Does land abundance explain African institutions?

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November 2012

DOES LAND ABUNDANCE EXPLAIN AFRICAN INSTITUTIONS?

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ABSTRACT. The land abundance view of African history uses sparse population to explain pre-colonial land tenure and slavery. I document the geographic forcing variables that predict land rights, slavery, and population density in a cross section of global societies. I discuss whether these correlations support theories of land rights and slavery, including the land abundance view. I show that pre-colonial institutions predict institutional outcomes in Africa in the present, including land transactions, polygamy, and public goods. Pre-colonial institutions have effects above those of geography. The colonial reversal of fortune did not erase their influence.

1. INTRODUCTION

In contrast to Europe and Asia, Africa was less densely populated at the beginning of the twentieth century (Herbst, 2000, p. 16). By then, slavery was widespread in Africa (Lovejoy, 2000). Land tenure on much of the continent was, and still is, characterized by group rights and overlapping claims (Bruce et al., 1994). The "land abundance" view of African history connects these facts (Austin, 2008a; Hopkins, 1973; Iliffe, 1995). From this perspective, since land was not scarce, it had no price, and rights over it were ill-defined. Because independent farmers could not be persuaded to become hired workers, coerced and household labor substituted for wage employment.

In this paper, I use cross-sectional data on a sample of global societies to uncover the geographic forcing variables that have jointly determined historical land rights, slavery, and population density. I then use modern survey data to show that these past institutions predict institutional outcomes in Africa today. Though these exercises are ultimately descriptive, they are carried out with three purposes in mind. First, I add to our knowledge of the relationship between geography and institutions. Second, I use

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Date: November 27, 2012.
I would like to thank my advisors Timothy Guinnane, Benjamin Polak, and Christopher Udry for their guidance. I would also like to thank Tayo Adesina, Achyuta Adhvaryu, Gareth Austin, Reena Badiani, Benjamin Chabot, Adrian de la Garza, Rahul Deb, Shatakshee Dhongde, Oded Galor, Nils-Petter Lagerlöf, Naomi Lamoreaux, Giuseppe Moscarini, Nathan Nunn, Sheilagh Ogilvie, Florian Ploeckl, Mark Rosenzweig, Mir Salim, Veronica Santarosa, Ed Vytlacil, Warren Whatley, Ademola Yakubu, and the participants of the Economic History Association Annual Meeting, the Canadian Network for Economic History, the NEUDC, the LSE African Economic History Seminar, and seminars at the University of Warwick, Princeton University, Washington University in St. Louis, Northwestern University, the University of Rochester, the University of Toronto, Boston University and the University of Oxford for their comments and advice. Extra thanks are due to Christian Dippel and Nathan Nunn for their generous sharing of maps.

these results to evaluate whether existing theories of institutions, including the land abundance view, fit the facts. Third, I use the persistent influence of these institutions to draw conclusions about the relative importance of geography and institutions, and about the colonial "reversal of fortune."

I take data on institutions from the cross-section of global societies included in Murdock's (1967) *Ethnographic Atlas*. Combining maps of these societies with multiple sources of spatial data, I examine whether geographic features can predict the patterns of land rights, slavery, and population density in this sample. I test for persistent effects of these institutions within Africa. First, I use the Ghana Living Standards Study (GLSS) to investigate whether historical patterns of land rights predict differences in how plots of land are acquired in the present. Second, I use the *Demographic and Health Surveys* (DHS) to test for persistence in the prevalence of polygamy and for adverse effects of past slavery on the provision of public goods today.

Both land rights and slavery are correlated with the geographic features of the ethnic groups that practice them. Notably, the groups in my sample are more likely to possess rights over land if land quality is better. Within Africa, there is a positive correlation between land quality and slavery, but this does not hold in the full global sample. Many of the correlates of institutions and population become insignificant when fixed effects are included for ethnographic regions that approximate continents, and the determinants of institutions within Africa differ from those in the full sample.

Influential theories of land rights emphasize population pressure and the market value of output as key determinants of property institutions. The results here suggest that rights existed historically where land was most scarce and more valuable, though there is only mixed evidence that access to trade was a determining factor. The most widely accepted theories of slavery in the literature focus on labor scarcity, workers' outside options, and the productivity of slavery in specific tasks. My results suggest that slavery evolves with time alongside population. The results here do not offer unqualified support for any particular theory of slavery. In particular, the fragility of the main results when explaining intra-regional differences suggests that the causes of slavery may differ across regions, may depend on unobserved characteristics of these regions, or that intra-regional institutional spill-overs weaken the link between institutions and local geographic endowments.

In the present, I compare Ghanaian ethnic groups in which a child could inherit a parent's land with groups in which land could pass out of the nuclear family through inheritance. Where the nuclear family was strong in the past relative to the wider lineage, land is more likely to be acquired through commercial transactions today. I show that women whose ethnic groups regularly practiced polygamy before colonial rule are more likely to be in polygamous marriages today. Children born in African ethnic groups where slavery existed in the past receive fewer vaccinations today. Pre-colonial African institutions, then, continue to exert a persistent influence over and above the effects of the geographic features that have shaped them. Whatever "reversal of fortune" may have occurred as a result of colonial rule, pre-colonial institutions that matter in the present were not entirely swept away by the process of colonization and decolonization.

I contribute to our understanding of historical institutions and to the role of geography in shaping them. Land tenure and slavery matter in the present. Rights over land shape investment incentives (Goldstein and Udry, 2008), labor-supply (Field, 2007), and violence (Andre and Platteau, 1998). Nunn (2008a) shows that those African countries that exported the most slaves are comparatively poor today. These effects are not limited to Africa. Within the Americas, legacies of slavery explain differences in income across countries and U.S. counties (Engerman and Sokoloff, 1997; Nunn, 2008b), as well as long term racial gaps in education and income (Miller, 2011; Sacerdote, 2005).

Other historical "ethnic" institutions also matter today. Pre-colonial states predict economic activity (Michalopoulos and Papaioannou, 2012), provision of public goods (Gennaioli and Rainer, 2007), and governance (Acemoglu et al., 2002a). The existence of polygamy reduces the incentives to invest in capital (Tertilt, 2005). Local institutions such as land rights and polygamy have been resilient to national policies (Bubb, 2009; Fenske, 2012a). As little is known about the origins of institutions that have not been established by Europeans, I add to our knowledge of the evolution of institutions.

Bio-geographic features such as continental orientation (Diamond, 1997), domesticable species (Olsson and Hibbs, 2005), population (Acemoglu et al., 2002b), settler mortality (Acemoglu et al., 2001), ruggedness (Nunn and Puga, 2012) and crop suitability (Engerman and Sokoloff, 1997) predict contemporary institutional differences across countries (Easterly and Levine, 2003). Though the existing literature has focused largely on the effect of geography on institutions created by Europeans, there are exceptions. Michalopoulos et al. (2010) and Michalopoulos (2011) link heterogeneity in land quality to both ethnic fragmentation and the spread of Islam. I continue this line of research by testing what geographic features of societies predict land rights, slavery, and population density.

In Section 2, I describe my sources of data and the econometric specifications that I use. In Section 3, I report my results and discuss their robustness. Detailed robustness checks are confined to the web appendix. In Section 4, I discuss the theories of land rights and slavery that are consistent with these results, including the "land abundance" view. In Section 5, I show that pre-colonial institutions in Africa have persistent effects on institutions in the present. In Section 6, I conclude.

