in the homeland, this means that women complementarities inside the group do not affect it. This condition requires that humans previous to the pre-industrial world (1850-1920) have not modified the mean of world temperature, a plausible assumption provided that some of the first effect of climate change dates from the end of twenty century. Therefore, the instrument is not affected by human activities, leading to isolate the endogeneity associate with women's complementarities inside the cultural group.

The exclusion restriction imposes that the only effect that the index may have on the cultural practices occurs through the prevalence of malaria in the homeland. Gething et al. (2011) calculated the index at 1km-1km of resolution for *P. Falciparum* and *P. Vivax*, both measures are highly correlated. In what follows, their average will be used and refer to that as *Plasmodium suitability*. Figure 1 Panel B shows the distribution of the instrument across all homelands in the sample. The first stage and reduced form regression are as follows

$$\text{Malaria Burden}_{e,r} = \nu \text{Plasmodium Suitability}_e + \mathbf{\Theta G}_e + \mathbf{\Pi W}_e + \mathbf{\Psi C}_e + \delta_R + \varepsilon_{e,r} \quad \text{(First Stage)}$$

$$y_{e,r} = \vartheta \text{Plasmodium Suitability}_e + \mathbf{\Upsilon G}_e + \mathbf{\Gamma W}_e + \mathbf{\Sigma C}_e + \delta_R + \varepsilon_{e,r} \quad \text{(Reduced Form)}$$

where all subscripts and control variables $\mathbf{G}$, $\mathbf{W}$, and $\mathbf{C}$ have the same meaning as before.

Table 3: First Stage Results: Plasmodium suitability

	Dep. Variable: Malaria Burden				
	(1)	(2)	(3)	(4)	(5)
Plasmodium Suitability	0.5711	0.6058	0.6035	0.5778	0.3813
	(0.0306)***	(0.0380)***	(0.0380)***	(0.0424)***	(0.0435)***
	[0.0429]***	[0.0547]***	[0.0557]***	[0.0626]***	[0.0650]***
	{0.0994}***	{0.1301}***	{0.1331}***	{0.1445}***	{0.1274}***
	⟨0.1118⟩***	⟨0.1304⟩***	⟨0.1314⟩***	⟨0.1326⟩***	⟨0.1128⟩***
Geographic	N	Y	Y	Y	Y
Water	N	N	Y	Y	Y
Climate	N	N	N	Y	Y
ONU Regions	N	N	N	N	Y
Obs.	525	524	524	524	524
Adj. R2	0.3249	0.3603	0.3674	0.3953	0.5483

Notes. Standardised beta coefficients. Controls definitions follows from Table 1. Robust standard errors in parenthesis. Conley et al. (1999) standard errors at cutoff of 111km in squared brackets, 555km in curly brackets and 1110km in angle brackets. $^{*}p < .10,^{**}p < .05,^{***}p < .01$.

Table 3 shows the first stage. *Plasmodium suitability* has a positive impact and a highly statistically significant effect on the historical malaria burden. These results are robust to the inclusion of geography, water, and climate controls. The point estimate changes from 0.58 to 0.38 standard deviations when the relevant variation comes from homelands within the same ONU region; this

reflects the great geographical variation across the entire continent. By construction, the *Plasmodium suitability* index relies on temperature data that may have spatial correlation. To account for that, Table 3 also shows Conley standard errors at 1110km, 555km, and 111km. The estimations remain significant at 1%. A crucial assumption in the IV estimates is the monotonicity of the instrument. Under monotonicity, homelands with a higher suitability index will have more probability of receiving the ancestral treatment of malaria. A treat to the validity of that assumption is the non-linearities between malaria and the suitability index. Figure 3 shows the first stage result, but splitting the *Plasmodium suitability* into quintiles. The omitted category is the first quintile, so all coefficients interpret regard to that quintile. The relation shows that monotonical increments on the instruments imply a higher burden of malaria in the homelands within the same ONU region.

2.3.1. Compliers' group

To correctly justify the mechanism that the *Plasmodium suitability* affects cultural practices through its effects on the ancestral malaria burden, it is necessary to confirm that the implemented instrument does not have a differential treatment effect according to the type of economic activity carried out in the homeland. In this case, the allocation to malaria treatment may correlate with the kind of economic activity performed, invalidating the exclusion restriction. A compliers characterization is essential to analyze further results in the second stage.

Table 4 characterizes the compliers' homelands of the historical treatment of malaria. The exercise aims to analyze how the first stage's results vary, conditioning in different homeland's economic activities. The *Ethnographic Atlas* estimates the homeland's relative dependence on the major types of subsistence activity: gathering, hunting, fishing, animal husbandry, and agriculture. The extent of economy dependence relies on the following values: (1) Lower than 5%; (2) 6-15%; (3) 26-35%; (4) 36% to 45%; (5) 46% to 55%; (6) 56% to 65%; (7) 66% to 75%; (8) 76% to 85%; (9) 86% to 100%. Under the orthogonality restriction, the instrument not correlates with the human activity developed in the homeland. Therefore, considering that the homelands locates in one of the most highly malarious regions in the world - i.e., Sub-Saharan Africa -, after a balance sample splitting, the expected result is that the coefficients' magnitudes will not be very different between the different extent of activity dependence. Otherwise, malaria mortality may not be the only mechanism through which the *Plasmodium Suitbaility* affects women's status in the homeland.

The first and second column considers the extent of dependence on agriculture. There are 182 homelands with a low dependence on agriculture (i.e., lower than 46%), and the remain 342 have a high agriculture dependence (i.e., greater than 46%).[8] The estimates remain positive and significant at 1%. An agriculture dependence higher than 46% implies that increasing one standard deviation the *Plasmodium suitability* raises the malaria burden in 0.09 standard deviation; this

[8]Other economic activities like Gathering, Hunting, Fishing have little variation so that any sample split will deliver a small number of observations. For example, of all homelands considered 96%, 88%, and 82% have a dependence lower than 15% on gathering, hunting, and fishing activities, respectively.

result is similar to the first column where homelands with a lower dependence in agriculture have an impact of 0.08 standard deviations. The third and fourth columns consider the agriculture intensity. Intensive agriculture is more related to the male's body-strength requirements, while shifting agriculture has lower physical requirements that increase the female's participation. The point estimates are significant at 1%, and their magnitude is not very distant. Intensive agriculture homelands have an ancestral impact of 0.10 p.p., in contrast, its extensive or shifting agriculture analogs have an effect of 0.08 p.p. The previous result is slightly lower, but dividing the fields for agriculture allows a lower concentration of people that can decrease the probability of contagion. However, the effect found is not far from that of intensive agriculture.

The fifth and sixth columns split the sample into a plow and non-plow users. The Boserup (1970)'s hypothesis states that the body-strength related to plow usage undermines the women's role in the homeland, and Alesina et al. (2013) find conclusive evidence in favor of that. There are a few homelands that do not use the plow, this fact increases the standard error of the estimations, but even that the point estimate is high, it is not statistically significant. Consequently, the compliers group refers more to non-plow users groups, which are the vast majority in Sub-Saharan Africa. The last two columns use the information on animal husbandry dependence. This activity may require body-strength to control the animals, so females are at a disadvantage regarding males. The coefficients are significant at 1%, and without much differences, even that only 36 homelands have a greater dependence on animal husbandry.

One important thing that emerges from the above complier's analysis is that the lack of knowledge about activities that exacerbate vector prevalence makes it plausible that homelands did not avoid some livelihoods based on malaria. In that sense, the ancestral malaria burden's impact does not change as a function of the economic activities carried out within the homeland. The consequence of a lower plow usage is that females may have the same conditions to work in agriculture except by the effect of malaria shocks, which in normal conditions have the same probability of affecting males or females.

Table 4: Compliers characterization

	Dep. Variable: Malaria Burden							
Sample Restriction	Agriculture Dependence $\leqslant 46\%$	Agriculture Dependence $> 46\%$	Intensive Agriculture	Shifting Agriculture	Plough Users	Non-Plough Users	Husbandry Dependence $\leqslant 46\%$	Husbandry Dependence $> 46\%$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Plasmodium Suitability	0.0816	0.0923	0.1034	0.0755	0.0520	0.0856	0.0873	0.1061
	$(0.0170)^{***}$	$(0.0149)^{***}$	$(0.0181)^{***}$	$(0.0157)^{***}$	(0.0396)	$(0.0113)^{***}$	$(0.0109)^{***}$	$(0.0415)^{**}$
	$[0.0181]^{***}$	$[0.0222]^{***}$	$[0.0268]^{***}$	$[0.0188]^{***}$	[0.0331]	$[0.0157]^{***}$	$[0.0167]^{***}$	$[0.0339]^{***}$
	$\{0.0305\}^{***}$	$\{0.0330\}^{***}$	$\{0.0322\}^{***}$	$\{0.0361\}^{**}$	{0.0358}	$\{0.0309\}^{***}$	$\{0.0317\}^{***}$	$\{0.0331\}^{***}$
Obs.	182	342	156	321	37	448	487	36
Adj. R2	0.5734	0.4943	0.5726	0.4247	0.4548	0.4733	0.5262	0.6534

Notes. Standardised beta coefficients. Controls definitions follows from the last column of Table 1. Robust standard errors in parenthesis. Conley et al. (1999) standard errors at cutoff of 111km in squared brackets and 555km in curly brackets $^{*}p < .10,^{**}p < .05,^{***}p < .01$

2.3.2. Instrumental Variable results

Table 5 shows the instrumental variable estimations. Panel A sheds light on the mechanism with the reduced form regressions. The first column relates to patrilineality, the coefficient shows a positive relationship between the *Plasmodium suitability* and the patrilineal kinship structure, but it is not statistically significant, albeit that the standard error is small. The interpretation of that result is that homelands with patrilineal or other kinship structures - in the same geographical region - do not have a different suitability for the killest parasites of human malaria. In terms of randomized control trial's jargon, the treatment allocation, or the intention to treat is not significant for patrilineal homelands. As a consequence of that, the IV result in Panel B let to conclude that the historical impact of malaria does not affect the probability of being patrilineal. The main limitation of the last analysis is the bundle of things that patrilineality means.

