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PRE-COLONIAL ETHNIC INSTITUTIONS AND CONTEMPORARY AFRICAN DEVELOPMENT

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We investigate the role of deeply rooted pre-colonial ethnic institutions in shaping comparative regional development within African countries. We combine information on the spatial distribution of ethnicities before colonization with regional variation in contemporary economic performance, as proxied by satellite images of light density at night. We document a strong association between pre-colonial ethnic political centralization and regional development. This pattern is not driven by differences in local geographic features or by other observable ethnic-specific cultural and economic variables. The strong positive association between pre-colonial political complexity and contemporary development also holds within pairs of adjacent ethnic homelands with different legacies of pre-colonial political institutions.

KEYWORDS: Africa, ethnicities, development, institutions.

1. INTRODUCTION

THERE HAS BEEN AMPLE RESEARCH on the institutional origins of African (under)development both in economics and in the broader literature in social sciences; yet the two strands have followed somewhat different paths. On the one hand, influenced by the studies of Acemoglu, Johnson, and Robinson (2001, 2002) and La Porta, de Silanes, Shleifer, and Vishny (1997, 1998), the empirical literature in economics has mainly focused on the impact of colonization in comparative development primarily via its effect on contractual institutions and property rights protection at the national level (see Acemoglu and Johnson (2005)). On the other hand, the African historiography has invariably stressed the role of deeply rooted, ethnic institutional characteristics (see Herbst (2000)

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for a summary). Motivated by the richness of anecdotal evidence and case studies documenting the importance of ethnic-specific institutional traits, in this study we systematically explore the relationship between pre-colonial ethnic institutions, political centralization in particular, and regional development.

We utilize data from the pioneering work of Murdock (1959, 1967), who mapped the spatial distribution of African ethnicities and compiled various quantitative indicators reflecting political institutions and cultural and economic traits of several ethnic groups around colonization. To overcome the paucity of economic indicators across African ethnic homelands, we combine this anthropological data with satellite images of light density at night.

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Our analysis shows that the complexity and hierarchical structure of pre-colonial ethnic institutions correlate significantly with contemporary regional development, as reflected in light density at night. This correlation does not necessarily imply a causal relationship, because one cannot rule out the possibility that other ethnic characteristics and hard-to-account-for factors drive the association. Nevertheless, this correlation holds across numerous permutations. First, it is robust to an array of controls related to the disease environment, land endowments, and natural resources at the local level. Accounting properly for geography is important, as there is a fierce debate in the literature on whether the correlation between institutional and economic development is driven by unobservable geographical features. Second, the strong positive association between pre-colonial political centralization and regional development retains its economic and statistical significance when we solely examine within-country variation. Including country fixed effects is crucial since we are able to account for all country-specific, time-invariant features. Third, regressing luminosity on a variety of alternative pre-colonial ethnic characteristics, such as occupational specialization, economic organization, the presence of polygyny, slavery, and proxies of early development, we find that political centralization is the only robust correlate of contemporary economic performance. This reassures that the positive association does not reflect differences in observable cultural and economic attributes across African ethnicities. Fourth, the positive correlation between ethnic political complexity and regional development prevails when we limit our analysis within pairs of neighboring homelands falling in the same country where ethnicities with different pre-colonial institutions reside.

These patterns hold both when the unit of analysis is the ethnic homeland and when we exploit the finer structure of the luminosity data to obtain multiple observations (pixels) for each homeland. Hence, although we do not have random assignment in ethnic institutions, the results clearly suggest that traits manifested in differences in the pre-colonial institutional legacy matter crucially for contemporary African development.

Ethnic Institutions: Past and Present

There was significant heterogeneity in political centralization across African ethnicities before colonization (Murdock (1967)). At the one extreme, there were states with centralized administration and hierarchical organization, such as the Shongai Empire in Western Africa, the Luba kingdom in Central Africa, and the kingdoms of Buganda and Ankole in Eastern Africa. At the other extreme, there were acephalous societies without political organization beyond the village level, such as the Nuer in Sudan or the Konkomba in Ghana and Togo. The middle of the spectrum occupied societies organized in large chiefdoms and loose alliances, such as the Ewe and the Wolof in Western Africa. While these societies lacked statehood, they tended to have conflict resolution mechanisms and a somewhat centralized decision-making process (Diamond (1997)).

The advent of the Europeans in Africa had limited impact on these preexisting local political structures. This was because colonization was (with some exceptions) quite limited in both timing and location (Herbst (2000)). Mamdani (1996) argued that, in fact, the European colonizers in several occasions strengthened tribal chiefs and kings via their doctrine of indirect rule. In the eve of African independence, some countries attempted to limit the role of ethnic institutions; however, the inability of African states to provide public goods and broadcast power beyond the capitals led African citizens to continue relying on the local ethnic-specific structures rather than the national government (Englebert (2009)). Herbst (2000), for example, noted that new states initially marginalized local chiefs in Mauritania, Mozambique, Niger, Nigeria, and Chad, but invited them back when they realized the extraordinary difficulties in governing rural areas.

There is ample evidence pointing to the ongoing importance of ethnic-specific institutions. First, ethnic leaders and chiefs enjoy considerable support and popularity across local communities (e.g., Baldwin (2010)). Second, both survey data and case studies show that local chiefs have significant power in allocating land rights. Analyzing data from the Afrobarometer Surveys, Logan (2011) documented that ethnic institutions are instrumental in assigning property rights and resolving disputes.[2] Along the same lines, Goldstein and Udry (2008) showed that informal ethnic institutions and local chiefs today exert significant de facto power in assigning land in rural Ghana (see also Bubb (2012)). Third, in many countries, local leaders collect taxes and provide some basic public goods (e.g., Glennerster, Miguel, and Rothenberg (2010), Acemoglu, Reed, and Robinson (2012)). Fourth, according to Herbst (2000), since

[2]Logan (2011) showed that ethnic leaders are as important as the local and central governments in assigning property rights. Respondents tend to rely more on local chiefs and ethnic institutional structures for the resolution of disputes as compared to national and local government. Ethnic-specific political actors and institutions also play some role in the provision of education and health.

the early 1990s, 14 out of 39 African countries have passed legislation or constitutional amendments (in the case of Uganda and Ghana) formally recognizing the role of ethnic institutional structures in settling property rights disputes and enforcing customary law (see Baldwin (2011)).

The African historiography has proposed various channels through which ethnic institutions shape contemporary economic activity. First, Herbst (2000) and Boone (2003) argued that, in centralized societies, there is a high degree of accountability of local chiefs. For example, in ethnic groups that had a state structure, poorly performing local rulers could be replaced by the king or superior administrators. Some ethnic groups have still assemblies and supreme officials that make local chiefs accountable. Second, Diamond (1997) and Acemoglu and Robinson (2012) described how ethnic groups that formed large states had organized bureaucracies providing policing and other public goods. Third, in centralized ethnicities, there was access to some formal legal resolution mechanism and some form of property rights steadily emerged (Herbst (2000)). Fourth, others have argued that centralized societies were quicker in adopting Western technologies, because the colonizers collaborated more strongly with politically complex ethnicities (Schapera (1967, 1970)). Fifth, tribal societies with strong political institutions have been more successful in obtaining concessions both from colonial powers and from national governments after independence. For example, Acemoglu and Robinson (2012) described how, in the initial period of colonization, Tswana leaders travelled from Bechuanaland (current Botswana) to England and convinced the British government to allow for a greater degree of autonomy.[3]

Related Literature

Our study contributes to the literature on the role of pre-colonial, institutional, and cultural features in African development reviewed above (Fortes and Evans-Pritchard (1940), Schapera (1967), Stevenson (1968), Goody (1971), Bates (1983), Robinson (2002), Boone (2003), Englebert (2009), Besley and Reynal-Querol (2012)). The most closely related line of research is that of Gennaioli and Rainer (2006, 2007), who presented cross-country evidence showing that pre-colonial political centralization correlates positively with public goods provision and contemporary institutions. We advance this literature by establishing that, unlike other observable ethnicity-level variables, pre-colonial ethnic institutions, measured by the degree of political complexity, are systematically linked to contemporary regional development within countries as well as within pairs of contiguous ethnic homelands.