2. Specifications and data

2.1. **Specifications.** My base sample is a cross section of 1,205 pre-industrial societies from around the world. I investigate the geographic determinants of land rights, slavery, and historic population density by estimating:

$$y_{ij} = x'_{ij}\beta + \delta_j + \epsilon_{ij}, \tag{1}$$

where y_{ij} is an outcome of interest for society i in ethnographic region j. In practice, this will be an indicator for the presence of land rights, an indicator for the presence of slavery, or the natural log of historic population density. x_{ij} is a vector of geographical controls that describe the society's historic territory. These controls will include land quality, date of observation, average annual precipitation, temperature, absolute latitude, the share of area in which malaria is prevalent, distance from the coast, elevation, presence of a major river, ruggedness, the share of area that is desert, the coefficient of variation of rainfall over time, and a constant. δ_j is a fixed effect for the major ethnographic regions: Africa (the omitted category), the circum-Mediterranean, East Eurasia (which includes the Indian subcontinent), the Insular Pacific, North America, and South America. ϵ_i is random error.

Where the outcome y_{ij} is binary, I estimate (1) using a logit. Where y_{ij} is continuous, I use ordinary least squares (OLS). I correct standard errors for spatial dependence using the method outlined by Conley (1999).[1] I allow spatial dependence up to a distance of ten decimal degrees. For each outcome of interest, I estimate (1) on the full sample with and without the fixed effects δ_j. I also estimate (1) on a "sub-Saharan Africa" sample that includes Ethiopia and the Horn and the Moslem Sudan, regions that my data source codes as Circum-Mediterranean. In the remainder of this section, I discuss my sources of data. Details of all variables and their sources are in the web appendix.

2.2. **Data on institutions.** Data on institutions are taken from Murdock's (1967) *Ethnographic Atlas*. This is a database of 1,267 societies from around the world. It contains categorical variables describing several institutional and cultural features of these societies, usually at the time of first description by Europeans. From this sample, I remove 2 duplicate observations (the Chilcotin and Tokelau), 8 societies observed before 1500 (Ancient Egypt, Aryans, Babylonia, Romans, Icelander, Uzbeg, Khmer, Hebrews), and 52 for which land quality information is missing (mostly small Pacific islands). This leaves a base sample of 1,205 societies. 801 of these have data on land rights, 1,040 on slavery.

I construct binary variables for whether land rights or slavery exist. Summary statistics are given in Table 1. For each society, I observe land rights and slavery at the same point in time. I map slavery in Figure 1.

Why use this data? The principal justification is availability. This is the only source of cross-cultural information on land rights and slavery that has global scope. The only other alternative, the *Standard Cross-Cultural Sample* of Murdock and White (1969), is a derivative of the *Ethnographic Atlas*. In addition, the variables were compiled by the same author, and so are internally consistent. The benefit of looking at pre-colonial societies is that they allow me to correlate institutions with the geographic characteristics

[1] In particular, I use the commands xgmlt and x_ols that are posted on his website.

of the societies that adopted them. Colonial institutions, by contrast, will depend both on the characteristics of colonizing and colonized societies. The use of a global sample, rather than an African sample, introduces additional institutional variation and makes it possible to test whether the geographic correlates of institutions in Africa are the same as those in the rest of the world.

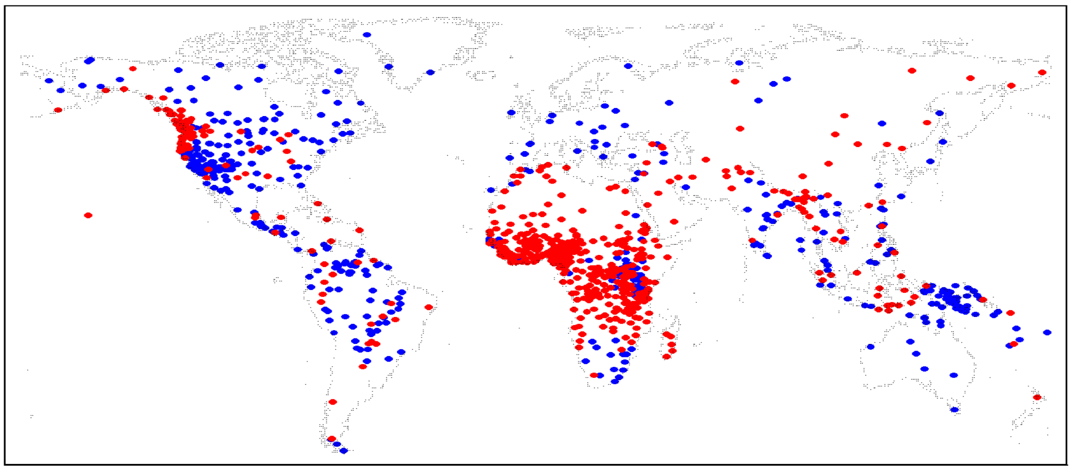
The greatest concern with these data is that they may be anachronistic. They are intended to cover societies at an idealized, timeless and synchronic moment of first European description. In practice, however, many of the observations are constructed from the works of colonial anthropologists. It is clear from Figure 1, however, that most of the observations are intended to be uncontaminated by colonial rule. While colonial governments generally abolished slavery sooner or later, what is coded in the data is what anthropologists recorded as a society's "historical" institutions; there is still much slavery in Africa according to the *Ethnographic Atlas*. In so far as the date at which a society is observed is a proxy for colonial effects and the severity of measurement error, I control for it in the econometric analysis. The Atlantic slave trade, by contrast, does pre-date the observations of the African societies in these data. I discuss this possible contamination in Section 3.2.

The use of Murdock's (1967) data is not unique to this paper. Baker and Jacobsen (2007b) use descriptive statistics from the *Ethnographic Atlas* to motivate a model of the gender division of labor. Gennaioli and Rainer (2007) have aggregated its data on state centralization to the country level using ethnic population numbers from the *Atlas Narodov Mira* (1964) in order to show that African countries with stronger pre-colonial states provide more public goods today. Bezemer et al. (2009) have performed a similar exercise, showing that the historical prevalence of slavery across African societies predicts lower incomes in the present.

Work also exists that attempts to explain variables recorded in ethnographic sources. Whatley and Gillezeau (2011) show that coastal regions in Africa hit hardest by the slave trade are more ethnically fragmented in the present, using a map of ethnic groups from Murdock (1959). Whatley (2012) shows that these same regions have more absolutist political structures, as recorded in the *Ethnographic Atlas*. Murdock and White (1969) created the *Standard Cross-Cultural Sample* as a spin-off from the *Ethnographic Atlas*, containing a larger number of variables for a smaller sample of societies. Matthew Baker has used this and other ethnographic sources to validate models of the transition to agriculture (Baker, 2008), hunter-gatherer territoriality (Baker, 2003), land inheritance rules (Baker and Miceli, 2005), and post-marital residence patterns (Baker and Jacobsen, 2007a).

More recent treatments have combined the *Ethnographic Atlas* with spatial data on geographic characteristics. Michalopoulos and Papaioannou (2012), for example, show that economic activity measured using nighttime lights is greater in parts of Africa with more centralized states before colonial rule. Excluding other work of my own (Fenske, 2012b), the only other paper of which I am aware that has used geographic data to predict outcomes recorded in the *Ethnographic Atlas* is Alesina et al. (2011). They use the suitability of an ethnic group's territory for plough-intensive crops to predict the historic gender division of labor in agriculture, which in turn explains female labor force participation rates today.

FIGURE 1. Slavery



Red circles indicate presence of slavery. Blue circles indicate absence.

2.3. **Population density.** In order to construct population density estimates for these societies, I first match these societies to ethnic maps. Next, I join these maps to raster data on historical population density. I begin with five ethnic maps. First, I join African societies to ethnic groups mapped by Murdock (1959). Second, I merge First Nations groups in the United States and Canada with maps from the *Handbook of North American Indians* (Heizer and Sturtevant, 1978).[2] Third, I join ethnic groups from the rest of the world to Global Mapping International's (GMI) detailed World Language Mapping System. Fourth, if no match can be found in the GMI map, I use the less detailed Geo-Referencing Ethnic Groups (GREG) map of Weidmann et al. (2010). Finally, if no match can be found in any of these, I match groups to modern administrative boundaries. For example, the Nunivak are matched to Nunivak Island.