Column 2 refers to the local headman succession. Diminishing the environmental constraints to the parasite's vectorial capacity in one standard deviation increases the probability of patrilineal headman succession in 0.13 standard deviations with a significance level of 1%. IV estimate in Panel B is double of the reduced form. Increasing one standard deviation the child probability of dying by malaria or sickle cell disease increases the likelihood of local headman succession in 0.32 p.p. The last result is statistically significant at 1%.

Column 3 uses the inheritance rule of land. Lower constraints to plasmodium suitability imply a higher probability of about 0.07 p.p. of land's patrilineal succession. This result is statistically significant at 5%. The second stage results are about the doubly, and the estimation error associated with the first stage exacerbates the standard error about triple regarding to OLS estimates. The final result shows that increasing one standard deviation of malaria burden increases the likelihood of patrilineal land succession in 0.18 p.p.

Column 4 refers to the inheritance rules of movable goods—both reduced-form and IV results are a twofold increase in the estimand related to land inheritance. A lower constraint of one standard deviation in *Plasmodium suitability* increases the probability of patrilineal succession in 0.15 p.p., approximately. The IV estimand shows a total effect of child mortality of 0.36 p.p. in the likelihood of patrilineal inheritance. There are two sources of the last sizeable effect on movable goods. First, there are lower missing observations in movable goods. While in the land inheritance rights, 27 homelands do not have property rights, in the movable goods, there are only 3. Second, along with the last one, movable goods are more related to the individual domain. In the case of the land property rights, it is more probable that the land usage are part of family heritage. In contrast, movable goods are more related to the proper authority.

Column 5 and 6 uses the marital residence and the bride price as a dependent variable, respectively. As malaria affects more pregnant women than adult men, it is expected that woman's family must support more her, so a residence close to her ethnic group could facilitate the treatment of the disease. The direction of the effect goes in line with this reasoning, increasing one standard deviation malaria burden implies a lower patrilocal residence. However, such as in the

patrilineality column (i.e., first column), the estimates are not statistically significant to both the reduced form and IV estimate. On the other hand, the impact on the women's valuation inside the homeland through the bride price practice has a negative relationship with malaria burden and *Plasmodium suitability*. The increasing deaths of pregnant women reduce the value of females in the group, so bride price practices are less common. The estimand shows a reduction of 0.03 p.p. in the likelihood of bride price, but this result is not statistically significant.

Column 7 shows the estimates of polygamy practices. The pressure exerted by the children mortality increases the total fertility according to Boucekkine et al. (2009). Polygamy practices assure that males have a higher possibility of having children, so the expected relationship is positive. The estimand validates the theory on the behavioral changes caused by epidemics. The intention to treat results shows that a lower constraints on *Plasmodium suitability* of one standard deviation increase the probability of polygamy practices in 0.11 p.p. The second stage results show a three-fold increase in the estimand. All results are significant at 1% level. The main polygamy practiced in Sub-Saharan Africa is in separate dwellings; it also brings the possibility of cultivating more than one land to males. Giuliano (2017) relies on anthropological work of Goody and Goody (1976) and Boserup (1970) to associate the polygamy practices to a more productive work of females in agriculture.[9] In line with the above, the results on the female labor force participation in agriculture in column (7) shows that the reduced form and the instrumental variable regression have a similar magnitude that those in polygamy regressions. The results may be fraught, but they only show the special relationship that the last two cultural traits have with the disease. First, the environmental constraints to *Plasmodium suitability* are lower in zones with high land quality to agriculture. For example, its correlation with the suitability index for yams and banana crops is about 0.67 and statistically significant at 0.1%. These crops are particular because the way to prepare the land for planting consists of clearing small forest areas with slash and burn practices, generating breeding places for Anopheles gambiae (Depetris-Chauvin and Weil, 2018). Second, the main kind of agriculture in the dataset is extensive. This type of agriculture requires less body strength relative to intensive or plow-farming (Alesina et al., 2013). Thus, women have more opportunities to participate in agriculture as long as they are less disadvantaged than men. Third, while the epidemic increases the extent of more reproductive behavior, given that pregnant women are profoundly affected, having more than one woman reduces this pressure. So, FLFP outweighs the negative effect that malaria may have in the reduction of labor supply. This result may vary depending on the physical requirements of the activity carried out, with more body-strength requirements, the complementarities that women may offer are less.

[9] According to the anthropologist, under shifting agriculture, having more than one woman gives the possibility of cultivating more than one land. In the current data, conditional on having information on the intensity of agriculture, 58% of homelands are polygamous and practice shifting or casual agriculture. Therefore, women are also economic assets that let to increase farm production. This reasoning has its counterpart in the data, where only 14% of polygamy practices relate to living in the same dwelling, and around 63% of homelands practice polygamy in a separate dwelling.

Table 5: Malaria Burden and pre-industrial women's status (IV Estimates)

Dep. Variable:	Patrilineality (1)	Local Headman Succession (2)	Land Succession (3)	Movable Succession (4)	Marital Residence (5)	Bride Price (6)	Polygamy (7)	FLFP Agriculture (8)
Panel A: Reduced Form Results								
Plasmodium Suitability	0.0103	0.1315***	0.0729**	0.1468***	−0.0160	−0.0127	0.1136***	0.1351***
	(0.0287)	(0.0394)	(0.0358)	(0.0344)	(0.0216)	(0.0228)	(0.0244)	(0.0165)
Obs.	512	365	399	422	514	522	510	306
Adj. R2	0.0426	0.0717	0.1784	0.1541	0.0120	0.0220	0.1951	0.3512
Panel B: Second Stage Results								
Malaria Burden	0.0271	0.3239***	0.1839*	0.3666***	−0.0413	−0.0333	0.3009***	0.3664***
	(0.0762)	(0.1128)	(0.0943)	(0.1019)	(0.0554)	(0.0599)	(0.0743)	(0.0691)
Obs.	512	365	399	422	514	522	510	306
Adj. R2	0.0065	-0.3350	0.0442	-0.3114	0.0213	-0.0129	-0.1986	-0.9495
F-statistic (First Stage)	71.221	56.088	58.978	57.106	77.072	76.462	73.564	45.715
P-value Underidentification	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes. Plasmodium Suitability and Malaria Burden have mean zero and one standard deviation. All specifications have the full set of controls from column 5 of Table 1. Robust standard errors. $^{*}p < .10,^{**}p < .05,^{***}p < .01$.

To summarize, there is no evidence of the impact of the ancestral malaria burden on patrilineality practices. The intention to treat estimates shows that the *Plasmodium suitability* has no differential effect on patrilineal or other forms of the kinship structure. However, the ancestral impact of malaria creates a disadvantage on the inheritance rights of females. There is strong evidence that the local headman succession, land inheritance, and movable goods inheritance are less likely with more prevalence of malaria. Polygamy emerges as a response to the change in the reproductive behavior, and female labor force participation in agriculture is large in homeland profoundly affected. The point estimates are higher than OLS or reduce form regressions; in part, this is a product of the severe consequences of increasing the children mortality from malaria or sickle cell disease conditional on not dying for something else in one standard deviation. This increase means that if in a common homeland, 5 out of 100 children die, by making the epidemic more severe in one standard deviation, 10 out of 100 children will die by malaria. Regarding standard errors, all reduced form estimates have the same precision of OLS estimates, but the first stage estimation introduces considerable error in the second stage results.

As a robustness check, Table 14 shows the instrumental variable results with spatial correlation at 1110km. The same results remain significant, with little changes. Tables 15, 16, 17 replicate the analysis using other pre-industrial characteristics that were not considered in the above analysis because they have little number of observations. The main results on FLFP show that women participate less, except by activities like fishing that require lower body strength, and as mentioned before, this is an economic activity where women have an important complementarity since the higher humidity conditions increase the mosquitoes suitability.

3. Persistence analysis

The next analysis tries to explain whether the historical learning (i.e., cultural beliefs) associated with the ancestral malaria burden suffered by homelands affects the perception of political gender roles. The focus on political perception follows the availability of data in the Afrobarometer round 3 regarding gender roles.

3.1. Data

The data on people's perception comes from Afrobarometer Survey 3 (AFB3), this dataset was used by Nunn and Wantchekon (2011) and has linked the name of the individuals' ethnic group to the homeland location in the Murdock's map. Thus, it is possible for each individual to determine the ancestral malaria burden suffered by its cultural group. There are 13 African countries: Benin, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Nigeria, Senegal, Tanzania, Uganda, Zambia, Zimbabwe. All surveys were conducted in 2005.

Initially, AFB3 has 25,397, observations. For only 13 countries is possible to assign the match between individual's ethnic group and Murdock's map (18,180 obs.). This data was used by Nunn and Wantchekon (2011), therefore using their matches of the individual ethnic group to Murdock's Map and improving the matching process[10], it is possible to have 16,970 observations with an associated Murdock's Map tribe name. Table 18 shows some summary statistics.