[3]Mamdani (1996), nevertheless, differed in his assessment on the beneficial contemporary role of hierarchical pre-colonial structures, arguing that the legacy of indirect rule in Africa through traditional chiefs was a basis for poor institutional and economic performance in the post-independence period.

Our study also belongs to a growing body of work on the historical origins and the political economy of African development. Nunn (2008) stressed the importance of the slave trades, while Huillery (2009), Berger (2009), and Arbesu (2011) quantified the long-run effects of colonial investments and tax collection systems. Englebert, Tarango, and Carter (2002), Alesina, Easterly, and Matuszeski (2011), and Michalopoulos and Papaioannou (2011b) examined the negative effects of the improper colonial border design during the Scramble for Africa.

On a broader scale, our work relates to the literature on the institutional origins of contemporary development (see Acemoglu, Johnson, and Robinson (2005) for a review). Our micro approach enables us to overcome problems inherent to the cross-country framework, adding to a vibrant body of research that examines the within-country impact of various historical institutional arrangements (e.g., Banerjee and Iyer (2005), Iyer (2010), Dell (2010)). Moreover, our within-country results linking pre-colonial political centralization to contemporary regional development complement the cross-country findings of Bockstette, Chanda, and Putterman (2002) on the beneficial long-run consequences of statehood.

Finally, our work has implications for the literature on state capacity that examines the origins and consequences of weak states' inability to monopolize violence, collect taxes, and protect private property (e.g., Besley and Persson (2011)). Our work shows that, in the presence of weak state capacity, local institutions (ethnic in Africa) may fill in the void created by the limited penetration of national institutions (Michalopoulos and Papaioannou (2012)).

Paper Structure

In the next section, we present the pre-colonial ethnic institutional measures and discuss the luminosity data. We cross-validate our main data and report descriptive statistics illustrating the relationship between ethnic-level political organization and development. Section 3 presents our results at the ethnic homeland level. First, we present the general econometric framework and report our benchmark within-country estimates. Then, we examine the role of other ethnic-specific features. In Section 4, we first report our baseline results at the pixel level and then examine whether regional development differs systematically across contiguous territories where ethnic groups with a different degree of political centralization reside. In Section 5, we conclude, discussing directions for future research.

2. DATA

2.1. *Data on the Location of Historical Ethnic Homelands*

The starting point in compiling our dataset is George Peter Murdock's (1959) ethnolinguistic map, which portrays the spatial distribution of ethnicities across Africa at the beginning of European colonization in the mid/late

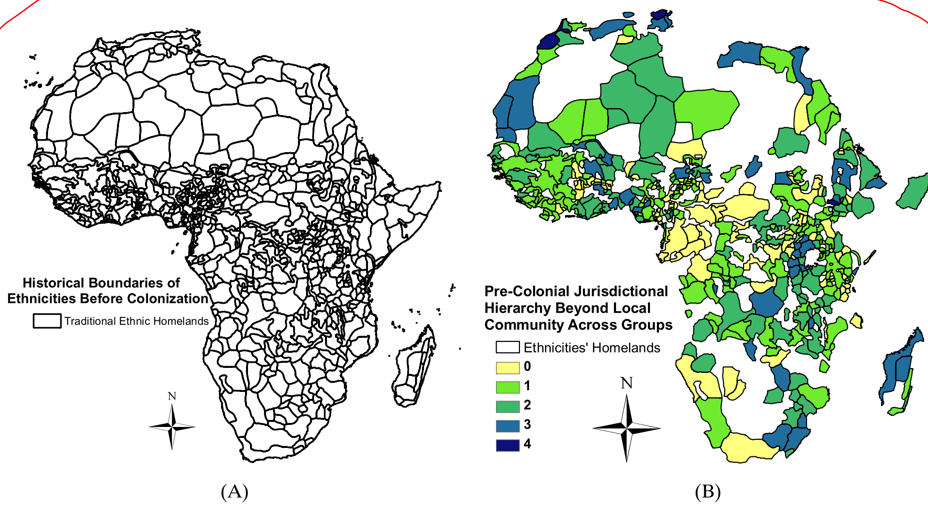


FIGURE 1.—(A) Ethnic boundaries. (B) Ethnic pre-colonial institutions.

19th century. Murdock's map (Figure 1(A)) includes 843 tribal areas (the mapped groups correspond roughly to levels 7–8 of the Ethnologue's (2005) language family tree). Eight areas are classified as uninhabited upon colonization and are therefore excluded. We also drop the Guanche, a group in the Madeira Islands that is currently part of Portugal. One may wonder how much the spatial distribution of ethnicities across the continent has changed over the past 150 years. Reassuringly, using individual data from the Afrobarometer, Nunn, and Wantchekon (2011) showed a 0.55 correlation between the location of the respondents in 2005 and the historical homeland of their ethnicity as identified in Murdock's map. Similarly, Glennerster, Miguel, and Rothenberg (2010) documented that in Sierra Leone, after the massive displacement of the 1991–2002 civil war, there has been a systematic movement of individuals toward their ethnic historical homelands. To identify partitioned ethnicities and assign each area to the respective country, we intersect Murdock's ethnolinguistic map with the 2000 Digital Chart of the World that portrays contemporary national boundaries.

2.2. *Ethnic Institutional Traits*

In his work following the mapping of African ethnicities, Murdock (1967) produced an Ethnographic Atlas (published in twenty-nine installments in the anthropological journal *Ethnology*) that coded approximately 60 variables, capturing cultural, geographical, and economic characteristics of 1270 ethnicities around the world. We assigned the 834 African ethnicities of Murdock's map of 1959 to the ethnic groups in his Ethnographic Atlas of 1967. The two sources do not always use the same name to identify an ethnic group. Utilizing several sources and the updated version of Murdock's Atlas produced by Gray (1999), we match 534 ethnicities from the Ethnographic Atlas to 490 ethnic homelands in Murdock's map (Figure 1(A)).[4]

We measure pre-colonial political institutions using Murdock's (1967) "Jurisdictional Hierarchy Beyond the Local Community Level" index (see also Gennaioli and Rainer (2006, 2007)). This is an ordered variable, ranging from 0 to 4, that describes the number of political jurisdictions above the local (usually village) level for each ethnicity. A zero score indicates stateless societies "lacking any form of centralized political organization." A score of 1 indicates petty chiefdoms; a score of 2 designates paramount chiefdoms; and 3 and 4 indicate groups that were part of large states. Murdock (1967) explicitly excluded colonial regimes and attempted to capture political complexity before European colonization. This classification is similar to that of Diamond (1997), who distinguished between four main types of societal arrangements: bands, tribes, chiefdoms, and centralized states. Figure 1(B) illustrates the significant heterogeneity in pre-colonial political organization across African groups. Examples of ethnicities without any level of political organization above the local level include the Bura and the Lango in Uganda. Examples of tribes belonging to petty chiefdoms are the Mende in Sierra Leone and the Ibo of Nigeria. The Mbundu in Angola and the Zerma in Niger were part of paramount chiefdoms, while the Ndebele in Zimbabwe and the Mossi in Burkina Faso are societies that were parts of states before colonization. The Bubi in Equatorial Guinea and the Bedouin Arabs are the only groups classified as having been part of large complex states (score of 4).

Cross-Validation of Murdock's Jurisdictional Hierarchy Index

We cross-validated Murdock's data going over the African historiography. Our reading of the literature suggests that the jurisdictional hierarchy index—while not perfect—is in accordance with works describing the degree of political complexity in pre-colonial Africa. Murdock (1967) classified as centralized the dominant ethnic groups of most major pre-colonial states. For example, the Ankale and the Buganda, which were the central ethnic groups in the strong kingdoms of Eastern Africa, get a score of 3. The same applies to other ethnic groups that were part of large states, such as the Zulu and the Swazi in South Africa, the Ife and the Igala in Nigeria, and the Shongai in Mali (Fortes and Evans-Pritchard (1940), Goody (1971)).