I use the historical maps first in order to reduce migration-induced errors. The Murdock (1959) and Heizer and Sturtevant (1978) maps show ethnic groups prior to European contact. I am not aware of similar historical maps for Asia or Latin America, necessitating use of the more modern GMI and GREG maps. Of 1,267 societies, 76 are matched to a larger group of which they form a smaller part (such as the Efik to the Ibibio). 100 groups that cannot be found in any map, instead of being matched to a modern administrative boundary, are matched to polygons representing ethnic groups

[2]These were digitized for the United States by Dippel (2010) and for Canada by myself.

in the same location. For example, the Kara of Ukerewe Island do not appear in any of the ethnic maps. Because the Kerewe people occupy roughly the same territory as the Kara, the Kara are assigned the geographic characteristics of the polygon labeled "Kerewe" in the Murdock (1959) map. A full table of matches and a map of the assembled polygons are given in the web appendix.[3]

All historical population reconstructions are guesses. One book on pre-Columbian America is entitled "Numbers from Nowhere" (Henige, 1998). The principal measure I use for historical population density is from the History Database of the Global Environment (HYDE) version 3.1. This raster data on historical population covers the years 1500, 1600, and every ten years since 1700. For each ethnic group, I measure historical population density as the average of the raster points within its territory for the year of observation recorded in the *Ethnographic Atlas*.[4]

Details of these estimates are reported by Bouwman et al. (2006), Klein Goldewijk et al. (2010) and Klein Goldewijk (2005). This data source takes as its base a map of 3441 administrative units from 222 countries. Historical data are then reconstructed on this base map using Lahmeyer (2004), Helders (2000), Tobler (1995), several local studies, interpolation, and back projection. The data are reported on a five minute grid.

I plot historical population density for my base sample of ethnic groups in Figure 2. I present the percentiles of the HYDE data and the two principal alternatives, described below, in Table 1. These range from nearly zero persons per square mile for several groups in the Mato Grosso and interior Amazon, to over 3,000 persons per square mile for the Okinawans of Japan.[5]

Because historical population reconstruction is unavoidably inexact, it is important to show that the results can be obtained using alternatives to the HYDE estimates.

The alternative sources of historical population data are not in raster format, and are often recorded at a lower resolution than the observations in the *Ethnographic Atlas*. For example, one number may be given for an entire country. I adopt a simple method to estimate spatially disaggregated historic population densities for the societies in my data using these alternative sources. I begin with raster data on population density in

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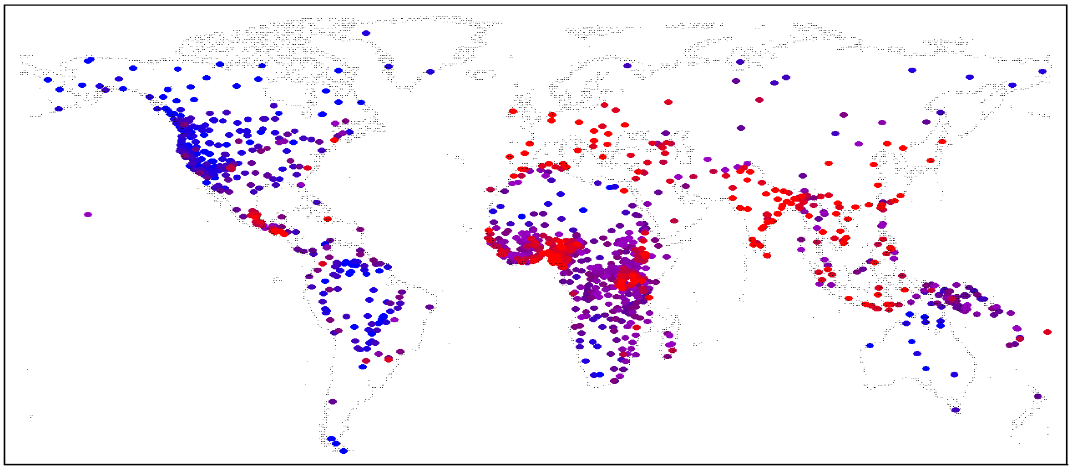
[3]The *Ethnographic Atlas* gives co-ordinates for each society. All but 46 of these societies are within 500 km of the centroid of the polygon to which they are joined. Of these discrepancies, 22 are due to obvious errors in the *Ethnographic Atlas*. For example, the *Ethnographic Atlas* gives the Koreans a coordinate that is in Tibet. 14 are groups that cover diffuse areas, making it difficult to assign them a meaningful coordinate. These include Russians and the Eastern Cree. 8 are given coordinates in the *Ethnographic Atlas* that differ from their locations in the other maps for no obvious reason. The remaining two are idiosyncratic. The GMI map divides the Botocudos into 3 polygons. Two of are in Minas Gerais, as expected, but one is in Rio Grande do Sul. Second, the polygon that represents the Diegueno in Heizer and Sturtevant (1978) is truncated at the US border.

[4]For computational reasons, I use data from each 50 year interval, imputing intermediate years exponentially.

[5]This is an over-estimate due to over-representation of Naha in the original data; administrate records give a modern density of just above 1,500 persons per square mile. Results are similar if I exclude the Okinawans (see the web appendix).

FIGURE 2. Historical population density



Red circles indicate denser population. Blue circles indicate sparser population.

1995 for each of these ethnic groups and combine it with historical estimates for the broader regions within which these groups are located. Specifically, my alternative estimates take the form:

$$\text{Historical population density} = \text{Population density in 1995} \times \frac{\text{Regional density at the date of observation}}{\text{Regional density in 1995}}. \tag{2}$$

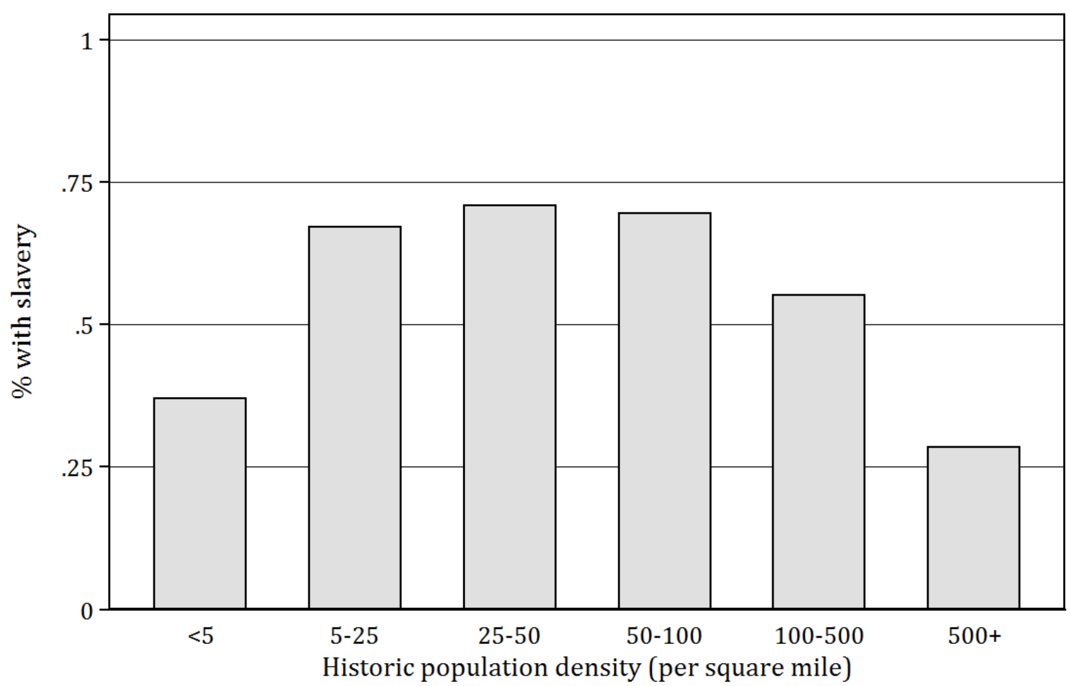
This assumes that the relative distribution of population has not changed within regions over time. If the Tamil were 1.37 times as dense as the entirety of the broad region "India" in 1995, this ratio is pushed back to 1880, the date at which they are observed. GIS data on population in 1995 is from the Food and Agriculture Organization's Global Agro-Ecological Zones project (FAO-GAEZ). I use two sources of regional estimates. The first is McEvedy and Jones (1978). There are well-known problems with these data (Austin, 2008b; Hopkins, 2009), and so I also use the ARVE Group's estimates (Krumhardt, 2010).