3.2. Movers

At the heart of the inference analysis are the characteristics of movers' people. The long-term impact of ancestral malaria may have promoted different institutions, policies, and market complementarities in the local environment. However, by the other side, it is also possible that the cultural beliefs or customs associated internally to the individual differs as a function of the ancestral malaria burden of their ancestors. The last statement is what is relevant to the culture. The movers' people let to separate what is environmental from what is inherent to the individual. In the current work, an individual is a mover if it resides in a different homeland of their ancestors. The aim is to separate the effect of the environment on people's cultural beliefs. That is, observing how people who come from places with a particular cultural trait (i.e., malaria burden) react in a different environment. Some characterizations need to be exposed before to show the main results of persistence.

Table 19 shows the variance decomposition of the local or ancestral treatment of malaria, when the variable refers to local treatment, the panel variable are the ethnic groups. For example, the Within Standard Deviation (WSD) of the local ancestral malaria burden refers to people with the same ethnic group, while the WSD of the ancestral malaria burden refers to people that live in the same homeland. There are 161 ethnic groups within 226 homelands. The most within variation comes from *Plasmodium suitability*, the little variation within the same homeland or ethnic group will attenuate the net effect of malaria burden. Figure 4-Panel A shows the distribution of Movers/Non-movers by quintiles of the ancestral malaria burden. On average, there are 1.776 movers by quintile. Another important issue is to validate that movers people are far from their ancestral homeland because it let to confirm that they live in an environment with

[10]There are 911 observations with Country-Language information (that belong to african ethnic group) for which Nunn and Wantchekon (2011) do not assign Murdock's group. Therefore, calculating the frequency of individuals by Country-Language-Murdock's Name and then, imputing the most frequently of them to the Country-Language observations, the matching process is improved.

different characteristics. Figure 4-Panel B shows the distance of the current movers' location to their ancestral homeland's centroid. On average, they reside 185 km away from their ancestral homeland. This distance is not negligible, as long as it can involve routes of between 4-5 hours, but it lets to understand the similarity between the variation within the homeland and the ethnic group.

3.2.1. Movers' Migration

The analysis of the cultural print left by ancestral malaria burden on people relies on the availability of movers in the sample. Separating the effect that the cultural environment may have on people's behavior let to assess the persistence of cultural traits. The problem with this migration of people is that the decision to leave the homeland is potentially endogenous, so this may be a problem with the inference strategy, whether the historical treatment of malaria may be a determinant of this decision.

A first step to assess the possibility of migration bias is looking at the characteristics of mover's people. Table 6 makes a balance on characteristics. The first row shows that on average, movers are slightly younger than non-movers; the former have, on average, 35 years old, while the latter have 36 years old; this difference is significant at 5%. Regarding gender, movers and no movers are not different. There is a balance in the proportion of males-females in the two groups. The third row shows that the 68% of non-mover people live in rural areas, while only 62% of movers locate in these zones. The difference is statistically significant at 1%, so in order to compare people in the same area, this indicator belongs to the battery of simple controls included in all estimations. Another important characteristic is the head of the house; it is the individual with the higher responsibility within the home and potentially who takes the main decisions in the household. Movers and Non-movers are not different in this characteristic; the average head of the house is about 34% for both groups and not statistically different. The next row considers whether the head of the house is a male, under the hypothesis that more patrilineal inheritance rules allow males to have more bargaining power over females, it is important to assess that there is no unbalanced in this characteristic. As expected by the las results, the differences are not statistically significant. The last row considers education, on average non-movers, have between some primary schooling and primary schooling completed, but movers' people have, on average, at least completed their primary schooling. This difference arises from the fact that there are more movers with a high education level degree. Figure 4-Panel C shows the share of movers by education level. Note that a 63% have university completed. However, the share of movers people in the other education level, albeit majority, is not highly unbalanced.

A second step is to assess directly whether the historical treatment of malaria is a determinant of the migration decision. Table 7 considers the four treatment analyzed, in order to compare people in the same homeland or within the same ethnic group, all regressions consider homeland or ethnic fixed effects depending on the treatment reference. Regressions have cluster standard error at the ethnic level. The first two rows uses the characteristics of the ancestral homeland; the

Table 6: Balance characteristics for movers

	Non-Movers	Movers	P-Value	Obs. Non-Movers	Obs. Movers
Age	36.0019	35.4853	0.0171	7966	8756
Male	0.4955	0.5044	0.2437	8089	8881
Rural Area	0.6788	0.6244	0.0000	8089	8881
Head of House	0.5025	0.5028	0.9642	8048	8830
Male - Head of House	0.3429	0.3470	0.5798	8048	8830
Education	2.8453	3.0710	0.0000	8046	8861

Notes. P-value reported for two-sided t-test.

former uses the ancestral malaria burden, which is not statistically significant; the latter use the *Plasmodium suitability* of the homeland, the relationship found states that people whose ancestors have lower constraints to malaria migrate less, on average they are 0.08 p.p. less probable of being a mover. The point estimate is weakly significant at 10%; whether this coefficient was a potential concern, the movers' ethnic diversity inside the homeland will be lower, but this is not the case as long as the probability of selecting two mover people with different ethnic group is about 47% (See Figure 2). The third and fourth column considers the local characteristic; an expected result is that people select places with a lower prevalence of malaria or with more constraints to *Plasmodium suitability*. To that end, the regressions compare only movers' people with the same ethnic group. The point estimates show a positive relationship against the preliminary idea, but the estimates are not statistically significant.

Table 7: Determinants of migration.

	Dep. Variable: Mover's indicator			
	(1)	(2)	(3)	(4)
Ancestral Malaria Burden	0.0160			
	(0.0528)			
Plasmodium Suitability$_e$		−0.0827*		
		(0.0459)		
Local Malaria Burden			0.0974	
			(0.0685)	
Plasmodium Suitability$_h$				0.0957
				(0.0650)
Obs.	16,707	16,707	16,702	16,702
Adj. R2	0.4846	0.4897	0.2808	0.2831
Ethnic Cluster	161	161	147	147
Simple Controls	Y	Y	Y	Y
Homeland FE	Y	Y	N	N
Ethnic FE	N	N	Y	Y

Notes. Treatment variables have mean zero and one standard deviation. Controls: age, age squared, rural indicator, male indicator. Clustered standard error at ethnic level. ***$p < .01$, **$p < .05$, *$p < 0.1$.

3.3. Cultural traits promoted by malaria in the past

Up to this point, there is causal evidence that homelands with higher intensity of malaria undermine the women's rights regarding inheritance rules, while the complementarities between polygamy and agriculture let to an active labor role of women. In the following section, the persistence of the cultural print left by malaria is the central focus of analysis. Not less detail is deciding at which geographical zone the individuals are going to be compared. At best, the more likely it is to find two people with a different ethnicity, the more cultural variation the analysis will have. A fractionalization index or ethnic diversity index says the probability that when selecting two people, they belong to different ethnic groups, Figure 2 shows the values of this index and the fraction of Homelands (Panel A) and Town/City (Panel B) that are in a particular bin. On average, there is 47% probability of selecting two people from different ethnic groups within a homeland, while this probability is about 31% at the Town/city level. Therefore, the relevant variation comes from the homeland.

The empirical strategy relies on treatment-variation of the following specification:

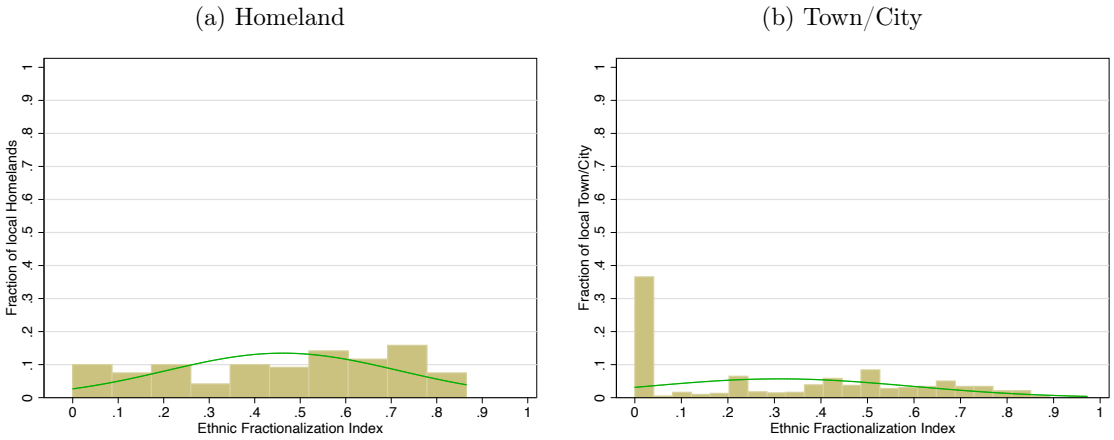
$$y_{i,e,h,c} = \text{Cultural Trait}_e + \Lambda \mathbf{X}_i + \alpha_c \left(\alpha_h\right) \left(\alpha_{hc}\right) + \varepsilon_{i,e,d,h,c}$$

the subscript y is the outcome of individual i, who belongs to the ethnic group e, residing in the homeland h and the country c. The α_c are fixed effects at the country level, so the source of variation is the people located in the same country. The α_h are homeland fixed effect, which absorbs the variation of local environment, letting to assess the persistence of the particular cultural trait. Finally, there are 15 homelands located in more than two countries. These homelands have a more diverse legal and institutional environment, so when the fixed effect is at country and homeland $\alpha_{h,c}$, the relevant variation comes from that place. The regression includes a set of simple controls $\mathbf{X}_i$ as: age, age squared, rural indicator and gender indicator. Following Abadie et al. (2017), given that the treatment variable is at ethnic level, the error are clustered at this level.