Murdock also seems to have correctly identified stateless ethnicities. The jurisdictional hierarchy index equals zero or 1 for the Amba, the Konkomba,

[4] In 34 instances, an ethnic homeland from Murdock's map is assigned to more than one group in the Ethnographic Atlas; in these cases, we assigned to the ethnic homeland the median value of the ethnic institutions index.

the Tiv, the Dinka, and the Lugbara, in line with the analysis of Middleton and Tait (1958), who described them as acephalous societies. Regarding the Amba, for example, Winter (1958) wrote that "the village is the largest unilateral unit of power," whereas Tait (1958) characterized the Konkomba as an ethnic group that is "organized locally, without formal laws, and central authority." Likewise, the Lobbi is classified as stateless, in line with Goody (1971), who characterized them as "people with no state organization at all." The classification also properly identifies societies with intermediate levels of political centralization (paramount chiefdoms). The Nupe in Nigeria, the Bemba in Zambia, and the Ngwato in Botswana, which formed small states, get a score of 2 (Fortes and Evans-Pritchard (1940)). Clearly, there is some subjectivity in Murdock's characterization of ethnic-specific institutional structures. Yet to the extent that these biases are not systematic, this should lead to attenuation, and as such, our estimates will be on the conservative side.

2.3. *Satellite Light Density at Night*

The nature of our study requires detailed spatial data on economic development. To the best of our knowledge, geocoded high-resolution measures of economic development spanning all of Africa are not available. To overcome this limitation, we use satellite light density at night to proxy for local economic activity. The luminosity data come from the Defense Meteorological Satellite Program's Operational Linescan System that reports images of the earth at night captured from 20: 30 to 22: 00 local time. The satellite detects lights from human settlements, fires, gas flares, lightning, and the aurora. The measure is a six-bit number (ranging from 0 to 63) calculated for every 30-second area (approximately 1 square kilometer). The resulting annual composite images of time-stable lights are created by overlaying all images captured during a calendar year, dropping images where lights are shrouded by cloud or overpowered by the aurora or solar glare (near the poles), and removing ephemeral lights like fires and lightning. We construct average light density per square kilometer for 2007 and 2008, averaging across pixels at the desired level of aggregation.

The use of luminosity data as a proxy for development builds on the recent contribution of Henderson, Storeygard, and Weil (2012) and previous works (e.g., Elvidge, Baugh, Kihn, Kroehl, and Davis (1997), Doll, Muller, and Morley (2006)) showing that light density at night is a robust proxy of economic activity (see also Pinkovskiy (2011)). These studies establish a strong within-country correlation between light density at night and GDP levels and growth rates. There is also a strong association between luminosity and access to electricity and public-goods provision, especially across low-income countries (see Min (2008)). Even Chen and Nordhaus (2011), who emphasized some of the problematic issues with using satellite image data, argued that luminosity can be quite useful for regional analysis in war-prone countries with poor-quality income data. Luminosity data are subject to saturation and blooming. Saturation occurs at a level of light similar to that in the urban centers of rich countries and results in top-coded values. Blooming occurs because lights tend to appear larger than they actually are, especially for bright lights over water and snow. These issues, however, are of less concern within Africa. First, there are very few instances of top-coding (out of the 30,457,572 pixels of light density, only 0.00017% are top-coded). Second, since luminosity is quite low across African regions, blooming (bleeding) is not a major problem. Moreover, in the within-contiguous-ethnic-homelands analysis, blooming would work against our hypothesis.

Cross-Validation: Satellite Light Density and Regional Development

In our empirical analysis, we primarily explore within-country variation. Thus, we examined the relationship between luminosity and economic performance using micro-level data from the Demographic and Health Surveys (DHS) (see the Supplemental Material (Michalopoulos and Papaioannou (2013)) for additional cross-validation checks). The DHS team in each country produced a composite wealth index, based on individual responses on whether households have access to basic public goods, such as electrification, clean water, etc. We examine the correlation between log light density and the wealth index within four large countries from different parts of Africa, namely, Nigeria from Western Africa, Tanzania from Eastern Africa, the Democratic Republic of Congo from Central Africa, and Zimbabwe from Southern Africa. We derive the average wealth index across households for each enumeration area (usually a village or a small town) and associate it with light density of each DHS area using a radius of 10 km. Figures 2(A)–2(D) offer a visual representation of the significant correlation (around 0.70) between luminosity and the composite wealth index.[5]

2.4. *Summary Statistics*

Figures 3(A) and 3(B) portray the distribution of luminosity across African ethnic homelands. In Figure 3(A), we aggregate the luminosity data at the country-ethnic homeland level, which serves as our unit of analysis in Section 3. In Figure 3(B), we divide the continent into pixels of 12.5 × 12.5 decimal degrees (approximately 12.5 km × 12.5 km) and map lit and unlit pixels. Table I reports descriptive statistics of the luminosity data both at the country-ethnic homeland level and at the pixel level. The mean value of luminosity at the ethnic homeland level is 0.368. The median is significantly lower, 0.022, because of few areas where light density is extremely high. There are 7 observations where luminosity exceeds 7.4, and 14 observations where light density exceeds

[5]To mitigate concerns that the correlation is driven by outliers, we also dropped the top 1% of lit areas, effectively excluding the capital city and a few other major urban hubs. The results are similar, and if anything, the correlation strengthens. See also Table A.II.

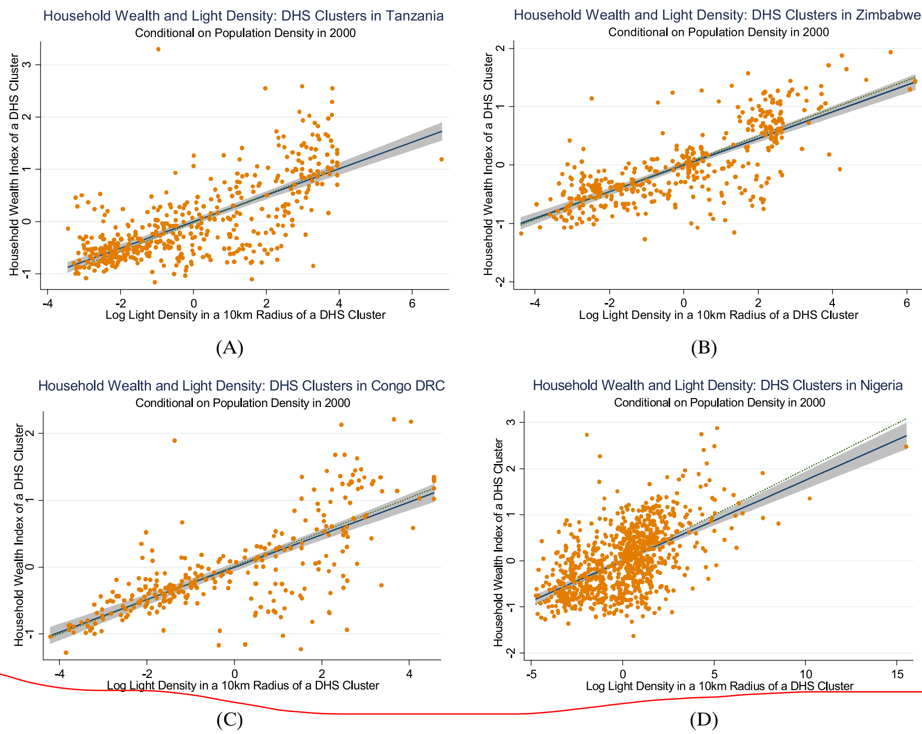


FIGURE 2.—Household wealth and luminosity within countries.