While only a first-order approximation, this approach is preferable to using the unweighted regional densities directly. McEvedy and Jones (1978), for example, assign a single population density to all of Canada. To treat the the Inuit and Ojibwe as equally dense would be implausible, and would introduce substantial measurement error.[6] In addition to these two main alternatives, I use the 1995 densities directly.

[6]Ruff (2006) suggests that the Northeast had a population density at contact roughly seven times that of the Arctic. The method used here assigns the Ojibwe a historic population density of 2.20 per square mile and the Copper Eskimo a population density of 0.31 per square mile – a roughly seven-fold difference.

These data reveal a positive correlation between land rights and historic population density, and an inverse-U relationship between slavery and historic population density (see Figure 3). As I discuss in Section 4, this is consistent with certain models that make arguments similar to the land abundance view. This is not, however, dispositive. Population density and institutions are both shaped by the same geographic forcing variables. As a result, I gather data on several other geographic characteristics of these societies, and test the extent to which historic population and institutions are predicted by features of the natural environment.

FIGURE 3. Slavery and historical population density



2.4. **Geographic data.** I join societies from the *Ethnographic Atlas* to several sources of geographic raster data. Sources and definitions for each variable are given in the web appendix. Each of the continuous variables are re-scaled as a standard normal variable for the regressions, so that marginal effects can be interpreted as the effect of a one standard-deviation change in the geographic variable.

The first control is land quality. To measure this, I re-scale Fischer et al.'s (2002) index of climate, soil and terrain slope constrains on rain-fed agriculture. Larger values of the re-scaled variable indicate better land. An advantage of this constraints-based measure is that it is not based on expected yields in contemporary agriculture. Crop diversity is greater today for many of the societies than at the time they are observed in the *Ethnographic Atlas*.[7] I also control for the presence of a major river, distance to the coast, elevation, the percentage of the society's territory in which malaria is endemic, precipitation, ruggedness, temperature, date of observation, absolute latitude, share desert, and the coefficient of variation of annual rainfall. This latter variable is intended as a measure of ecological risk.

2.5. **Modern outcomes.** I use two separate approaches to test whether African institutions have persistent influences in the present day. First, I use plot-level data from the fifth round of the Ghana Living Standards Survey (GLSS), conducted in 2005-2006. Using the ethnic groups reported in these data, I am able to merge plots with their users' historical institutions as recorded in the *Ethnographic Atlas*. I use OLS to estimate:

$$y_{ij} = \beta institution_j + x'_{ij}\gamma + \epsilon_{ij}. \tag{3}$$

Here, y_{ij} is an indicator for the manner in which plot i, currently used by a member ethnic group j, was acquired. I use indicators for whether the plot has purchased, rented, sharecropped, or acquired from family as outcomes. $institution_j$ is the presence or absence of an historical institution for the plot controller's ethnic group. β is the coefficient of interest. Because all ethnic groups merged to these plots possessed rights over land in the past, I use two alternative indicators of historic land rights for $institution_j$. First, I record whether land inheritance is patrilineal. Second, I record whether land was inherited by children. Here, I follow Goody (1969, p. 65), who argues that:

> [T]he scarcer productive resources become and the more intensively they are used, then the greater the tendency towards the retention of these resources within the basic productive and reproductive unit, which in the large majority of cases is the nuclear family.

If land is scarce, it is an important consideration in marriage. This puts emphasis on transmission of property from parents to children. Under patrilineal inheritance, land may pass from a man to his son or his brother. Under matrilineal inheritance, land necessarily passes out of the nuclear family to a man's brother or to his sister's son. I use an indicator for whether land is inherited by children as a more precise measure of the degree to which land is retained within the nuclear family.

Other controls in x_{ij} are plot area, plot area squared, the gender of the plot controller, the age and age squared of the plot controller, dummies for religion, dummies for region (roughly equivalent to a province), and ecological zone dummies. My final sample contains 8,669 plots of land. I cluster standard errors by ethnic group.

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[7] I do not adjust this measure to account for the spatial distribution of population, because this approach is very sensitive to measurement error. For example, it gives implausibly high estimates of land quality in the Arctic and Sahara.

Second, I compile data on 494,157 women from 34 sub-Saharan countries captured in the Demographic and Health Surveys. I have created this data set for a different project, and the details of these data are reported in Fenske (2012a). Using the ethnic groups reported in these data, I am able to merge these women with historical institutions from the *Ethnographic Atlas*. On this sample of women, I use OLS to estimate:

$$y_{ijc} = \beta institution_j + x'_{ijc}\gamma + \delta_c + \epsilon_{ijc}. \quad (4)$$

$institution_j$ is the presence or absence of an historical institution for the woman's ethnic group. β is the coefficient of interest. I use past polygamy and past slavery as measures of $institution_j$. The first tests directly for the persistence of polygamy as an institution. The second is motivated by the fact that most slaves retained within Africa were women, and that many served as the sometimes polygamous wives of their masters (Robertson and Klein, 1983). The vector of controls, x_{ijc} include absolute latitude, malaria prevalence, sutiability for rainfed agriculture, ruggedness, elevation, distance to the coast, dummies for ecological type, year of birth, year of birth squared, dummies for religion, urban, age, and age squared.[8] δ_c is a country-round fixed effect. I cluster standard errors at the level of the woman's ethnic group.

In addition, I use the DHS child recodes to collect information on the children born to these women in the five years preceding the survey. I now estimate (4) taking children as the unit of observation. The dependent variable y_{ijc} is now the number of vaccinations received. I take this as a proxy for the capacity of the state, and so follow the existing literature by measuring the ability of states to provide public goods (Berger, 2008; Gennaioli and Rainer, 2007). x_{ijc} contains the same controls as above, as well as the child characteristics birth date, birth order, an indicator for a multiple birth, and gender.

3. Results

In this section, I report my main results. I do not interpret these until later, in Section 4. In Section 3.1, I outline the principal geographic correlates of land rights, slavery, and historic population. In Section 3.2, I outline the robustness checks that are reported in the web appendix.

3.1. **Main results.**

3.1.1. *Land rights.* In Table 2, I report my main results concerning land rights. Land quality positively predicts land rights in both the full sample and the sub-Saharan Africa sub-sample. In the baseline, a one standard deviation increase in land quality increases the probability that land rights exist by 5 percentage points. This effect disappears, however, when fixed effects for the major ethnographic regions are included.

[8]Year of birth and age can both be included because these are repeated cross-sections. With country-round fixed effects, the linear term is dropped due to collinearity.

Precipitation has a negative and significant correlation with land rights in the baseline, but this is not significant within the sub-Saharan sample nor with major region fixed effects included. Temperature is only significantly negative within major regions. Societies that are observed later are more likely to possess land rights, though this too does not hold within regions or within sub-Saharan Africa. Malaria prevalence predicts land rights in all three specifications, though it is statistically weak within sub-Saharan Africa. Ruggedness positively predicts land rights in the baseline and within sub-Saharan Africa, though it is not statistically significant within major regions. Land rights become less common as one moves away from the equator. Distance from the coast does not predict land rights in the global sample, and predicts greater land rights within Africa. I find no effect of elevation, the coefficient of variation of rainfall, or access to a major river in any specification.