Afrobarometer survey 3 asks a relevant question regarding gender political roles. The relevant question states: *Which of the following statements is closest to your view? Choose Statement 1 or Statement 2, Statement 1: Men make better political leaders than women, and should be elected rather than women, Statement 2: Women should have the same chance of being elected to political office as men.* Answers coding is one whether an individual agrees very strongly or Agree with Statement 1, and 0 whether it agrees very strongly or agree with Statement 2.[11] Table 20 shows the estimations using the cultural traits for which the ancestral malaria burden has some impact at homeland level. The first three columns compare people in the same country; the results show that patrilineal's people are on average, 0.04 p.p. agree with males as better political leaders. Column (2) uses the subsample of males, but surprisingly, there is no effect, while column (3) shows that the source of the agreement with statement 1 comes from females; patrilineal's women are on average

[11]The neutral category has only 214 observations, so they are noisily in the estimation. In order to facilitate the interpretation these observations are missing values in the current dataset.

Figure 2: Fractionalization index



Notes. The X-axis shows the fractionalization index or ethnic diversity within a particular unit. The Y-axis shows the fraction of unit areas that are in a particular bin of the index. Panel A considers as unit area all homelands where people resides in AFB3. Panel B considers all Town/City declared in the AFB3.

0.05 p.p. agree with males as better political leaders. The point estimates are both significant at 5%. The results may be reflecting some differences across the country, so the next three columns (i.e., 4,5,6) explores mover's variation using local homeland fixed effects. The net effect is that within the same homeland, movers who are patrilineal are, on average, 0.02 p.p. agree with males as better political leaders, but this estimand is not statistically significant. The column (6) shows that the magnitude of the coefficient comes from female's answers, but neither subsample have significant estimands. The final three columns (i.e., 7, 8, 9) explore a special variation that comes from homelands who locates in more than one country.[12] These places are special because there is more institutional or legal diversity inside them. Thus, it is more probable that the perception of men's political participation has a strong variance. The last three estimates do not differ from the columns 4-6, showing that results persist even in more legal- diversity zones; however, the results should be taken with caution because the database does not have many homelands in more than one country.

The local headman succession is the next cultural trait considered. The country variation (Columns 1-3) shows that people from homelands with patrilineal succession of local headman offices are less agree with males as better political leaders. Columns 2 and 3 show that the result comes from both genders with similar magnitude. The point estimates, except by the male sample, which is significant at 10%, are significant at 5%. The variation within the homeland shows that the results are not robust; the estimate in the main sample reduces to half of the last considered and is weakly significant. Indeed, splitting the sample into males and females do not

[12]In the current data, 15 homelands locates in more than one country. When countries border lines where delimited, homelands' borders were not considered. Therefore this variation is useful in contexts where the effect of political organization in the tribes affects the contemporary development. See Michalopoulos and Papaioannou (2014) as a reference.

let to confirm the result. The same conclusion arises from the particular homelands locate in more than one country. The other inheritance rules for which malaria creates a gender inequality, such as patrilineal succession of land, movable goods succession, and the other cultural practices as polygamy and the FLFP in agriculture, follow in the next rows. These results show two main facts: 1) there is no effect of inheritance rules on the contemporary perception of gender political roles; 2) the estimates are about zero, which may be a consequence of little variation at the ethnic group level. The number of ethnic groups considered is less than a quarter of the total available in the analysis of the historical impact of malaria carried out in the previous sections; therefore, extrapolating the results to all ethnic groups of Sub-Saharan Africa may lack broad external validity. Finally, the above evidence is mainly suggestive as long as people's cultural traits may be potentially endogenous.

3.4. Ancestral Malaria Burden

The subsequent analyses go to the effect of ancestral malaria on the perception of gender political roles. Table 8 refers to the historical treatment of malaria that an individual's ancestors received in their homeland. The countries' variation shows a negative relationship, the same obtained in the local headman succession, between the ancestral malaria burden and males as better political leaders. That is, increasing one standard deviation, the historical treatment of malaria in the people's ancestral homeland reduces the advantage of men as better political leaders in 0.028 p.p. approximately, this is significant at 1%. The main source of this effect comes from males who consider that females have the same chance of being elected in political office as men. In the male sample, the point estimate reflects that increasing one standard deviation of the children's probability of dying by malaria or sickle cell disease reduces the male's favorability in 0.033 p.p.; this result is significant at 1%. By the female's side, the impact is similar, albeit with a lower magnitude. On average, the treatment of ancestral malaria reduces the perception of the male's advantage in 0.025 p.p., a significant result at 5% level. The little variation within the homeland difficults to capture lower effects at homeland level. Columns 4-6 show that the point estimate is roughly zero, even though the estimates' standard deviation is low. The same conclusion arises from the homelands who have more legal diversity (i.e., Columns 7-9).

The *Plasmodium suitability* offers more variation within the homeland. The reduced form between the exogenous instrument of malaria and the contemporary perception of gender political participation is important as long as human activities do not manipulate the parasite's temperature constraints. Therefore, it is a plausible exogenous regression. Table 9 shows that at the country level, the *Plasmodium suitability* of the ancestral homelands have little effect on the perception of males as better political leaders. The point estimates are not significant, but the vast heterogeneity across the country may net out the intention to treat estimates. People who come from highly temperature-constrained homelands outweigh the effect of the people who come from low temperature-constrained homelands. The regressions with homeland fixed give evidence in

Table 8: Ancestral Malaria Burden and Men Political Participation (OLS)

	Dep. Variable: Perception of Men Political Participation								
	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ancestral Malaria Burden	−0.0284***	−0.0331***	−0.0247**	−0.0074	−0.0060	−0.0086	−0.0066	−0.0051	−0.0081
	(0.0092)	(0.0105)	(0.0105)	(0.0081)	(0.0116)	(0.0100)	(0.0082)	(0.0118)	(0.0101)
Obs.	16,441	8,286	8,155	16,427	8,279	8,145	16,427	8,279	8,145
Adj. R2	0.0671	0.0759	0.0453	0.0999	0.1092	0.0865	0.1001	0.1091	0.0863
Ethnic Cluster	161	153	152	161	153	152	161	153	152
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N	N	N	N	N
Homeland FE	N	N	N	Y	Y	Y	N	N	N
Country FE Homeland FE	N	N	N	N	N	N	Y	Y	Y

Notes. Ancestral Malaria Burden has mean zero and one standard deviation. Clustered standard error at ethnic level. Controls: age, age squared, rural indicator, male indicator (out of columns 2-3, 5-6 and 8-9). Only males restricts the sample to male. Only females restricts the sample to females. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$.

favor of a lower male's advantage as political leaders. Increasing one standard deviation, the *Plasmodium suitability* of the individual's ancestral homeland, reduces the male's advantage in 0.015 p.p. approximately, with a significance level of 5%. The primary source of this result is the males' sample. On average, males in the same homeland agree that women may have the same chance of being elected as political leaders in 0.023 p.p., a significant result at 5%. One potential explanation for the result is that since women are responsible for childcare, they offer a vital complementarity in children's health. They are the first to detect if the child is sick, so males associate with them a better capacity to make decisions. The results remain even for the more diverse homelands in the sample, but with a significance level of 10%. Therefore, *Plasmodium suitability* of the ancestral homeland is a strong predictor of the men's political advantage today.

Table 9: *Plasmodium suitability* and Men Political Participation (OLS)

	Dep. Variable: Perception of Men Political Participation								
	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
P. Suitability	−0.0199	−0.0158	−0.0241	−0.0153**	−0.0225**	−0.0060	−0.0140*	−0.0222*	−0.0040
	(0.0134)	(0.0130)	(0.0156)	(0.0071)	(0.0100)	(0.0083)	(0.0080)	(0.0114)	(0.0092)
Obs.	16,441	8,286	8,155	16,427	8,279	8,145	16,427	8,279	8,145
Adj. R2	0.0664	0.0746	0.0455	0.1001	0.1097	0.0864	0.1002	0.1095	0.0862
Ethnic Cluster	161	153	152	161	153	152	161	153	152
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N	N	N	N	N
Homeland FE	N	N	N	Y	Y	Y	N	N	N
Country FE Homeland FE	N	N	N	N	N	N	Y	Y	Y

Notes. Plasmodium suitability has mean zero and one standard deviation. Clustered standard error at ethnic level. Controls: age, age squared, rural indicator, male indicator (out of columns 2-3, 5-6 and 8-9). Only males restricts the sample to male. Only females restricts the sample to females. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$.

3.5. Local Malaria Burden

The cultural print left by malaria may be a consequence of a similar environment where movers live. Whether the real action of the malaria burden comes from the local environment, the hypothesis, associated with the cultural print left by malaria, may fail. The next analysis consider

the following especification,

$$y_{i,e,h,c} = \text{Local Malaria Burden}_h + \Lambda \mathbf{X}_i + \alpha_c \left(\alpha_e\right) \left(\alpha_{e,c}\right) + \varepsilon_{i,e,h,c}$$

all subscripts have the same definition as before, but the treatment is at the local homeland where the individual i resides. So, to explore the behavior of people with the same cultural characteristics, the fixed effects are at the ethnic level, α_e. Some ethnic groups have movers' people in more than one country, and these people have a higher variance in their local environment. When the fixed effects are ethnic and country-level, $\alpha_{e,c}$, the variation comes from those groups.

Table 10 shows the results for the local ancestral malaria burden, that is, the impact of malaria in the homeland where people reside. The first columns show the same negative relationship founded in Table 8, but the effect is less significant and only comes from the males' sample. Increasing one standard deviation of the ancestral malaria burden of the local homeland, decreases males' advantage as better political leaders in 0.024 p.p., at 5% of significance. The result for males is also significant at 5% with a lower value of -0.032 p.p. There is no effect on females' sample, this reinforces the idea that the cultural print left by malaria makes that men associate to women a better capacity to make decisions, diminishing their own advantage as better political leaders. The next three columns add ethnic fixed effects, so only movers' people from the same ethnic group are being compared. The effect is about zero. The final three columns compare movers' people that belong to the same ethnic group, but reside in different countries. They are ethnic groups whose movers have a more diverse legal-environment since they locate in different countries. The effect is about zero; there is little variation of local malaria burden for that movers.