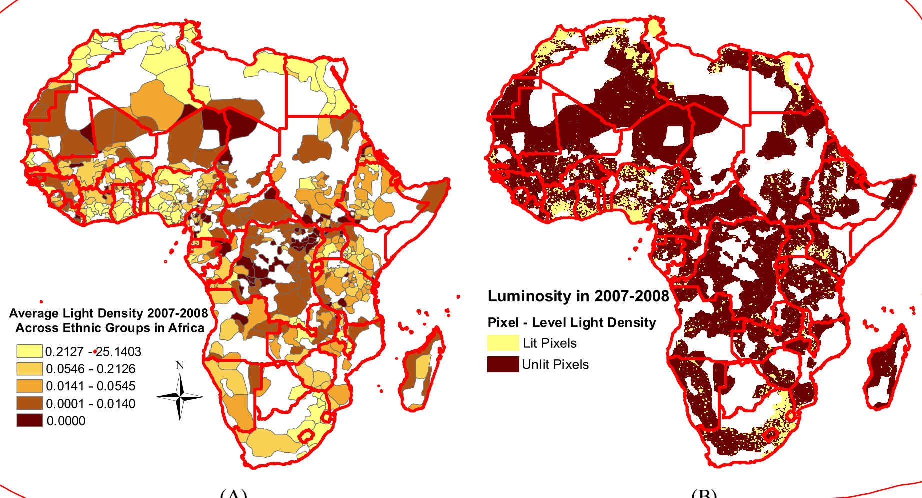


FIGURE 3.—(A) Luminosity at the ethnic homeland. (B) Pixel-level luminosity.

TABLE I

SUMMARY STATISTICS[a]

Variable	Obs.	Mean	St. Dev.	p25	Median	p75	Min	Max
Panel A: All Observations								
Light Density	683	0.368	1.528	0.000	0.022	0.150	0.000	25.140
ln(0.01 + Light Density)	683	−2.946	1.701	−4.575	−3.429	−1.835	−4.605	3.225
Pixel-Level Light Density	66,570	0.560	3.422	0.000	0.000	0.000	0.000	62.978
Lit Pixel	66,570	0.167	0.373	0.000	0.000	0.000	0.000	1.000
Panel B: Stateless Ethnicities								
Light Density	176	0.257	1.914	0.000	0.018	0.082	0.000	25.140
ln(0.01 + Light Density)	176	−3.231	1.433	−4.605	−3.585	−2.381	−4.605	3.225
Pixel-Level Light Density	13,174	0.172	1.556	0.000	0.000	0.000	0.000	55.634
Lit Pixel	13,174	0.100	0.301	0.000	0.000	0.000	0.000	1.000
Panel C: Petty Chiefdoms								
Light Density	264	0.281	1.180	0.000	0.015	0.089	0.000	13.086
ln(0.01 + Light Density)	264	−3.187	1.592	−4.605	−3.684	−2.313	−4.605	2.572
Pixel-Level Light Density	20,259	0.283	2.084	0.000	0.000	0.000	0.000	60.022
Lit Pixel	20,259	0.129	0.335	0.000	0.000	0.000	0.000	1.000
Panel D: Paramount Chiefdoms								
Light Density	167	0.315	0.955	0.002	0.039	0.203	0.000	9.976
ln(0.01 + Light Density)	167	−2.748	1.697	−4.425	−3.017	−1.544	−4.605	2.301
Pixel-Level Light Density	20,972	0.388	2.201	0.000	0.000	0.000	0.000	58.546
Lit Pixel	20,972	0.169	0.375	0.000	0.000	0.000	0.000	1.000
Panel E: Pre-Colonial States								
Light Density	76	1.046	2.293	0.012	0.132	0.851	0.000	14.142
ln(0.01 + Light Density)	76	−1.886	2.155	−3.836	−1.976	−0.150	−4.605	2.650
Pixel-Level Light Density	12,165	1.739	6.644	0.000	0.000	0.160	0.000	62.978
Lit Pixel	12,165	0.302	0.459	0.000	0.000	1.000	0.000	1.000

[a]The table reports descriptive statistics for the luminosity data that we use to proxy economic development at the country-ethnic homeland level and at the pixel level. Panel A gives summary statistics for the full sample. Panel B reports summary statistics for ethnicities that lacked any form of political organization beyond the local level at the time of colonization. Panel C reports summary statistics for ethnicities organized in petty chiefdoms. Panel D reports summary statistics for ethnicities organized in large paramount chiefdoms. Panel E reports summary statistics for ethnicities organized in large centralized states. The classification follows Murdock (1967). The Data Appendix in the Supplemental Material (Michalopoulos and Papaioannou (2013)) gives detailed variable definitions and data sources.

4.06. On average, 16.7% of all populated pixels are lit, while in the remaining pixels satellite sensors do not detect the presence of light.

The summary statistics reveal large differences in luminosity across homelands where ethnicities with different pre-colonial political institutions reside. The mean (median) luminosity in the homelands of stateless societies is 0.248 (0.017), and for petty chiefdoms the respective values are 0.269 (0.013); and only 10% and 12.9% of populated pixels are lit, respectively. Focusing on groups that formed paramount chiefdoms, average (median) luminosity is 0.311 (0.037), while the likelihood that a pixel is lit is 16.9%. Average (median) luminosity in the homelands of ethnicities that were part of centralized states before colonization is 0.993 (0.082). On average, 30.2% of pixels falling in the homelands of highly centralized groups are lit, three times more than the respective likelihood for stateless societies. Light density in the homelands of pre-colonial states is significantly higher, even when compared to groups organized as paramount chiefdoms. The mean (median) difference is 0.68 (0.045); and simple tests of means (medians) suggest that these differences are significant at the 99% confidence level. The descriptive statistics reveal that regional development across ethnic homelands correlates with the form of the pre-colonial political organization. Light density increases significantly when one moves from the homelands of societies that at the time of colonization were either stateless or organized into petty chiefdoms, to the homelands of ethnicities organized as paramount chiefdoms; and luminosity is even higher in the homelands of ethnicities that were part of large states.

3. ETHNIC HOMELAND ANALYSIS

3.1. *Empirical Framework*

To formally examine the relationship between pre-colonial ethnic institutions and development across ethnic homelands, we estimate variants of the following specification:

$$y_{i,c} = a_0 + \gamma \, \mathrm{IQL}_i + X'_{i,c}\Phi + \lambda \, \mathrm{PD}_{i,c} + a_c + \varepsilon_{i,c}. \tag{1}$$

The dependent variable, $y_{i,c}$, reflects the level of economic activity in the historical homeland of ethnic group i in country c, as proxied by light density at night. IQL_i denotes local ethnic institutions as reflected in the degree of jurisdictional hierarchy beyond the local level. For ethnicities that fall into more than one country, each partition is assigned to the corresponding country c. For example, regional light density in the part of the Ewe in Ghana is assigned to Ghana, while the adjacent region of the Ewe in Togo is assigned to Togo.[6] In most specifications, we include country fixed effects (a_c), so as to exploit within-country variation. While fixed effects estimation may magnify problems of measurement error (by absorbing a sizable portion of the variation), it accounts for differences in national policies, the quality of national institutions, the identity of the colonizer, and the type of colonization, as well as other country-wide factors.

A merit of our regional focus is that we can account for local geography and other factors (captured in vector $X_{i,c}$). In many specifications, we include a rich set of controls, reflecting land endowments (elevation and area under water),

[6] After intersecting Murdock's ethnolinguistic map with the 2000 Digital Chart of the World, we drop ethnic partitions of less than 100 km^2, as such small partitions are most likely due to the lack of precision in the underlying mapping.

ecological features (a malaria stability index, land suitability for agriculture), and natural resources (diamond mines and petroleum fields). Several studies recommend the inclusion of these variables. First, Nunn and Puga (2012) showed that elevation and terrain ruggedness have affected African development both via goods and via slave trades. Second, the inclusion of surface area under water accounts for blooming in the lights data and for the potential positive effect of water streams on development via trade. Third, controlling for malaria prevalence is important, as Gallup and Sachs (2001) and subsequent studies have shown a negative impact of malaria on development. Fourth, there is a vast literature linking natural resources like oil and diamonds to development (e.g., Ross (2006)). Fifth, Michalopoulos (2012) showed that differences in land suitability and elevation across regions lead to the formation of ethnic groups, whereas Ashraf and Galor (2011) showed that land quality is strongly correlated with pre-colonial population densities. We also control for the location of each ethnic area inside a country, augmenting the specification with the distance of the centroid of each ethnic group i in country c from the respective capital, the national border, and the nearest sea coast. The coefficient on distance from the capital reflects the impact of colonization and the limited penetration of national institutions. Distance to the national border captures the potentially lower level of development in border areas, whereas distance to the sea reflects the effect of trade as well as the penetration of colonization. In several specifications, we control for log population density ($\text{PD}_{i,c}$), although the latter is likely endogenous to ethnic institutional development. Table A.I reports the summary statistics for all control variables.