3.1.2. *Slavery.* In Table 2, I report my main results concerning slavery. There is a positive but insignificant relationship between land quality and slavery in the global sample. This is due to the high incidence of slavery in the Pacific Northwest; if a control is added for a society's dependence on fishing, the effect of land quality becomes positive and significant, though not with fixed effects (not reported). Within sub-Saharan Africa the correlation is larger and more significant. A one standard deviation increase in land quality predicts a 5 percentage point increase the probability of slavery within sub-Saharan Africa. I discuss this difference in more detail in Section 4.

The positive correlations of slavery with temperature and malarial prevalence are robust across specifications and samples. There is a negative correlation between date of observation and slavery that survives the inclusion of major region fixed effects. It is not significant within Africa. Similarly, slavery is more common in rugged areas and further from the equator, even with major-region fixed effects, though these correlations do not hold within Africa. The magnitude of the correlation between access to a major river and slavery is large across specifications (5-8 percentage points), though the standard error is also large and the estimate is not significant with fixed effects. I find no effect of precipitation, share desert, distance from the coast, elevation, or the coefficient of variation of rainfall in any specification.

3.1.3. *Population density.* In Table 2, I report my main results concerning population density. Here, coefficients can be interpreted directly as the impact of a one standard-deviation change in the right-hand-side variable. A one standard deviation increase in land quality is associated here with a large increase in population density; the effect is between 54 and 73% in the whole-world sample, and 15% in the sub-Saharan sample. Precipitation depresses population in the base sample and within Africa, though this is not significant if I include major-region fixed effects. Societies that are observed later are also more densely settled, though this correlation does not hold within major regions.

Societies further from the coast are more sparsely settled, though this is only statistically significant within major regions, and does not hold within Africa. Across specifications, there is a negative correlation between population density and elevation. In the baseline, population is most dense where malaria is most prevalent, though this is not true within major regions and is of marginal significance within Africa. Rugged societies are more densely settled, though this too is not significant within major regions. Societies closer to the equator are more thickly populated. Population density is negatively correlated with the coefficient of variation of rainfall and positively associated with access to a major river, though these correlations only hold within broad regions, and not within Afirca. There is no significant link between historical population density and temperature.

3.1.4. *Slavery and crop suitability.* In Table 3, I extend the main results concerning slavery. I include the suitability of the ethnic group's territory for rain-fed cultivation of the crop types reported by the FAO-GAEZ. These are: cereals, roots/tubers, pulses, oil crops, sugar, and cotton. The magnitude and significance of the other controls do not change in any meaningful way from Table 2, excepting that land quality and access to a major river now have significant positive correlations with slavery within broad regions. Roots/tubers and oil crops enter negatively. Pulses and sugar enter positively, though sugar is only statistically significant with major region fixed effects, or in the African sub-sample.

3.2. **Robustness.** Because the institutions reported in the *Ethnographic Atlas* are reported roughly at the time of first European description, it is possible that African slavery in this sample is contaminated by the institutional legacies of the slave trade. I show in the web appendix that the effect of ethnicity-level Atlantic slave exports reported by Nunn and Wantchekon (2011) on indigenous African slavery is insignificant, while there does appear to be a positive correlation between Indian Ocean slave exports and slavery across African ethnic groups. If the slave trade were responsible for establishing slavery in Africa, this would be expected to bias the coefficient on distance from the coast in a negative direction, since African societies closest to the coast were hardest hit by the slave trade. If, however, I include an interaction term between "sub-Saharan Africa" and "distance to coast" in Table 2, the main effect does not change, while the interaction is small and insignificant (not reported).

The measures of land rights and slavery are coarse indicators. I test in the web appendix whether alternative measures of these institutions give results consistent with Table 2. Similarly, I use three alternative measures of historical population, attempting to recreate the results of Table 2. While many estimates move in and out of significance, most of these are small changes in magnitude. Some exceptions are worth noting. Malaria changes sign when land inheritance by children is used as a dependent variable, and distance from the coast has a much larger marginal effect when patrilineal inheritance of land is used as an outcome. With alternative measures of slavery, date of observation, temperature and malaria become insignificant and quantitatively small. Date of observation is a poor predictor of population density in the present day, and the coefficient of variation of rainfall is not a significant predictor of the alternative historical population measures.

Because land rights and slavery are missing for several observations, I show in the web appendix that the results are similar when estimated on a consistent sample for which both institutions are known. I also show that the main results do not hold when observations are weighted by their estimated populations. Though this would be expected to correct the influence of the large number of small societies on the results, it instead only adds noise to the analysis, because this procedure multiplies any errors in estimated population densities by errors in estimated area.

Results are broadly similar with absolute latitude excluded. Excluding high leverage observations also has little effect on the results. Controlling for the possible endogeneity of land quality, I show that its effect is not overstated in the baseline specification.

4. Facts and theories

The results presented above have been descriptive, uncovering geographic variables that predict land rights, slavery, and historic population density. In this section, I discuss whether these correlations are consistent with influential theories of land rights and slavery. I summarize the implications of these theories in Table 4.

4.1. **Theories of land rights.** The two most influential theories of land rights are those that focus on population, and those that focus on trade. Boserup (1965) argues that exogenous population increase is the principal driver of agricultural intensification and more permanent tenure. This is the intuition captured by the "land abundance" view of African history. Austin (2009, p. 33), for example, argues that authorities were were eager to attract more immigrants in order to subdue nature and their neighbors. Thus, strangers could generally acquire land indefinitely for token payments, while citizens were given land virtually for free (Austin, 2008a, p. 591-594). Formalizations of this theory have captured these changes as the selection of certain production technologies in response to the relative scarcity of land and labor (Hayami, 1997; Quisumbing and Otsuka, 2001), or as the profit-maximizing choice of an elite (Lagerlöf, 2009).

There is a positive correlation between population density and land rights in the full sample that holds conditional on region fixed effects (nor reported). Within Africa, there is still a positive correlation, though it is significant only at the 12% level (nor reported). This is congruent with a population-centered view, though it does not specify the mechanism by which land scarcity leads property rights to emerge.

There is also substantial overlap between the geographic variables that predict greater population and those that predict land rights. In the global sample, these include greater land quality, less precipitation, a later date of observation, greater malaria prevalence, greater ruggedness, and proximity to the equator. Conditional on region fixed effects, this pattern is less clear. Similarly, there are many variables in the sub-Saharan Africa sample that do not predict significant co-movement of population density and land rights. These include date of observation, desert, elevation, and malaria. Together, these results are supportive of a population-based mechanism that explains patterns of land tenure across broad regions, but that becomes less powerful at explaining differences within regions. This could be due, for example, to intra-regional spill-overs.

Trade-centered theories date at least as far back as Demsetz (1967). He argues that land rights internalize externalities when the gains outweigh the costs. This drives enclosure of the commons in the formal treatments of Hotte et al. (2000) or Copeland and Taylor (2009), and explains the empirical results of Bogart and Richardson (2011). It is similar to the greater effort expended in defending rights over more valuable resources predicted by models of the economics of conflict (e.g. Baker (2003); Grossman and Kim (1995)).

That better land predicts land rights is consistent with this view, since land that can produce more valuable output will be more strongly defended. The lower prevalence of land rights further from the equator is driven by the low-productivity zones of the Arctic and Australian desert, reinforcing this interpretation. The data do not unambiguously support a trade-centred view, however. The two controls that best capture trade in the data – proximity to the coast and access to a major river – do not significantly predict the existence of land rights. Within Africa, coastal distance enters significantly, but with the wrong sign.