Table 10: Local Malaria Burden and Men Political Participation - (OLS)

	Dep. Variable: Perception of Men Political Participation								
	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Local Malaria Burden	−0.0241**	−0.0322**	−0.0174	0.0100	0.0087	0.0100	0.0048	−0.0013	0.0101
	(0.0108)	(0.0127)	(0.0131)	(0.0132)	(0.0175)	(0.0169)	(0.0136)	(0.0165)	(0.0175)
Obs.	16,436	8,283	8,153	16,422	8,272	8,141	16,422	8,272	8,141
Adj. R2	0.0665	0.0757	0.0445	0.0880	0.0934	0.0729	0.0890	0.0971	0.0724
Ethnic Cluster	161	153	152	147	142	140	147	142	140
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N	N	N	N	N
Ethnic FE	N	N	N	Y	Y	Y	N	N	N
Country FE Ethnic FE	N	N	N	N	N	N	Y	Y	Y

Notes. Local Malaria Burden has mean zero and one standard deviation. Clustered standard error at ethnic level. Controls: age, age squared, rural indicator, male indicator (out of columns 2-3, 5-6 and 8-9). Only males restricts the sample to male. Only females restricts the sample to females. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$.

Table 11 considers the local *Plasmodium suitability*. Even though the constraints to malaria have a higher variation within the ethnic group, the point estimates are not significant in any column. The local effect of the environment is about zero within countries (i.e., columns 1-3) within movers from the same ethnic group (i.e., columns 4-6) and within ethnic groups located in more than one country (i.e., columns 7-9). These results give evidence in favor of the cultural print left by malaria. The local *Plasmodium suitability* is not a strong predictor of the men's political

advantage today.

Table 11: Local *Plasmodium suitability* and Men Political Participation - (OLS)

	Dep. Variable: Perception of Men Political Participation								
	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Local P. Suitability	−0.0196	−0.0152	−0.0242	0.0007	0.0065	−0.0043	−0.0002	0.0080	−0.0072
	(0.0136)	(0.0129)	(0.0160)	(0.0076)	(0.0102)	(0.0108)	(0.0085)	(0.0112)	(0.0113)
Obs.	16,436	8,283	8,153	16,422	8,272	8,141	16,422	8,272	8,141
Adj. R2	0.0665	0.0748	0.0456	0.0879	0.0934	0.0729	0.0890	0.0972	0.0724
Ethnic Cluster	161	153	152	147	142	140	147	142	140
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N	N	N	N	N
Ethnic FE	N	N	N	Y	Y	Y	N	N	N
Country FE Ethnic FE	N	N	N	N	N	N	Y	Y	Y

Notes. Local *Plasmodium suitability* has mean zero and one standard deviation. Clustered standard error at ethnic level. Controls: age, age squared, rural indicator, male indicator (out of columns 2-3, 5-6 and 8-9). Only males restricts the sample to male. Only females restricts the sample to females. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$.

3.6. Heterogeneities

A final step is to use the movers' residence location to explore whether those locating in homelands with a different intensity of ancestral malaria burden or a different *Plasmodium suitability* behaves in a different manner regard to all population in the same homeland. In that sense, the following analysis classifies as High those homelands whose ancestral malaria burden (or *Plasmodium suitability* index) is in quintiles 4 or 5, and Low those homelands who are in the quintiles 1 or 2. Therefore, the treatment variable High in Low (Low in High) refers to movers' people who come from a high (low) prevalence of ancestral malaria burden and reside in a homeland with low (high) prevalence of ancestral malaria burden.

Table 12 shows the results. Columns 1-4 refer to the ancestral malaria burden as the treatment variable, while columns 5-8 refer to *Plasmodium suitability* as the treatment variable. All regressions have homelands fixed effects, so the coefficients are the effect on movers' people, and the standard errors are clustered at the ethnic level as before. When treatment variables are High in Low, Low in High, and High in High, there is no effect. However, movers' people who come from Low homelands and live in homelands with the same ancestral malaria characteristic have a different behavior than the rest of the population. On average, mover's people with the Low in Low treatment of ancestral malaria consider that males are better political leaders than women in 0.05 p.p.; this result is significant at 5%. The same conclusion arises from the *Plasmodium suitability* treatment, but the point estimate is lower because this variable is exogenous to the human activity, so women's complementarities does not affect it. On average, movers' people whose homelands have low constraints on *Plasmodium suitability* are 0.026 p.p. agree with males as better political leaders, a significant result at 5%. In the intensive margin, those movers who did not perceive the women's complementarities in childcare, because the ancestral treatment in their homelands were low, will not be able to have a positive judgment regarding women's capacities as political leaders. The political perception of women as leaders is lower as a potential

consequence of fewer complementarities in childcare against malaria. The evidence is not causal, but the *Plasmodium suitability* and the ancestral treatment of malaria are strong predictors of women's political perception.

Table 12: Heterogeneities of Movers

Treatment:	Dep. Variable: Perception of Men Political Participation							
	Ancestral Malaria Burden				*Plasmodium suitability*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High in Low	−0.0155				−0.0109			
	(0.0221)				(0.0170)			
Low in High		−0.0162				−0.0011		
		(0.0227)				(0.0277)		
High in High			−0.0038				0.0029	
			(0.0138)				(0.0199)	
Low in Low				0.0498**				0.0256*
				(0.0196)				(0.0146)
Obs.	16,427	16,427	16,427	16,427	16,427	16,427	16,427	16,427
Adj. R2	0.0999	0.0999	0.0999	0.1003	0.0999	0.0999	0.0999	0.1000
Ethnic Cluster	161	161	161	161	161	161	161	161
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y
Homeland FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes. High in Low (Low in High) is an indicator that refers to mover's people from High (Low) malaria burden homelands that resides in Low (High) malaria burden homelands. High in High (Low in Low) is an indicator that refers to people from High (Low) malaria burden homelands that resides in High (Low) malaria burden homelands. Clustered standard error at ethnic level. Controls: age, age squared, rural indicator, male indicator. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$.

4. Conclusions

Malaria is an epidemic with a high social burden, but little is know about that. The above work starts with the stylized fact that the most malaria risk people are children under five years old and pregnant women, to show causal evidence that there is a malaria cultural print. The last analysis shows that for the Sub-Saharan Africa, ethnic groups with a higher prevalence of malaria have more patrilineal characteristics in what concerns to local headman succession, land inheritance rules, and inheritance rules of movable succession. The epidemic exerts a force on the survival of individuals that allowed the development of polygamy and, along with it, a higher female labor participation in agriculture.

The persistence of the cultural print left by malaria confirms that the suitability for the *Plasmodium parasite* is a strong predictor of the perception of gender political roles. On average, people who come from homelands with a higher prevalence of malaria believe that women should have the same chance of being elected by the political office. The main explanation of that result is that people whose ancestors perceived the women's complementarities in the disease treatment believe more in the women's capacities than people whose ancestors do not perceived that complementarities.

However, it is necessary more efforts to provide causal evidence of the persistence. The main limitation in the persistence analysis was the little within the variation of the ancestral malaria

burden treatment, a problem that will be overcome in the next analysis with more contemporary surveys that have information on gender roles in the Sub-Saharan Africa.

> *After all, a true culture is popular: borns and grows from the periphery to the center and from the bottom up.*
>
> Gabriel García Marquez, July 6 of 1994