The distribution of luminosity across ethnic homelands is not normal, as (i) a significant fraction (around 24%) of the observations takes on the value of zero, and (ii) we have a few extreme observations in the right tail of the distribution (Figure A.1(A)). To account for both issues, we use as dependent variable the log of light density, adding a small number ($y_{i,c} \equiv \ln(0.01 + \text{Light Density}_{i,c})$; Figure A.1(B)).[7] This transformation ensures that we use all observations and that we minimize the problem of outliers. We also estimate specifications ignoring unlit areas ($y_{i,c} \equiv \ln(\text{Light Density}_{i,c})$), as in this case the dependent variable is normally distributed (Figure A.1(C)). Moreover, in our pixel-level analysis, where we focus on regions of 0.125×0.125 decimal degrees, we use as dependent variable a dummy that takes on the value 1 when the pixel is lit and zero otherwise.

In all specifications, we employ the approach of Cameron, Gelbach, and Miller (2011) and cluster standard errors at the country level and at the ethnic-family level. Murdock assigned the 834 groups into 96 ethnolinguistic clusters/families. Double-clustering accounts for the fact that ethnicity-level characteristics are likely to be correlated within an ethnolinguistic family. Moreover, clustering at the ethnic-family level is appropriate because partitioned

[7]In the previous draft of the paper, we added 1 to the luminosity data before using the logarithm, finding similar results.

ethnicities appear more than once. Finally, the multiway clustering method allows for arbitrary residual correlation within both dimensions and thus accounts for spatial correlation. (Cameron, Gelbach, and Miller (2011) explicitly cited spatial correlation as an application of the multiclustering approach.) We also estimate standard errors accounting for spatial correlation of an unknown form using Conley's (1999) method. The two approaches yield similar standard errors; and if anything, the two-way clustering produces somewhat larger standard errors.

3.2. *Preliminary Evidence*

Table II reports cross-sectional least squares specifications that associate regional development with pre-colonial ethnic institutions. Below the estimates,

TABLE II

PRE-COLONIAL ETHNIC INSTITUTIONS AND REGIONAL DEVELOPMENT CROSS-SECTIONAL ESTIMATES[a]

	(1)	(2)	(3)	(4)	(5)	(6)
Jurisdictional Hierarchy	0.4106***	0.3483**	0.3213***	0.1852***	0.1599***	0.1966***
Double-clustered s.e.	(0.1246)	(0.1397)	(0.1026)	(0.0676)	(0.0605)	(0.0539)
Conley's s.e.	[0.1294]	[0.1288]	[0.1014]	[0.0646]	[0.0599]	[0.0545]
Rule of Law (in 2007)					0.4809**	
Double-clustered s.e.					(0.2213)	
Conley's s.e.					[0.1747]	
Log GDP p.c. (in 2007)						0.5522***
Double-clustered s.e.						(0.1232)
Conley's s.e.						[0.1021]
Adjusted R-squared	0.056	0.246	0.361	0.47	0.488	0.536
Population Density	No	Yes	Yes	Yes	Yes	Yes
Location Controls	No	No	Yes	Yes	Yes	Yes
Geographic Controls	No	No	No	Yes	Yes	Yes
Observations	683	683	683	683	680	680

[a]Table II reports OLS estimates associating regional development with pre-colonial ethnic institutions, as reflected in Murdock's (1967) index of jurisdictional hierarchy beyond the local community. The dependent variable is $\log(0.01 + \text{light density at night from satellite})$ at the ethnicity–country level. In column (5) we control for national institutions, augmenting the specification with the rule of law index (in 2007). In column (6) we control for the overall level of economic development, augmenting the specification with the log of per capita GDP (in 2007). In columns (2)–(6) we control for $\log(0.01 + \text{population density})$. In columns (3)–(6) we control for location, augmenting the specification with distance of the centroid of each ethnicity–country area from the respective capital city, distance from the closest sea coast, and distance from the national border. The set of geographic controls in columns (4)–(6) includes $\log(1 + \text{area under water(lakes, rivers, and other streams)})$, log(surface area), land suitability for agriculture, elevation, a malaria stability index, a diamond mine indicator, and an oil field indicator.

The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and ethnolinguistic family dimensions. We also report in brackets Conley's (1999) standard errors that account for two-dimensional spatial autocorrelation. ***, **, and * indicate statistical significance, with the most conservative standard errors at the 1%, 5%, and 10% level, respectively.

we report both double-clustered (in parentheses) and Conley's (in brackets) standard errors.[8] Column (1) reports the unconditional estimate. In line with the pattern shown in Table I, the coefficient on the jurisdictional hierarchy index is positive (0.411) and highly significant. The coefficient remains significant when we control for population density in column (2). In column (3), we control for distance to the capital city, distance to the border, and distance to the coast ("location controls"), whereas in column (4), we augment the specification with a rich set of geographic features.[9] Adding these controls reduces the size of the coefficient on the jurisdictional hierarchy index; yet the estimate retains significance at the 99% confidence level. In columns (5) and (6), we examine whether the strong positive correlation between pre-colonial political institutions and regional development is driven by differences in national institutional quality or income per capita, respectively. This check is motivated by Gennaioli and Rainer (2006), who showed that, across African countries, there is a positive association between the average level of pre-colonial political centralization and contemporary national institutions (in our sample, the correlation between the rule of law in 2007 and the jurisdictional hierarchy index is 0.19). Conditioning on either (or both) of these country-level measures of institutional and economic development has little effect on our main result. The coefficient on jurisdictional hierarchy remains intact.[10]

3.3. *Benchmark Fixed Effects Estimates*

The positive correlation between local institutions and regional development may be driven by a myriad of nationwide features. In Table III, we estimate country fixed effects specifications associating regional development with pre-colonial ethnic institutions. Table III(A) reports estimates using all observations. In Table III(B), we focus on the intensive margin of luminosity. By doing so, we (i) account for nonlinearities in the dependent variable, and (ii) focus on densely populated areas (since non-lit areas have a median population density of 11.06 people per square kilometer, whereas lit regions have a median of 35.54).

[8]Conley's method requires a cutoff distance beyond which the spatial correlation is assumed to be zero; we experimented with values between 100 km and 3000 km. We report errors with a cutoff of 2000 km, which delivers the largest in magnitude standard errors.

[9]Land suitability for agriculture, which reflects climatic and soil conditions, enters most models with a positive and significant estimate. The malaria stability index enters with a statistically negative estimate. The coefficient on land area under water is positive and, in many specifications, significant. Elevation enters with a negative estimate, which is significant in some models. The petroleum dummy enters always with a positive and significant coefficient. The diamond dummy enters in most specifications with a negative estimate.

[10]We lose three observations when we condition on the rule of law or GDP, because we lack data on Western Sahara. The results are unaffected if we assign the Western Saharan ethnic homelands to Morocco.