Beyond these two influential theories, there is a literature on the enclosure of common property (e.g. Baland and Francois (2005); Baland and Platteau (2003); Grantham (1980); Lueck (1994); Netting (1976); Ostrom (1991); Runge (1986)). These works identify several benefits of common property that help explain why it survives. These include scale economies, risk pooling, exclusion and effort costs, and equity concerns. Many of these benefits cannot be captured by the geographic variables included here. However, the lack of a significant correlation with ecological risk and land rights in Table 2 is inconsistent with models suggesting that common property over land is motivated by risk pooling.

4.2. **Theories of slavery.** Several theoretical analyses of slavery and coercion exist (e.g. Barzel (1977); Bergstrom (1971); Canarella and Tomaske (1975); Findlay (1975); Genicot (2002)). Three of the most influential theories stress labor scarcity, the outside options available to workers, and the productivity of forced labor in specific tasks. Nieboer (1900) and Domar (1970) both argue that coercion is cheaper than paying a wage when labor is scarce and wages high. Proponents of the "land abundance" view of African history, such as Austin (2008a, p. 606-610), build on this argument. Lagerlöf (2009) and Conning (2004) both provide models that formally capture this intuition. In Lagerlöf (2009), very low population densities also discourage slavery, since the opportunity cost of labor used to guard slaves is very high. Because land quality raises free wages for a given population density, his model predicts that greater land quality can lead to the use of slave labor.

The inverse-U correlation between slavery and population density in Figure 3 is similar to the pattern predicted by the Lagerlöf (2009) model, though this would be predicted by many possible models in which slavery emerges during an intermediate state of development. There is, however, little overlap between the variables that predict population density and those that predict slavery. Some variables predict that population density and slavery move in the same direction (ruggedness), while others predict they move in opposite directions (absolute latitude). The correlation of land quality with slavery only holds in Africa. There are many possible reasons for this. The Lagerlöf (2009) model may better apply to Africa than to other regions. Alternatively, the correlation between slavery and the measure of a society's dependence on agriculture in the *Ethnographic Atlas* is greater in the sub-Saharan sample ($\rho = 0.25$) than in the rest of the world ($\rho = 0.04$).

Several theories emphasize coerced workers' outside options. North and Thomas (1971), for example, hold that serfs voluntarily exchanged their labor for protection in an environment where a lack of markets made it difficult for payments to occur in cash or output. Several models find that worse outside options for workers increase the degree of coercion in labor contracts (Beber and Blattman, 2012; Chwe, 1990).[9] Similarly, Acemoglu and Wolitzky (2011) find that labor scarcity has two effects, raising coercion through a Domar-type increase in the price of output, but also reducing coercion by improving workers' outside options.

The evidence on outside options is mixed. There appears to be no strong link between slavery and distance from the coast, which would suggest that markets do not matter much. Access to a major river predicts slavery, leading to the opposite conclusion. Greater temperatures indicate less hospitable environments, where escape is more difficult. Slavery is more common in these regions. By contrast, ruggedness is expected to improve the outside option of slaves by making it easier for them to flee (Nunn and Puga, 2012). Contrary to this intuition, the correlation between ruggedness and slavery is positive.

In certain contexts, slavery may be more productive than free labor. Productivity-centered views use this to explain its relative prevalence. For Fenoaltea (1984), this occurs where "pain incentives" are effective and detailed care is unnecessary. Fogel and Engerman (1974) link the productivity of slaves in the American south to economies of scale that could only be achieved through gang labor. Engerman and Sokoloff (1997), similarly, argue that the cultivation of crops with economies of scale is more conducive

[9]Naidu and Yuchtman (2012), by contrast, argue that British industrial workers committed to coercive contracts in order to reduce wage variation.

to slavery. Hanes (1996) explains the concentration of slaves in rural and domestic production by invoking the high turnover costs in these industries.

The crop suitability measures in Table 3 do have predictive power. At face value, these suggest that the relative productivity of different agricultural systems, conditional on land quality as a whole, does predict differences in the use of slaves. These do not, however, map neatly into any classification according to economies of scale or productivity under gang labor. Caribbean-type sugar plantations are not a feature of the indigenous societies in the data.

4.3. **Summary.** The correlation of land rights with both population and its geographic predictors is supportive of a population-centered view. There is less evidence for a trade-centered view of land rights. In both cases, however, these theories better predict differences across regions than differences within regions.

The correlation of population density with slavery is similar to the specific population-centered view of Lagerlöf (2009). That land quality better predicts slavery in Africa than elsewhere supports application of this model to Africa alone. There is no strong evidence in favor of a model centered on workers' outside options. There is suggestive evidence that the relative productivity of slaves in different agricultural systems contributed to the prevalence of slavery, but it is difficult to map the broad crop types recorded here into existing theories.

5. PERSISTENCE

In this section, I show that pre-colonial institutions of land rights, slavery, polygamy, and states have persistent effects on present-day institutions in sub-Saharan Africa. Though I have not focused on polygamy and states in the previous sections, they feature largely in both the literature linking African institutions to sparse population (Herbst, 2000; Tambiah and Goody, 1973), and in the literature on current African development (Michalopoulos and Papaioannou, 2012; Tertilt, 2005).

5.1. **Land Rights.** In Table 5, I present estimates of (3). Pre-colonial land rights institutions predict the transactions that have been used to acquire plots of land in Ghana in the present. Members of ethnic groups that historically practiced patrilineal inheritance and those in which children could inherit land in the past are more likely to have acquired their land through commercial transactions such as rental and sharecropping. They are less likely to have acquired land through their village or family. Individuals whose ethnic groups allowed children to inherit in the past are more likely to have bought their current plot. Together, these results tell a consistent story; ethnic groups in Ghana in which nuclear families had more control over land vis-a-vis lineages in the pre-colonial period display greater commercialization of land in the present.

To account for spatial correlation at a level above the ethnic group, I also report standard errors clustered by region. These units are roughly equivalent to provinces, and there are 10 in Ghana. The significance of the results is unchanged, with one exception: ethnic groups in which children inherited land in the past are no longer significantly more likely to purchase land.

5.2. **Slavery.** In Table 5, I report estimates of equation (4) using slavery as a measure of pre-colonial institutions. At the individual level, there is no evidence that past slavery predicts polygamy in the present. Though there is a positive bivariate correlation that survives the inclusion of past polygamy, this does not survive the inclusion of geographic and individual controls. In the child-level regressions, however, I find that children whose ethnic groups practiced slavery in the past receive fewer vaccinations in the present. Coefficients can be compared to the standard deviation of the dependent variable, which is 3.33. Though this does not survive the inclusion of country-round fixed effects, the point estimate remains negative. Standard errors are similar when clustered by minor ethnographic region.

5.3. **Polygamy.** In Table 5, I present additional estimates of (4), using polygamy as a measure of past institutions. Here, there is clear persistence. A woman whose ethnic group regularly practiced polygamy in the past is roughly 10-14% more likely to be married polygamously today. This is robust to additional controls and country-round fixed effects.

5.4. **State centralization.** Though the importance of pre-colonial states for contemporary African development has been established in other contexts (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2012), I find no evidence in Table 5 that the benefits of a pre-colonial state extend to the capacity of modern states to provide vaccinations to children.

5.5. **Implications for comparative development.** The persistent effects of pre-colonial institutions are relevant to at least two literatures in comparative development. First, it is not settled whether geography matters most for development through its direct effects (Sachs, 2003), through its impact on institutions (Easterly and Levine, 2003; Rodrik et al., 2004), or through its influence on culture (Alesina et al., 2011; Ashraf and Galor, 2011). Because the above results are conditional on geographic controls, these suggest that historical institutions exert an influence over and above the direct effects of the geographic features that have shaped them. This does not rule out a direct role for geography in shaping current institutions. Though I do not report coefficients on these, many of the geographic controls are also significant predictors of contemporary institutions, conditional on historic institutions.