A. Appendix: Ancestral impact of malaria

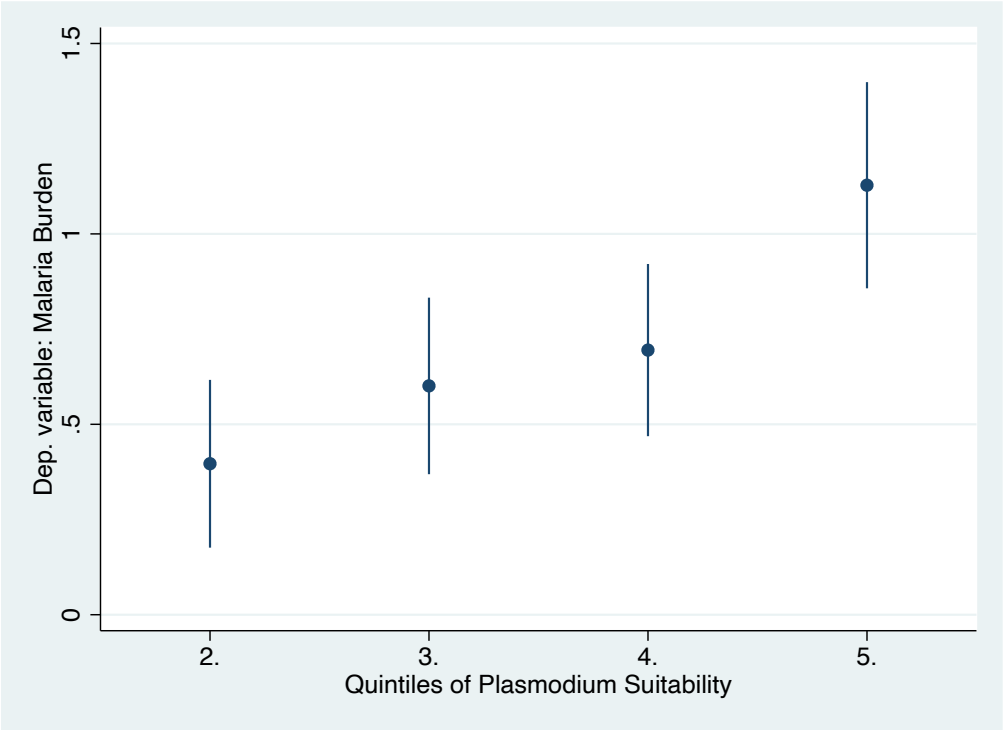
Table 13: Summary statistics

						Quintiles of Malaria Burden				
Variable	Obs	Mean	SD	Min.	Max.	1	2	3	4	5
Patrilineality	513.0000	0.7135	0.4526	0.0000	1.0000	0.8173	0.7327	0.6731	0.6863	0.6569
Local Headman Succesion	366.0000	0.5055	0.5007	0.0000	1.0000	0.5333	0.5000	0.5333	0.4085	0.5455
Land Succession	400.0000	0.6925	0.4620	0.0000	1.0000	0.6667	0.6410	0.7470	0.6786	0.7273
Movable Succession	423.0000	0.6643	0.4728	0.0000	1.0000	0.7215	0.6310	0.6250	0.6778	0.6707
Marital Residence	515.0000	0.8505	0.3569	0.0000	1.0000	0.9223	0.8932	0.8431	0.7941	0.8000
Bride Price	523.0000	0.8337	0.3727	0.0000	1.0000	0.8350	0.8667	0.8476	0.8381	0.7810
Polygamy	511.0000	0.7965	0.4030	0.0000	1.0000	0.5700	0.7647	0.8350	0.9029	0.9029
Cousin Marriage	381.0000	0.2415	0.4285	0.0000	1.0000	0.2877	0.2917	0.2073	0.2368	0.1923
Sex Behavior	191.0000	0.4974	0.5013	0.0000	1.0000	0.2889	0.4857	0.6765	0.5000	0.5946
FLFP Agriculture	307.0000	0.5472	0.2327	0.0000	1.0000	0.5000	0.5129	0.5507	0.5859	0.5882
FLFP Pottery	198.0000	0.9116	0.2661	0.0000	1.0000	0.9634	0.8514	0.8850	0.9459	0.9167
FLFP House	122.0000	0.2316	0.3249	0.0000	1.0000	0.2955	0.3929	0.1855	0.2188	0.0476
FLFP Gathering	104.0000	0.8077	0.3001	0.0000	1.0000	0.9565	0.7024	0.8600	0.7885	0.7045
FLFP Hunting	288.0000	0.0017	0.0208	0.0000	0.2500	0.0000	0.0000	0.0037	0.0042	0.0000
FLFP Fishing	173.0000	0.2659	0.3122	0.0000	1.0000	0.0667	0.2941	0.2391	0.2733	0.3500
FLFP Husbandry	211.0000	0.1931	0.2334	0.0000	1.0000	0.2090	0.1888	0.1534	0.1667	0.2708
Mean Land	525.0000	0.4611	0.2527	0.0000	0.9900	0.5069	0.4569	0.4466	0.4580	0.4373
Mean Terrain Elevation	525.0000	675.0782	496.8074	-30.6700	2,361.1600	977.5439	671.6380	620.1382	602.9256	503.1454
Ecological diversity	524.0000	0.2814	0.2288	0.0000	0.7400	0.4344	0.2825	0.2614	0.2129	0.2171
Log. total water available	525.0000	2.1456	3.3816	0.0000	11.1800	2.5950	2.4030	2.3336	2.1611	1.2351
Log. Distance to coast	525.0000	5.9584	1.1901	0.4000	7.3700	5.6092	6.0360	6.3335	6.0471	5.7664
Temp. Mean (1901-2012)	525.0000	24.2588	3.2717	14.3600	29.5800	20.7753	24.7812	25.5053	25.0534	25.1787
Temp. Std (1901-2012)	525.0000	0.7942	0.7148	0.0100	4.1500	1.4887	0.8135	0.5458	0.6130	0.5098
Malaria Burden	525.0000	0.0564	0.0413	0.0000	0.1500	0.0022	0.0255	0.0551	0.0845	0.1144
Plasmodium Suitability	525.0000	0.5303	0.1743	0.0900	0.8100	0.3707	0.4954	0.5337	0.5921	0.6597
Plough	487.0000	0.0780	0.2685	0.0000	1.0000	0.3333	0.0417	0.0097	0.0000	0.0000

Variance decomposition

Variable	Obs	ONU Regions	Obs. Within	SD Within	SD Between	SD Overall
Malaria Burden	525	5	105	0.0300		0.0413
P. Suitability	525	5	105	0.1439		0.1743

Figure 3: Monotonicity of Plasmodium Suitability



Notes. Standardised beta coefficients. Controls definitions follows from the last column of Table 1. Robust standard errors. All coefficients are interpreted regarding to the first quintile.

Table 14: Malaria Burden and pre-industrial women's status - Conley Standard Errors (IV Estimates)

Dep. Variable:	Patrilineality	Local Headman Succession	Land Succession	Movable Succession	Marital Residence	Bride Price	Polygamy	FLFP Agriculture
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Reduced Form Results								
Plasmodium Suitability	0.0103	0.1315***	0.0729**	0.1468***	−0.0160	−0.0127	0.1136***	0.1351***
	(0.0528)	(0.0353)	(0.0354)	(0.0250)	(0.0361)	(0.0359)	(0.0379)	(0.0188)
Obs.	512	365	399	422	514	522	510	306
R2	0.0461	0.0634	0.1880	0.1652	0.0148	0.0129	0.1073	0.2130
Panel B: Second Stage Results								
Malaria Burden	0.0271	0.3239**	0.1839*	0.3666**	−0.0413	−0.0333	0.3009*	0.3664***
	(0.1453)	(0.1583)	(0.0962)	(0.1468)	(0.0868)	(0.0875)	(0.1713)	(0.1235)
Obs.	512	365	399	422	514	522	510	306
R2	0.0317	-0.2875	0.0753	-0.2710	0.0460	0.0123	-0.1680	-0.8667

Notes. Plasmodium Suitability and Malaria Burden have mean zero and one standard deviation. All specifications have the full set of controls from column 5 of Table 1. Conley et al. (1999) standard errors at cutoff of 1110km. $^{*}p < .10$,$^{**}p < .05$,$^{***}p < .01$.

Table 15: Malaria Burden, Cousin marriage, Pre-marital behavior and Female Labor Force Participation (OLS)

Dep. Variable:	Cousin Marriage	Free Sex behavior	FLFP Pottery	FLFP House	FLFP Gathering	FLFP Hunting	FLFP Fishing	FLFP Husbandry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Malaria Burden	0.0473	0.0243	−0.0105	−0.0933***	−0.0000	−0.0011	0.0068	−0.0131
	(0.0305)	(0.0517)	(0.0307)	(0.0323)	(0.0413)	(0.0009)	(0.0313)	(0.0281)
Obs.	380	191	198	122	104	287	172	211
Adj. R2	0.1336	0.1138	0.0748	0.2540	0.0982	-0.0043	0.1213	0.0191

Notes. Malaria Burden has mean zero and one standard deviation. Free sex behavior is an indicator variable that takes the value of one whether the premarital sexual norms are freely permitted or allowed (censured only if pregnancy) within the ethnic group. All specifications have the full set of control from column 5 Table 1. Robust Standard errors. $^{*}p < .10,^{**}p < .05,^{***}p < .01$.

Table 16: Malaria Burden, Cousin marriage, Pre-marital behavior and Female Labor Force Participation (IV Estimates)

Dep. Variable:	Cousin Marriage	Free Sex behavior	FLFP Pottery	FLFP House	FLFP Gathering	FLFP Hunting	FLFP Fishing	FLFP Husbandry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Reduced Form Results								
Plasmodium Suitability	−0.0696**	0.0713	−0.0476*	−0.1399***	−0.1572***	0.0023	0.0748**	−0.0220
	(0.0340)	(0.0555)	(0.0278)	(0.0401)	(0.0467)	(0.0017)	(0.0321)	(0.0279)
Obs.	380	191	198	122	104	287	172	211
Adj. R2	0.1371	0.1210	0.0868	0.2866	0.2093	-0.0010	0.1470	0.0213
Panel B: Second Stage Results								
Malaria Burden	−0.1480**	0.3052	−0.1612	−0.3068***	−0.4661**	0.0065	0.2075**	−0.0533
	(0.0739)	(0.2720)	(0.1013)	(0.1016)	(0.2120)	(0.0048)	(0.1016)	(0.0679)
Obs.	380	191	198	122	104	287	172	211
Adj. R2	-0.0100	-0.0875	-0.1071	-0.0041	-1.2109	-0.0990	-0.2539	-0.0208
F-statistic (First Stage)	74.909	9.365	18.748	30.763	9.966	36.224	23.838	46.136
P-value Underidentification	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.000

Notes. Plasmodium Suitability and Malaria Burden have mean zero and one standard deviation. Free sex behavior is an indicator variable that takes the value of one whether the premarital sexual norms are freely permitted or allowed (censured only if pregnancy) within the ethnic group. All specifications have the full set of controls from column 5 of Table 1. Robust standard errors. $^{*}p < .10,^{**}p < .05,^{***}p < .01$.