TABLE III

PRE-COLONIAL ETHNIC INSTITUTIONS AND REGIONAL DEVELOPMENT WITHIN AFRICAN COUNTRIES[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Pre-Colonial Ethnic Institutions and Regional Development Within African Countries All Observations												
Jurisdictional Hierarchy	0.3260***	0.2794***	0.2105***	0.1766***								
	(0.0851)	(0.0852)	(0.0553)	(0.0501)								
Binary Political Centralization					0.5264***	0.5049***	0.3413***	0.3086***				
					(0.1489)	(0.1573)	(0.0896)	(0.0972)				
Petty Chiefdoms									0.1538	0.1442	0.1815	0.1361
									(0.2105)	(0.1736)	(0.1540)	(0.1216)
Paramount Chiefdoms									0.4258*	0.4914*	0.3700**	0.3384**
									(0.2428)	(0.2537)	(0.1625)	(0.1610)
Pre-Colonial States									1.1443***	0.8637***	0.6809***	0.5410***
									(0.2757)	(0.2441)	(0.1638)	(0.1484)
Adjusted R-squared	0.409	0.540	0.400	0.537	0.597	0.661	0.593	0.659	0.413	0.541	0.597	0.661
Observations	682	682	682	682	682	682	682	682	682	682	682	682
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Geographic Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Population Density	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

(*Continues*)

TABLE III—*Continued*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel B: Pre-Colonial Ethnic Institutions and Regional Development Within African Countries Focusing on the Intensive Margin of Luminosity												
Jurisdictional Hierarchy	0.3279***	0.3349***	0.1651**	0.1493**								
	(0.1238)	(0.1118)	(0.0703)	(0.0728)								
Binary Political Centralization					0.4819**	0.6594***	0.2649**	0.2949**				
					(0.2381)	(0.2085)	(0.1232)	(0.1391)				
Petty Chiefdoms									0.1065	0.1048	0.0987	0.0135
									(0.2789)	(0.2358)	(0.1787)	(0.1725)
Paramount Chiefdoms									0.2816	0.6253*	0.2255	0.2374
									(0.3683)	(0.3367)	(0.2258)	(0.2388)
Pre-Colonial States									1.2393***	0.9617***	0.5972***	0.4660**
									(0.3382)	(0.3209)	(0.2207)	(0.2198)
Adjusted R-squared	0.424	0.562	0.416	0.562	0.638	0.671	0.636	0.671	0.431	0.564	0.639	0.672
Observations	517	517	517	517	517	517	517	517	517	517	517	517
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Geographic Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Population Density	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

[a]Table III reports within-country OLS estimates associating regional development with pre-colonial ethnic institutions. In Panel A the dependent variable is the log(0.01 + light density at night from satellite) at the ethnicity-country level. In Panel B the dependent variable is the log(light density at night from satellite) at the ethnicity-country level; as such we exclude areas with zero luminosity. In columns (1)–(4) we measure pre-colonial ethnic institutions using Murdock's (1967) jurisdictional hierarchy beyond the local community index. In columns (5)–(8) we use a binary political centralization index that is based on Murdock's (1967) jurisdictional hierarchy beyond the local community variable. Following Gennaioli and Rainer (2007), this index takes on the value of zero for stateless societies and ethnic groups that were part of petty chiefdoms and 1 otherwise (for ethnicities that were organized as paramount chiefdoms and ethnicities that were part of large states). In columns (9)–(12) we augment the specification with three dummy variables that identify petty chiefdoms, paramount chiefdoms, and large states. The omitted category consists of stateless ethnic groups before colonization. All specifications include a set of country fixed effects (constants not reported).

In even-numbered columns we control for location and geography. The set of control variables includes the distance of the centroid of each ethnicity-country area from the respective capital city, the distance from the sea coast, the distance from the national border, log(1 + area under water (lakes, rivers, and other streams)), log(surface area), land suitability for agriculture, elevation, a malaria stability index, a diamond mine indicator, and an oil field indicator. The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Jurisdictional Hierarchy Beyond the Local Community

The coefficient on the jurisdictional hierarchy index in column (1) of Table III(A) is 0.326 and highly significant.[11] The estimate is moderately smaller than the analogous unconditional specification reported in Table II, column (1), suggesting that common-to-all-ethnicities country-level factors are not driving the positive cross-sectional correlation.[12] Standard errors also drop with the inclusion of country fixed effects and, as such, the statistical significance of the estimate is unaffected. In column (2), we augment the specification with distance to the coast, distance to the border, distance to the capital, and the rich set of geographic controls. The coefficient on the jurisdictional hierarchy beyond the local community index retains its statistical and economic significance. In column (3), we control for population density, while in column (4), we control jointly for geography, location, and population density. Compared to column (1), the estimate on jurisdictional hierarchy falls by almost a half. This is not surprising as, according to African historiography (e.g., Stevenson (1968), Fenske (2009)), there is a strong interplay between geography, population density, and political complexity.[13] The size of the coefficient in Table III(A), column (3) implies that a one-standard-deviation increase in the jurisdictional hierarchy index (which corresponds to approximately one-unit increase; see Table A.I) is associated with a 0.12 standard-deviation increase in luminosity. This magnitude is similar to the one documented by Nunn and Wantchekon (2011) in their within-country cross-regional examination of the effect of the African slave trades on trust (where they reported "beta" coefficients in the range 0.10–0.16).

Political Centralization

In columns (5) and (8), we use an alternative indicator of pre-colonial political institutions. Following Gennaioli and Rainer (2006, 2007), we define a dummy variable that takes the value of zero when the group lacks any political organization beyond the local level or is organized as a petty chiefdom; the index equals 1 if Murdock classified the ethnicity as being a large chiefdom or part of a state. Experimenting with the rescaled index is useful because the aggregation may account for measurement error in the jurisdictional hierarchy index. Moreover, the binary classification is in line with the distinction of

[11] When we add country fixed effects, we lose one observation. This is because in Swaziland we have only one group, the Swazi.

[12] The Hausman-type test that compares the coefficient on the jurisdictional hierarchy index of the cross-sectional to the within-country model, suggests that one cannot reject the null hypothesis of coefficient equality.

[13] Since population density may be both a cause and an effect of ethnic institutions, the specifications where we also control for population density should be cautiously interpreted. Following Angrist and Pischke's (2008) recommendation, we also used lagged (at independence) population density. In these models (not reported), the estimates on the ethnic institutions measures are larger (and always significant at the 95% level).

African pre-colonial political systems into centralized ones and those lacking any form of centralized political authority.[14] The coefficient on political centralization is positive and highly significant. The estimate retains significance when we control for geography (in (6)), current levels of population density (in (7)), or both (in (8)). The magnitude of political centralization in column (8) in Table III(B) suggests that luminosity is 34% ($\exp(0.295) - 1 = 0.343$) higher in ethnic homelands where politically centralized societies reside (e.g., Yoruba in Nigeria), as compared to stateless societies or small chiefdoms (e.g., the Sokoto or the Tiv in Nigeria).

Flexibly Estimating the Role of Jurisdictional Hierarchy

In columns (9)–(12), we flexibly estimate the relationship between pre-colonial political institutional structures and contemporary development. We define three dummy variables that take on the value 1 for petty chiefdoms, paramount chiefdoms, and pre-colonial states, respectively; the comparison group being stateless societies.[15] The difference in regional development between stateless societies and small chiefdoms is statistically indistinguishable from zero. This result is in accord with the African historiography that usually does not distinguish between these organizational structures (see also Gennaioli and Rainer (2006, 2007)). Sizable differences in regional development emerge for large paramount chiefdoms and particularly for groups that were part of pre-colonial states. This finding is consistent with Diamond (1997), Bockstette, Chanda, and Putterman (2002), and Acemoglu and Robinson (2012), who argued that centralization and statehood experience of pre-industrial societies are the traits most conducive to development.

Nigeria offers an illustration of these results. Average (median) luminosity in the homelands of the five ethnic groups that were part of states in pre-colonial Africa, namely the Yoruba, the Fon, the Ife, the Igala, and the Edo, is 1 (0.72). Mean (median) luminosity in the homelands of ethnic groups organized solely at the local level or in petty chiefdoms is 0.88 (0.075). Likewise, in the Democratic Republic of Congo, average luminosity in the homeland of stateless ethnicities and petty chiefdoms is 0.037; luminosity in paramount chiefdoms is only slightly higher, 0.042; yet mean luminosity across homelands of ethnicities belonging to pre-colonial centralized states is three times larger, 0.12.