Second, if indeed geography matters predominantly through institutions, the degree to which colonialism brought about a "reversal of fortune" remains controversial (Acemoglu et al., 2002b; Austin, 2008b). The results here suggest that the institutional upheaval of colonial rule could not sweep away what came before it. Though the global reversal is plainly visible, my results are consistent with other recent findings that the effects of colonial rule were heterogeneous (Banerjee and Iyer, 2005; Olsson, 2009), varied according to local conditions (Arias and Girod, 2011; Bruhn and Gallego, 2012), and that the evidence for an intra-African reversal is weaker than for a global reversal (Hopkins, 2009; Huillery, 2011).

6. Conclusion

Bad institutions are one of the fundamental causes of African poverty, and the institutions that exist on the continent currently have been shaped by those that existed prior to colonial rule. I have addressed a theme in the economics literature – how geography affects institutions – by outlining the geographic features that predict the historical prevalence of land rights, slavery, and dense population.

Though this exercise has been mostly descriptive, these results can be used to make several points relevant to existing theories about land rights, slavery, and African history. Historical population has evolved alongside these institutions in response to underlying geographic characteristics. While institutional outcomes across broad ethnographic regions are predicted by geography, these predictions become more tenuous when looking within specific regions. Geographic correlates of land rights and slavery differ across regions. Notably, land quality predicts slavery in Africa, but not elsewhere. Within Africa and across the world, there is stronger evidence that land rights are present where land is scarce and productive than there is of any link with trade. Though the results are suggestive of connections between slavery and labor scarcity, workers' outside options, and the relative productivity of slaves in certain tasks, they cannot distinguish any one explanation with dispositive clarity.

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Table 1

Summary statistics and percentiles of population density

	(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)
							HYDE	ARVE	
	Mean	s.d.	Min	Max	N	Pct.	Estimate	Base	MJ Base
						5	0.02	0.05	0.29
Any slavery	0.54	0.50	0	1	1,040	10	0.09	0.17	0.59
Any land rights	0.74	0.44	0	1	801	15	0.26	0.28	1.21
Historic pop density	42.7	141	2.6e-07	3,627	1,205	20	0.51	0.49	1.92
Land quality	1.33	0.90	-4.0e-07	3.98	1,205	25	1.21	0.88	2.58
Date observed	1,905	53.1	1,500	1,965	1,205	30	2.39	1.96	3.79
Precipitation	1,262	855	12.6	6,164	1,205	35	3.70	3.86	5.07
Temperature	7,198	2,776	35.5	10,830	1,205	40	5.78	7.08	6.61
Absolute latitude	20.7	17.0	0.017	78.1	1,205	45	7.64	10.03	8.27
Pct. malarial	0.17	0.20	0	0.69	1,205	50	10.04	14.72	10.10
Dist. to coast	4.26	3.88	0	16.5	1,205	55	12.56	19.39	13.11
Elevation	167	9.60	141	230	1,205	60	15.78	24.39	17.33
Major river	0.28	0.45	0	1	1,205	65	20.14	32.31	22.56
Ruggedness	121,220	132,855	137	977,941	1,205	70	25.97	40.25	29.84
Share desert	0.11	0.26	0	1	1,205	75	35.17	55.00	39.13
Rainfall C.V.	0.21	0.13	0.061	1.73	1,205	80	47.25	76.05	53.36
ln (1+ Atlantic exports/area)	0.16	0.51	0	3.66	532	85	62.98	105.86	71.90
ln (1+ Indian exports/area)	0.037	0.23	0	3.33	532	90	95.85	151.97	115.18
						95	162.79	246.17	197.82

Means by major region

	Any land rights	Any slavery	Historic pop density	N
Africa	0.93	0.83	35.42	414
+ Ethiopia and the Horn + Moslem Sudan	0.93	0.84	35.51	486
+ Sahara + North Africa	0.93	0.84	35.65	526
Circum-Mediterranean	0.92	0.70	64.53	157
East Eurasia	0.83	0.54	154.27	123
Insular Pacific	0.73	0.24	41.74	119
North America	0.29	0.27	5.02	284
South America	0.27	0.27	12.21	109

Notes: Variable definitions are in the web appendix.

Table 2

Geographic correlates of historic institutions and population

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Any land rights			*Any slavery*			*Log historic pop density*		
Land quality	0.048**	0.010	0.024***	0.031	0.019	0.054***	0.727***	0.543***	0.145*
	(0.019)	(0.018)	(0.009)	(0.029)	(0.032)	(0.018)	(0.146)	(0.109)	(0.076)
Precipitation	-0.051**	0.014	-0.005	-0.039	0.054	0.018	-0.763***	-0.191	-0.327
	(0.022)	(0.029)	(0.022)	(0.047)	(0.046)	(0.039)	(0.218)	(0.191)	(0.200)
Temperature	-0.025	-0.089**	0.010	0.221***	0.184***	0.132***	0.231	-0.114	0.146
	(0.038)	(0.041)	(0.013)	(0.066)	(0.056)	(0.051)	(0.364)	(0.255)	(0.164)
Date observed	0.047*	0.003	-0.026*	-0.051**	-0.084***	-0.019	0.471***	0.071	0.914***
	(0.025)	(0.017)	(0.015)	(0.023)	(0.027)	(0.028)	(0.139)	(0.106)	(0.122)
Share desert	0.020	0.005	-0.013	0.010	0.008	0.035	-0.114	-0.204	-0.193**
	(0.021)	(0.034)	(0.016)	(0.040)	(0.035)	(0.031)	(0.212)	(0.159)	(0.085)
Dist. to coast	-0.023	-0.015	0.021*	0.033	0.039	0.003	-0.328	-0.339**	0.020
	(0.023)	(0.023)	(0.012)	(0.031)	(0.031)	(0.017)	(0.205)	(0.149)	(0.099)
Elevation	-0.009	-0.020	-0.019	0.026	0.002	-0.001	-0.299*	-0.276**	-0.601***
	(0.022)	(0.025)	(0.012)	(0.028)	(0.029)	(0.027)	(0.164)	(0.135)	(0.122)
Pct. malarial	0.173***	0.068*	0.016	0.434***	0.368***	0.087***	0.574**	-0.095	0.221*
	(0.031)	(0.035)	(0.011)	(0.045)	(0.058)	(0.028)	(0.247)	(0.146)	(0.121)
Ruggedness	0.054***	0.035	0.044**	0.138***	0.133***	0.022	0.542***	0.211	0.676***
	(0.019)	(0.022)	(0.018)	(0.028)	(0.030)	(0.030)	(0.191)	(0.150)	(0.150)
Absolute latitude	-0.103***	-0.147***	-0.094***	0.175**	0.209***	-0.004	-0.757**	-0.981***	-0.999***
	(0.040)	(0.050)	(0.027)	(0.072)	(0.072)	(0.066)	(0.362)	(0.305)	(0.244)
Rainfall c.v.	-0.013	-0.025	-0.005	0.020	0.034	-0.010	-0.320	-0.331**	-0.148
	(0.021)	(0.021)	(0.014)	(0.031)	(0.029)	(0.034)	(0.204)	(0.160)	(0.122)
Major river	-0.026	-0.021	-0.010	0.082*	0.072	0.053*	0.292	0.407**	0.084
	(0.036)	(0.040)	(0.023)	(0.046)	(0.049)	(0.031)	(0.214)	(0.167)	(0.113)
Circum-Mediterranean		0.136**			0.077			1.205***	
		(0.066)			(0.131)			(0.352)	
East Eurasia		0.010			-0.131			1.559***	
		(0.099)			(0.160)			(0.381)	
Insular Pacific		-0.270*			-0.404***			-1.609***	
		(0.154)			(0.154)			(0.547)	
North America		-0.369*			-0.338**			-2.139***	
		(0.191)			(0.151)			(0.596)	
South America		-0.627***			-0.218			-4.036***	
		(0.125)			(0.136)			(0.780)	
Observations	801	801	371	1,040	1,040	416	1,205	1,205	486
R-squared							0.440	0.590	0.919
Sample	Full	Full	S.S. Africa	Full	Full	S.S. Africa	Full	Full	S.S. Africa

Notes: ***Significant at 1%. **Significant at 5%. *Significant at 10%. Regressions with land rights and slavery are logit, with marginal effects reported. Regressions with population density are OLS, with coefficients reported. In both cases, these are interpretable as the effect of a one standard deviation change for continuous variables, and a one unit change for dummy variables. Each regression contains a constant (not reported). Standard errors in parentheses are adjusted using Conley's (1999) method, with a distance cutoff of 10 decimal degrees.