Table 17: Malaria Burden, Cousin marriage, Pre-marital behavior and Female Labor Force Participation - Conley Standard Errors (IV Estimates)

Dep. Variable:	Cousin Marriage	Free Sex behavior	FLFP Pottery	FLFP House	FLFP Gathering	FLFP Hunting	FLFP Fishing	FLFP Husbandry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Reduced Form Results								
Plasmodium Suitability	−0.0696	0.0713	−0.0476***	−0.1399***	−0.1572***	0.0023**	0.0748***	−0.0220
	(0.0479)	(0.0522)	(0.0103)	(0.0394)	(0.0213)	(0.0010)	(0.0285)	(0.0287)
Obs.	380	191	198	122	104	287	172	
R2	0.1335	0.1326	0.1200	0.3257	0.2614	0.0180	0.1129	
Panel B: Second Stage Results								
Malaria Burden	−0.1480	0.3052	−0.1612**	−0.3068*	−0.4661*	0.0065**	0.2075*	−0.0533
	(0.1056)	(0.3325)	(0.0723)	(0.1575)	(0.2359)	(0.0032)	(0.1111)	(0.0817)
Obs.	380	191	198	122	104	287	172	211
R2	0.0245	-0.0135	-0.0345	0.1029	-0.9345	-0.0492	-0.1591	0.0421

Notes. Plasmodium Suitability and Malaria Burden have mean zero and one standard deviation. Free sex behavior is an indicator variable that takes the value of one whether the premarital sexual norms are freely permitted or allowed (censured only if pregnancy) within the ethnic group. All specifications have the full set of controls from column 5 of Table 1. Conley et al. (1999) standard errors at cutoff of 1110km. $^{*}p < .10,^{**}p < .05,^{***}p < .01$.

B. Appendix: Persistence analysis

Table 18: Summary statistics Afrobarometer Round 3

						Quintiles of Ancestral Malaria Burden				
	Obs	Mean	SD	Min	Max	1	2	3	4	5
Patrilineality	16917	0.549	0.498	0.000	1.000	0.454	0.374	0.657	0.549	0.715
Local Headman Succession	13375	0.543	0.498	0.000	1.000	0.525	0.494	0.548	0.423	0.709
Land Succession	15568	0.661	0.473	0.000	1.000	0.663	0.380	0.726	0.565	0.981
Movable Succession	15662	0.615	0.487	0.000	1.000	0.739	0.367	0.617	0.600	0.744
Patrilocality	16903	0.771	0.420	0.000	1.000	0.781	0.662	0.791	0.662	0.969
Bride Price	16970	0.749	0.434	0.000	1.000	0.802	0.420	0.802	0.783	0.944
Polygamy	16878	0.925	0.263	0.000	1.000	0.905	0.853	0.907	0.970	0.992
Free sex behavior	10444	0.432	0.495	0.000	1.000	0.697	0.691	0.349	0.533	0.098
Cousin marriage	16155	0.330	0.470	0.000	1.000	0.247	0.409	0.371	0.526	0.053
FLFP Agriculture	13936	0.563	0.215	0.000	1.000	0.669	0.573	0.512	0.520	0.550
FLFP Pottery	10310	0.890	0.309	0.000	1.000	1.000	0.806	0.754	0.868	1.000
FLFP House	7419	0.111	0.193	0.000	0.750	0.147	0.045	0.101	0.382	0.007
FLFP Gathering	5507	0.858	0.188	0.000	1.000	0.940	0.817	0.763	0.823	0.942
FLFP Hunting	11246	0.000	0.002	0.000	0.250	0.000	0.000	0.000	0.000	0.000
FLFP Fishing	9084	0.171	0.229	0.000	1.000	0.154	0.360	0.068	0.205	0.042
FLFP Husbandry	11167	0.190	0.284	0.000	1.000	0.068	0.110	0.141	0.167	0.525
Men Political Participation	16682	0.238	0.426	0.000	1.000	0.237	0.201	0.234	0.216	0.306

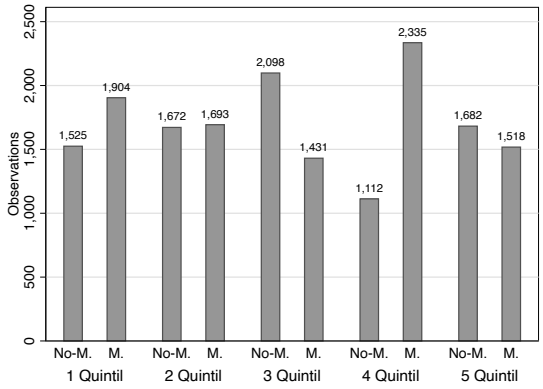
Table 19: Standard deviation decomposition for treatment variables

Variable	Obs	Homelands/Ethnic	Obs. Within	SD Within	SD Between	SD Overall
Ancestral Malaria Burden	16970	226	75	0.0139	0.0318	0.0340
Local Ancestral Malaria Burden	16964	161	105	0.0133	0.0305	0.0338
Plasmodium suitability of Ancestral Homeland	16970	226	75	0.0748	0.1503	0.1730
Local *Plasmodium suitability*	16964	161	105	0.0794	0.1568	0.1707

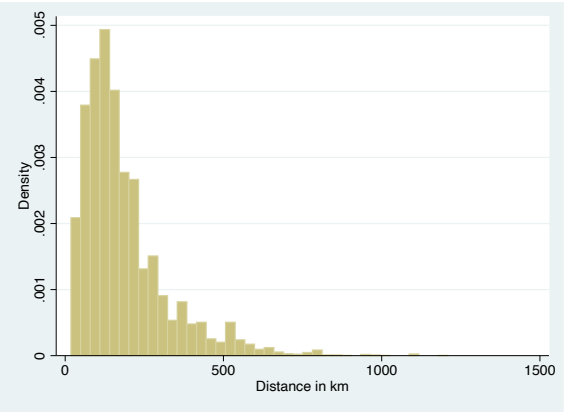
Notes. The panel variable for local treatments (i.e., local ancestral maria burden, local *Plasmodium suitability*) is the ethnic group identifier. The panel variable for ancestral treatment (i.e., ancestral malaria burden, *Plasmodium suitability* of Ancestral Homeland) is the local homeland where the individual lives.

Figure 4: Some characteristics of movers

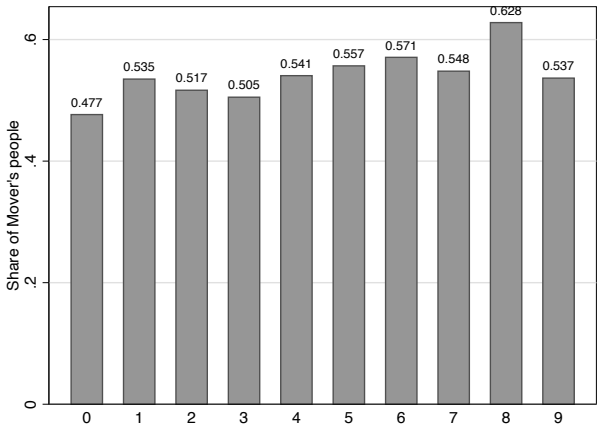
(a) Distribution by Ancestral Malaria Burden



(b) Distance to their ancestral homeland's centroid



(c) Share of movers' people by education level



Notes. Panel A shows the distribution of observations over mover definition and quintiles of ancestral malaria burden. No-M: No Movers; M: Movers. Panel B shows the density of the distance in km of each mover's location to the centroid of its ancestral homeland. Panel C refers to movers' distribution by education level, X-axis refers to the education level: (0) No formal schooling; (1) Informal Schooling; (2) Some primary schooling; (3) Primary school completed; (4) Some secondary school/High school; (5) Secondary school completed/High school; (6)Post-secondary qualifications, other than university (e.g., technical, polytechnic, college); (7) Some university; (8) University completed; (9) Post-graduate.

Table 20: Persistence of Cultural Traits

	Dep. Variable: Perception of Men Political Participation								
	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females	Main Sample	Only Males	Only Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Patrilineality	0.0427**	0.0299	0.0527**	0.0164	0.0055	0.0207	0.0164	0.0052	0.0208
	(0.0199)	(0.0217)	(0.0208)	(0.0120)	(0.0172)	(0.0136)	(0.0120)	(0.0175)	(0.0135)
Obs.	16,388	8,224	8,083	16,374	8,217	8,073	16,388	8,224	8,083
Adj. R2	0.0666	0.0744	0.0470	0.0999	0.1090	0.0868	0.0666	0.0744	0.0470
Ethnic Cluster	159	151	150	159	151	150	159	151	150
Local Headman Succession	−0.0545**	−0.0487*	−0.0575**	−0.0246*	−0.0291	−0.0150	−0.0253*	−0.0296	−0.0161
	(0.0250)	(0.0267)	(0.0259)	(0.0133)	(0.0205)	(0.0148)	(0.0133)	(0.0207)	(0.0149)
Obs.	12,989	6,507	6,430	12,974	6,498	6,417	12,989	6,507	6,430
Adj. R2	0.0681	0.0754	0.0473	0.1030	0.1122	0.0896	0.0681	0.0754	0.0473
Ethnic Cluster	124	116	117	124	116	117	124	116	117
Land Succession	−0.0123	0.0093	−0.0359	−0.0022	0.0060	−0.0148	−0.0043	0.0039	−0.0174
	(0.0249)	(0.0255)	(0.0297)	(0.0156)	(0.0200)	(0.0173)	(0.0157)	(0.0207)	(0.0176)
Obs.	15,091	7,557	7,461	15,077	7,549	7,449	15,091	7,557	7,461
Adj. R2	0.0639	0.0721	0.0451	0.1001	0.1087	0.0893	0.0639	0.0721	0.0451
Ethnic Cluster	136	128	129	136	128	129	136	128	129
Movable Succession	−0.0510	−0.0405	−0.0626*	−0.0120	−0.0236	0.0001	−0.0128	−0.0245	−0.0015
	(0.0312)	(0.0288)	(0.0358)	(0.0137)	(0.0186)	(0.0160)	(0.0136)	(0.0188)	(0.0162)
Obs.	15,183	7,597	7,511	15,173	7,591	7,500	15,183	7,597	7,511
Adj. R2	0.0640	0.0720	0.0459	0.0987	0.1082	0.0873	0.0640	0.0720	0.0459
Ethnic Cluster	141	133	133	140	132	133	141	133	133
Polygamy	−0.0086	−0.0102	−0.0042	−0.0070	−0.0114	−0.0021	−0.0067	−0.0115	−0.0018
	(0.0271)	(0.0352)	(0.0253)	(0.0200)	(0.0194)	(0.0257)	(0.0199)	(0.0193)	(0.0259)
Obs.	16,356	8,211	8,068	16,342	8,204	8,058	16,356	8,211	8,068
Adj. R2	0.0654	0.0736	0.0446	0.0999	0.1085	0.0872	0.0654	0.0736	0.0446
Ethnic Cluster	159	151	150	159	151	150	159	151	150
FLFP agriculture	−0.0305	−0.0052	−0.0623	−0.0410	−0.0391	−0.0290	−0.0426	−0.0398	−0.0293
	(0.0594)	(0.0673)	(0.0567)	(0.0262)	(0.0374)	(0.0436)	(0.0261)	(0.0374)	(0.0436)
Obs.	13,537	6,761	6,737	13,522	6,749	6,723	13,537	6,761	6,737
Adj. R2	0.0515	0.0517	0.0373	0.0786	0.0864	0.0634	0.0515	0.0517	0.0373
Ethnic Cluster	120	115	112	120	115	112	120	115	112
Simple Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N	N	N	N	N
Homeland FE	N	N	N	Y	Y	Y	N	N	N
Country FE Homeland FE	N	N	N	N	N	N	Y	Y	Y