[14] Fortes and Evans-Pritchard (1940) argued that "the political systems fall into two main categories. One group consists of those societies which have centralized authority, administrative machinery, and judicial institutions—in short, a government—and in which cleavages of wealth, privilege, and status correspond to the distribution of power and authority. This group comprises the Zulu, the Ngwato, the Bemba, the Banyankole, and the Kede. The other group consists of those societies which lack centralized authority, administrative machinery, and judicial institutions—in short which lack government—and in which there are no sharp divisions of rank, status, or wealth. This group comprises the Logoli, the Tallensi, and the Nuer." Other African scholars make a trichotomous distinction between stateless societies, large chiefdoms, and centralized states.

[15] Since we have just two ethnic groups where the jurisdictional hierarchy index equals 4, we assign these ethnicities into the groups where the jurisdictional hierarchy index equals 3.

3.4. *Institutions or Other Ethnic Traits?*

One concern with the previous estimates is that some other aspect of a society's economy, culture, or structure is driving the positive correlation between luminosity and pre-colonial institutions. To address this issue, we examined whether some other ethnic trait, in lieu of political centralization, correlates with contemporary development. In Table IV, we report within-country specifications associating log light density with around twenty different variables from Murdock's Ethnographic Atlas (see the Data Appendix in the Supplemental Material (Michalopoulos and Papaioannou (2013)) for detailed variable definitions).[16] These measures reflect the type of economic activity (dependence on gathering, hunting, fishing, animal husbandry, milking of domesticated animals, and agriculture), societal arrangements (polygyny, presence of clans at the village level, slavery), early development (size and complexity of pre-colonial settlements), and proxies of local institutional arrangements (an indicator for the presence of inheritance rule for property, elections for local headman, class stratification, and jurisdictional hierarchy at the village level).

In Table IV, Specification A, we regress regional light density on the ethnic-level variables, simply conditioning on country fixed effects and on population density (the results are similar if we omit population density). Most of the additional variables are statistically insignificant. An indicator for societies where fishing contributes more than 5% in the pre-colonial subsistence economy enters with a positive coefficient, as economic development is higher in regions close to the coast and other water sources, and because of potential blooming in luminosity. An agricultural intensity index ranging from 0 to 9, where higher values indicate higher dependence, is negative and significant, but the correlation between pre-colonial agricultural intensity and regional development is not robust to an alternative index of agricultural dependence.

The results in columns (1) and (2) show that class stratification, a societal trait that has been linked to property rights protection and the emergence of centralized states with a bureaucratic structure, correlates significantly with luminosity.[17] Regional development is higher across regions populated by stratified, as compared to egalitarian, societies. The positive association between stratification and regional development, though surprising at first glance, is in line with recent works in Southern America (e.g., Acemoglu, Bautista, Querubin, and Robinson (2008), Dell (2010)). A potential explanation is that, in weakly institutionalized societies, inequality may lead to some form of legal institutions, property rights, and policing, as the elite has the incentive to establish constraints (Diamond (1997), Herbst (2000)).

In Specification B, we add the jurisdictional hierarchy beyond the local community index to test whether it correlates with regional development condi-

[16]We are grateful to an anonymous referee for proposing this test.

[17]In line with these arguments, in our sample the correlation of class stratification and the jurisdictional hierarchy index is 0.63.

TABLE IV

EXAMINING THE ROLE OF OTHER PRE-COLONIAL ETHNIC FEATURES[a]

	Specification *A*		Specification *B*		
	Additional Variable	Obs.	Additional Variable	Jurisdictional Hierarchy	Obs.
	(1)	(2)	(3)	(4)	(5)
Gathering	−0.1034 (0.1892)	682	−0.0771 (0.1842)	0.2082*** (0.0550)	682
Hunting	−0.0436 (0.1316)	682	−0.0167 (0.1236)	0.2099*** (0.0562)	682
Fishing	0.2414* (0.1271)	682	0.2359* (0.1267)	0.2087*** (0.0551)	682
Animal Husbandry	0.0549 (0.0407)	682	0.0351 (0.0432)	0.2008*** (0.0617)	682
Milking	0.1888 (0.1463)	680	0.0872 (0.1443)	0.2016*** (0.0581)	680
Agriculture Dependence	−0.1050** (0.0468)	682	−0.1032** (0.0454)	0.2078*** (0.0558)	682
Agriculture Type	0.0128 (0.1043)	680	−0.0131 (0.1021)	0.2092*** (0.0549)	680
Polygyny	0.0967 (0.1253)	677	0.0796 (0.1288)	0.2140*** (0.0561)	677
Polygyny Alternative	−0.0276 (0.1560)	682	0.0070 (0.1479)	0.2106*** (0.0543)	682
Clan Communities	−0.1053 (0.1439)	567	−0.0079 (0.1401)	0.2158*** (0.0536)	567
Settlement Pattern	−0.0054 (0.0361)	679	−0.0057 (0.0377)	0.2103*** (0.0571)	679
Complex Settlements	0.2561 (0.1604)	679	0.2154 (0.1606)	0.1991*** (0.0553)	679
Hierarchy of Local Community	0.0224 (0.0822)	680	−0.0009 (0.0867)	0.2085*** (0.0565)	680
Patrilineal Descent	−0.1968 (0.1329)	671	−0.2011 (0.1307)	0.1932*** (0.0499)	671
Class Stratification	0.1295** (0.0526)	570	0.0672 (0.0580)	0.1556** (0.0696)	570
Class Stratification Indicator	0.4141** (0.1863)	570	0.2757 (0.1896)	0.1441** (0.0562)	570
Elections	0.3210 (0.2682)	500	0.2764 (0.2577)	0.2217*** (0.0581)	500

(*Continues*)

TABLE IV—*Continued*

	Specification *A*		Specification *B*		
	Additional Variable	Obs.	Additional Variable	Jurisdictional Hierarchy	Obs.
	(1)	(2)	(3)	(4)	(5)
Slavery	0.0191 (0.1487)	610	−0.1192 (0.1580)	0.2016*** (0.0617)	610
Inheritance Rules for Property Rights	−0.1186 (0.2127)	529	−0.1788 (0.2283)	0.2196*** (0.0690)	529

[a]Table IV reports within-country OLS estimates associating regional development with pre-colonial ethnic features as reflected in Murdock's (1967) Ethnographic Atlas. The dependent variable is the log(0.01 + light density at night from satellite) at the ethnicity-country level. All specifications include a set of country fixed effects (constants not reported). In all specifications we control for log(0.01 + population density at the ethnicity-country level). In specification *A* (in columns (1)–(2)) we regress log(0.01 + light density) on various ethnic traits from Murdock (1967). In specification *B* (columns (3)–(5)) we regress log(0.01 + light density) on each of Murdock's additional variables and the jurisdictional hierarchy beyond the local community index. The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

tional on the other ethnic traits. In all specifications, the jurisdictional hierarchy index enters with a positive and stable coefficient (around 0.20), similar in magnitude to the (more efficient) estimate in Table III(A), column (3). The coefficient is always significant at standard confidence levels (usually at the 99% level). Clearly, the positive correlation between pre-colonial political institutions and contemporary development may still be driven by some other unobservable factor, related, for example, to genetics or cultural similarities with some local frontier economy (see, e.g., Spolaore and Wacziarg (2009), Ashraf and Galor (2012)). However, the results in Table IV suggest that we are not capturing the effect of cultural traits, the type of economic activity, or early development, at least as reflected in Murdock's statistics.

3.5. *Further Sensitivity Checks*

In the Supplemental Material (Michalopoulos and Papaioannou (2013)), we further explore the sensitivity of our results: (1) dropping observations where luminosity exceeds the 99th percentile; (2) excluding capitals; (3) dropping a different part of the continent each time; (4) using log population density as an alternative proxy for development. Moreover, using data from the Afrobarometer Surveys on living conditions and schooling, we associate pre-colonial institutions with these alternative proxies of regional development. Across all specifications, we find a significantly positive correlation between a group's current economic performance and its pre-colonial political centralization.