Table 3

Geographic correlates of slavery, including crop suitabilities

	(1)	(2)	(3)
		Any slavery	
Land quality	0.047	0.082**	0.042**
	(0.035)	(0.036)	(0.018)
Precipitation	-0.011	0.085	0.047
	(0.052)	(0.053)	(0.045)
Temperature	0.209***	0.150**	0.097***
	(0.069)	(0.066)	(0.028)
Date observed	-0.053**	-0.090***	-0.036
	(0.023)	(0.030)	(0.025)
Share desert	0.009	-0.011	0.021
	(0.045)	(0.039)	(0.025)
Dist. to coast	0.035	0.046	0.002
	(0.030)	(0.029)	(0.012)
Elevation	0.033	0.005	0.006
	(0.029)	(0.031)	(0.021)
Pct. malarial	0.462***	0.378***	0.092***
	(0.047)	(0.060)	(0.032)
Ruggedness	0.120***	0.100***	-0.001
	(0.031)	(0.031)	(0.027)
Absolute latitude	0.160**	0.190***	-0.019
	(0.069)	(0.072)	(0.053)
Rainfall c.v.	0.025	0.027	-0.018
	(0.030)	(0.028)	(0.027)
Major river	0.090*	0.086*	0.040*
	(0.049)	(0.052)	(0.024)
Wheat suitability	0.022	-0.051	0.011
	(0.037)	(0.045)	(0.022)
Maize suitability	0.009	0.057	0.031
	(0.077)	(0.078)	(0.040)
Cereals suitability	0.091	0.005	-0.003
	(0.083)	(0.085)	(0.030)
Roots/tubers suitability	-0.131*	-0.128*	-0.095**
	(0.073)	(0.076)	(0.044)
Pulses suitability	0.135*	0.156*	0.081**
	(0.079)	(0.080)	(0.033)
Oil crops suitability	-0.246***	-0.302***	-0.115***
	(0.076)	(0.071)	(0.034)
Sugar suitability	0.063	0.127**	0.058*
	(0.045)	(0.050)	(0.034)
Cotton suitability	0.075	0.091	0.029
	(0.071)	(0.072)	(0.031)
Circum-Mediterranean		0.176	
		(0.122)	
East Eurasia		-0.211	
		(0.161)	
Insular Pacific		-0.483***	
		(0.132)	
North America		-0.374**	
		(0.147)	
South America		-0.269*	
		(0.139)	
Observations	1,040	1,040	416
Sample	Full	Full	S.S. Africa

Notes: ***Significant at 1%. **Significant at 5%. *Significant at 10%. All regressions are logit, with marginal effects reported. These are interpretable as the effect of a one standard deviation change for continuous variables, and a one unit change for dummy variables. Each regression contains a constant (not reported). Standard errors in parentheses are adjusted using Conley's (1999) method, with a distance cutoff of 10 decimal degrees.

Table 4

Theories of land rights and slavery

	Examples	*Implications*
Land rights		
Population-centred	Boserup (1965), Hayami (1997), Lagerlöf (2009), Quisumbing and Otsuka (2001)	Variables that predict greater population will predict land rights. In Lagerlöf, better land quality predicts land rights.
Trade-centred	Demsetz (1967), Hotte et al. (2000), Copeland and Taylor (2009)	Variables that predict greater market values of output will predict land rights.
Slavery		
Population-centred	Conning (2004), Domar (1970), Lagerlöf (2009), Nieboer (1900)	Variables that predict lower population (Nieboer) or intermediate population (Lagerlöf) will predict slavery. In Lagerlöf, better land quality predicts slavery.
Outside option-centred	Acemoglu and Wolitzky (2011), Beber and Blattman (2012), Chwe (1990), North and Thomas (1971)	Variables that improve workers' outside options or that make it more difficult to coerce workers should reduce slavery.
Productivity-centred	Engerman and Sokoloff (1997), Fenoaltea (1984), Fogel and Engerman (1974), Hanes (1996)	Suitability for certain crops should make slavery more likely, over and above the effect of land quality in general.

Table 5

Institutional persistence in sub-Saharan Africa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: GLSS 5	*Bought*		*Rented*		*Sharecropped*		*Distributed through village or family*		
Patrilineal land inheritance	0.012		0.073***		0.124***		-0.245***		
	(0.011)		(0.024)		(0.038)		(0.058)		
	[0.022]		[0.021]		[0.051]		[0.058]		
Children inherit land		0.025***		0.066***		0.095***		-0.227***	
		(0.006)		(0.011)		(0.024)		(0.074)	
		[0.022]		[0.014]		[0.038]		[0.079]	
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	8,669	8,669	8,669	8,669	8,669	8,669	8,669	8,669	
Panel B: DHS Individual Recodes	*Polygamous*								
Usual polygyny	0.136***	0.126***	0.097***				0.137***	0.125***	0.094***
	(0.050)	(0.026)	(0.020)				(0.050)	(0.027)	(0.020)
	[0.048]	[0.017]	[0.020]				[0.049]	[0.018]	[0.018]
Any slavery				0.143***	0.015	0.040	0.144***	-0.006	0.021
				(0.048)	(0.033)	(0.027)	(0.049)	(0.036)	(0.030)
				[0.060]	[0.044]	[0.027]	[0.060]	[0.048]	[0.030]
Other controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country-Round Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Observations	235,408	156,108	156,108	235,372	156,556	156,556	231,460	153,978	153,978
Panel C: DHS Child Recodes	*Total number of vaccines received*								
Any slavery	-1.572***	-0.720**	-0.189				-1.738***	-0.817**	-0.261
	(0.409)	(0.326)	(0.271)				(0.416)	(0.354)	(0.272)
	[0.491]	[0.342]	[0.228]				[0.482]	[0.321]	[0.228]
State centralization				0.130	0.074	0.123	0.238	0.085	0.148*
				(0.180)	(0.108)	(0.079)	(0.167)	(0.111)	(0.080)
				[0.173]	[0.069]	[0.049]	[0.147]	[0.069]	[0.039]
Other controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country-Round Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Observations	149,755	91,136	91,136	148,516	90,110	90,110	146,050	88,952	88,952

Notes: ***Significant at 1%. **Significant at 5%. *Significant at 10%. All regressions are OLS. All regressions include a constant (not reported). Other controls in the GLSS regressions include plot area, plot area squared, plot controller male, plot controller age and age squared, dummy for household member, dummies for religion, dummies for region, and ecological zone dummies. Other controls in the DHS individual recodes are absolute latitude, malaria prevalence, sutiability for rainfed agriculture, ruggedness, elevation, distance to the coast, dummies for ecological type, year of birth, year of birth squared, dummies for religion, urban, age, and age squared. Controls in the DHS child recodes include the same controls as in the individual recodes (which are now maternal characteristics), as well as the child characteristics birth date, birth order, multiple birth, and female. Standard errors in each regression are clustered by *Ethnographic Atlas* ethnicity. In the GLSS panel, additional standard errors clustered by region are reported in brackets. In the DHS data, additional standard errors clustered by ethnographic region (e.g. Equatorial Bantu) are reported in brackets.