Notes. Clustered standard error at ethnic leve. Controls: age, age squared, rural indicator, male indicator (out of columns 2-3, 5-6 and 8-9). Only males restricts the sample to male. Only females restricts the sample to females. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < 0.1$

References

(2018). Global burden of disease collaborative network. global burden of disease study 2017 (gbd 2017). 2

Abadie, A., Athey, S., Imbens, G. W., and Wooldridge, J. (2017). When should you adjust standard errors for clustering? Technical report, National Bureau of Economic Research. 22

Alesina, A., Brioschi, B., and La Ferrara, E. (2019). Violence against women: A cross-cultural analysis for africa. *Economica*, n/a(n/a). 10

Alesina, A., Giuliano, P., and Nunn, N. (2013). On the origins of gender roles: Women and the plough. *The Quarterly Journal of Economics*, 128(2):469. 5, 15, 17

Angrist, J. D. and Pischke, J.-S. (2009). *Mostly harmless econometrics : an empiricist's companion*. Princeton : Princeton University Press, Princeton. 7

Boserup, E. (1970). The role of women in economic development. *New York: St. Martin's*. 15, 17

Boucekkine, R., Desbordes, R., and Latzer, H. (2009). How do epidemics induce behavioral changes? *Journal of Economic Growth*, 14(3):233–264. 2, 4, 17

Boyd, R. and Richerson, P. J. (2005). *The origin and evolution of cultures*. Oxford University Press. 2, 5

Cervellati, M., Chiovelli, G., and Esposito, E. (2019). Bite and divide: Malaria and ethnolinguistic diversity. 2

Depetris-Chauvin, E. and Weil, D. N. (2018). Malaria and early african development: Evidence from the sickle cell trait. *Economic journal (London, England)*, 128(610):1207. 3, 6, 8, 9, 17

Fenske, J. (2013). Does land abundance explain african institutions? *The Economic Journal*, 123(573):1363–1390. 6, 11

Fenske, J. (2014). Ecology, trade and states in pre-colonial africa. *Journal of the European Economic Association*, 12(3):612. 8, 9

Fernández, R. and Fogli, A. (2009). Culture: An empirical investigation of beliefs, work, and fertility. *American Economic Journal. Macroeconomics*, 1(1):146–177. 5

Fernández, R., Parsa, S., and Viarengo, M. (2019). Coming out in america: Aids, politics, and cultural change. Technical report, National Bureau of Economic Research. 2

Gething, P., Van Boeckel, T., Smith, D., Guerra, C., Patil, A., Snow, R., and Hay, S. (2011). Modelling the global constraints of temperature on transmission of plasmodium falciparum and p. vivax. *Parasites & Vectors*, 4(1):92. 3, 12, 13

Giuliano, P. (2017). Gender: An Historical Perspective. *NBER Working Paper Series*, page 23635. 2, 7, 10, 17

Giuliano, P. and Nunn, N. (2018). Ancestral characteristics of modern populations. *Economic History of Developing Regions*, 33(1):1–17. 10

Giuliano, P. and Nunn, N. (Working Paper). Understanding cultural persistence and change. 11

Global Malaria Programme, W. G. (2019). *World Malaria Report 2019*. World Health Organization. 2, 3

Goody, J. and Goody, J. R. (1976). *Production and reproduction: a comparative study of the domestic domain*. Number 17. Cambridge University Press. 17

Gorodnichenko, Y. and Roland, G. (2017). Culture, institutions, and the wealth of nations. *The Review of Economics and Statistics*, 99(3):402. 5

Guiso, L., Sapienza, P., and Zingales, L. (2009). Cultural biases in economic exchange? *The Quarterly Journal of Economics*, page 1095. 5

Janko, M. M., Irish, S. R., Reich, B. J., Peterson, M., Doctor, S. M., Mwandagalirwa, M. K., Likwela, J. L., Tshefu, A. K., Meshnick, S. R., and Emch, M. E. (2018). The links between agriculture, Anopheles mosquitoes, and malaria risk in children younger than 5 years in the Democratic Republic of the Congo: a population-based, cross-sectional, spatial study. *The Lancet. Planetary health*, 2(2):e74–e82. 8

Jedwab, R., Johnson, N. D., and Koyama, M. (2019). Negative shocks and mass persecutions: evidence from the black death. *Journal of Economic Growth*, 24(4):345–395. 2, 4

Jones, C. O. and Williams, H. A. (2004). The social burden of malaria: What are we measuring? *American Journal of Tropical Medicine and Hygiene*, 71(2 SUPPL.):156–161. 3

Kiszewski, A., Mellinger, A., Spielman, A., Malaney, P., Sachs, S. E., and Sachs, J. (2004). A global index representing the stability of malaria transmission. *Am J Trop Med Hyg*, 70(5):486–498. 3, 12

Lado, C. (1992). Female labour participation in agricultural production and the implications for nutrition and health in rural Africa. *Social Science and Medicine*, 34(7):789–807. 4

Livingstone, F. B. (1958). Anthropological Implications of Sickle Cell Gene Distribution in West Africa. *American Anthropologist*, 60(3):533–562. 8

Lowes, S. (2018). Matrilineal kinship and spousal cooperation: Evidence from the matrilineal belt. *Working paper*. Media: World Bank Blog Post. 7, 9, 12

McCann, J. (2011). *Deposing the malevolent spirit: a historical cultural ecology of malaria in northwest Ethiopia*. Program for the Study of the African Environment, African Studies Center. 12

Michalopoulos, S. and Papaioannou, E. (2014). National institutions and subnational development in africa. *The Quarterly journal of economics*, 129(1):151–213. 23

Murdock, G. P. (1959). *Africa: Its Peoples and Their Culture History*. McGraw-Hill. 6

Murdock, G. P. (1967). *Ethnographic Atlas*. University of Pittsburgh Press, Pittsburgh, PA. 6

National Center for Atmospheric Research Staff (Eds) (2014). The Climate Data Guide: CRU TS Gridded precipitation and other meteorological variables since 1901. 9

Nunn, N. and Wantchekon, L. (2011). The slave trade and the origins of mistrust in africa. *American Economic Review*, 101(7):3221–3252. 4, 19

Oster, E. (2004). Witchcraft, weather and economic growth in renaissance europe. *Journal of Economic Perspectives*, 18(1):215–228. 4

Ramankutty, N., Foley, J. A., Norman, J., and Mcsweeney, K. (2002). The global distribution of cultivable lands: Current patterns and sensitivity to possible climate change. *Global Ecology and Biogeography*, 11(5):377–392. 8, 9

Rogers, A. R. (1988). Does biology constrain culture? *American Anthropologist*, 90(4):819–831. 5

Snowden, F. M. (2019). *Epidemics and Society: From the black death to the present*. Yale University Press. 2

Tishoff, S., Varkonyi, R., and Cahinhinan, N. (2001). Haplotype diversity and linkage disequilibrium at human G6PD: Recent origin of alleles that confer malarial resistance. *Science*, 293(5529):455–462. 8

Voigtländer, N. and Voth, H.-J. (2012). Persecution perpetuated: the medieval origins of anti-semitic violence in nazi germany. *The Quarterly Journal of Economics*, 127(3):1339–1392. 2

Volkman, S. K., Barry, A. E., Lyons, E. J., Nielsen, K. M., Susan, T. M., Choi, M., Thakore, S. S., Day, K. P., Wirth, D. F., and Hartl, D. L. (2001). Recent Origin of Plasmodium falciparum from a Single Progenitor. *Science*, 293(5529):482–484. 8

White, F. (1983). The vegetation of africa: A descriptive memoir to accompany the unesco/aetfat/unso vegetation map of africa. *Natur Resource Research*, 20:1–356. 8

Wiesenfeld, S. L. (1967). Sickle-Cell Trait in Human Biological and Cultural Evolution. *Science*, 157(3793):1134–1140. 8