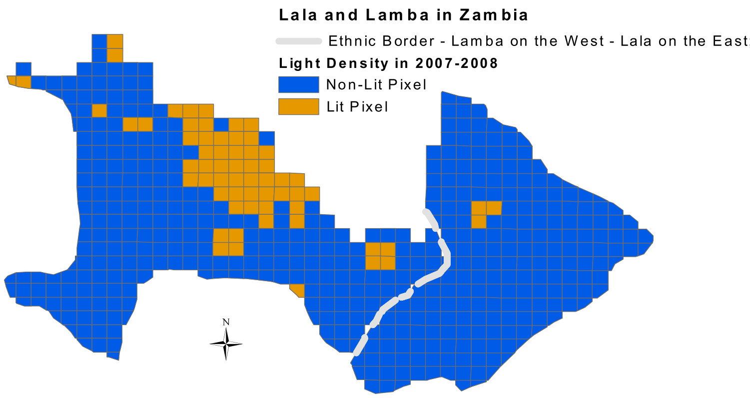


FIGURE 4.—Example of the pixel-level analysis.

4. PIXEL-LEVEL ANALYSIS

We now proceed to the pixel-level analysis. In this section, the unit of analysis is a pixel of 0.125×0.125 decimal degrees. As a result, we now have multiple observations within each ethnic area in each country. Since there are several unpopulated pixels (in the Sahara and the rainforests), we exclude pixels with zero population (including unpopulated pixels if anything strengthens the results). Figure 4 illustrates the new unit of analysis, showing pixel-level luminosity within two Bantu groups in Northern Zambia, the Lala and the Lamba.

Moving to the pixel level offers some advantages. First, we can condition on geography, natural resources, and the disease environment at an even finer level. Second, since the dependent variable is an indicator for lit pixels, the nonlinear nature of luminosity is no longer a concern. Third, we account for the possibility that average luminosity in the ethnic homeland also reflects inequality; this may be the case when average light density in the ethnic homeland is driven by a few extremely lit pixels.

4.1. *Benchmark Pixel-Level Estimates*

Our specification for the pixel-level analysis reads

$$y_{p,i,c} = a_0 + a_c + \gamma\,\mathrm{IQL}_i + \lambda\,\mathrm{PD}_{p,i,c} + Z'_{p,i,c}\Psi + X'_{i,c}\Phi + \zeta_{p,i,c}.$$

The dependent variable, $y_{p,i,c}$, reflects economic activity in pixel p that belongs to the historical homeland of ethnicity i in country c. $\mathrm{PD}_{p,i,c}$ denotes log population density, while vector $Z'_{p,i,c}$ includes other controls at the pixel level; $X'_{i,c}$ is the set of conditioning variables at the ethnic-country level.

Table V, Panel A reports the results. In columns (1)–(5), we report linear probability models, where the dependent variable equals 1 if the pixel is lit

TABLE V

PRE-COLONIAL ETHNIC INSTITUTIONS AND REGIONAL DEVELOPMENT: PIXEL-LEVEL ANALYSIS[a]

	Lit/Unlit Pixels					ln(0.01 + Luminosity)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Jurisdictional Hierarchy Beyond the Local Community Level										
Jurisdictional Hierarchy	0.0673**	0.0447**	0.0280***	0.0308***	0.0265***	0.3619**	0.2362**	0.1528***	0.1757***	0.1559***
Double-clustered s.e.	(0.0314)	(0.0176)	(0.0081)	(0.0074)	(0.0071)	(0.1837)	(0.1035)	(0.0542)	(0.0506)	(0.0483)
Adjusted R-squared	0.034	0.272	0.358	0.375	0.379	0.045	0.320	0.418	0.448	0.456
Panel B: Pre-Colonial Institutional Arrangements										
Petty Chiefdoms	0.0285	0.0373	0.0228	0.0161	0.0125	0.1320	0.1520	0.0796	0.0642	0.0531
Double-clustered s.e.	(0.0255)	(0.0339)	(0.0220)	(0.0175)	(0.0141)	(0.1192)	(0.1832)	(0.1271)	(0.0976)	(0.0837)
Paramount Chiefdoms	0.0685**	0.0773	0.0546*	0.0614**	0.0519***	0.3103**	0.3528	0.2389	0.3054**	0.2802***
Double-clustered s.e.	(0.0334)	(0.0489)	(0.0295)	(0.0266)	(0.0178)	(0.1560)	(0.2472)	(0.1498)	(0.1347)	(0.0964)
Pre-Colonial States	0.2013**	0.1310**	0.0765***	0.0798***	0.0688***	1.0949**	0.6819**	0.4089***	0.4544***	0.3994***
Double-clustered s.e.	(0.0956)	(0.0519)	(0.0240)	(0.0216)	(0.0235)	(0.5488)	(0.2881)	(0.1432)	(0.1430)	(0.1493)
Adjusted R-squared	0.033	0.271	0.357	0.375	0.379	0.046	0.319	0.417	0.448	0.456
Country Fixed Effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Population Density	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Controls at the Pixel Level	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Controls at the Ethnic-Country Level	No	No	No	No	Yes	No	No	No	No	Yes
Observations	66,570	66,570	66,570	66,173	66,173	66,570	66,570	66,570	66,173	66,173

[a]Table V reports OLS estimates associating regional development, as reflected in satellite light density at night, with pre-colonial ethnic institutions. The unit of analysis is a pixel of 0.125×0.125 decimal degrees (around 12×12 kilometers). In columns (1)–(5) the dependent variable is a dummy variable that takes on the value of 1 if the pixel is lit and zero otherwise. In columns (6)–(10) the dependent variable is the log(0.01 + light density at night from satellite). In Panel A we measure pre-colonial ethnic institutions with Murdock's (1967) jurisdictional hierarchy beyond the local community index. In Panel B we examine in a flexible way the role of each pre-colonial political structure on regional development, augmenting the specification with three dummy variables that identify ethnic groups that were organized as petty chiefdoms, large paramount chiefdoms, and large states before colonization. The omitted category consists of stateless upon colonization ethnic groups.

In columns (3)–(5) and (8)–(10) we control for ln(pixel population density). In columns (4), (5), (9), and (10) we control for a set of geographic and location variables at the pixel level. The set of controls includes the distance of the centroid of each pixel from the respective capital city, the distance of each pixel from the sea coast, the distance of each pixel from the national border, an indicator for pixels that have water (lakes, rivers, and other streams), an indicator for pixels with diamond mines, an indicator for pixels with oil fields, the pixel's land suitability for agriculture, pixel's mean elevation, pixel's average value of a malaria stability index, and the log of the pixel's area. In columns (5) and (10) we also control for location and geographic features at the ethnic-country level. Specifically, the set of control variables includes the distance of the centroid of each ethnicity-country area from the respective capital city, the distance from the sea coast, the distance from the national border, log(1 + area under water (lakes, rivers, and other streams)), log(surface area), land suitability for agriculture, elevation, a malaria stability index, a diamond mine indicator, and an oil field indicator. The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

and zero otherwise. The coefficient on the jurisdictional hierarchy index in the unconditional specification in column (1) is positive and highly significant. The estimate retains significance when we add a vector of country constants (in (2)). In column (3), we control for log pixel population density. As in our analysis at the ethnic homeland level, the coefficient on the pre-colonial ethnic institutions index declines, though it remains significant. In column (4), we augment the specification with a rich set of pixel-specific controls. Namely, we control for land suitability for agriculture, elevation, malaria stability, surface area, distance from the centroid of each pixel to the sea coast, the capital city, and the national border, and we add indicators capturing the presence of diamond mines, petroleum fields, and bodies of water.[18] In spite of the inclusion of this rich set of controls, the jurisdictional hierarchy beyond the local community continues to enter with a positive and highly significant (at the 99% confidence level) coefficient. In column (5), we condition on the location and geographic controls at the country-ethnic level. The coefficient on the jurisdictional hierarchy index remains intact. The estimate (0.031) in column (4) implies that, compared to stateless ethnicities, pixels in the homelands of ethnic groups that were part of paramount chiefdoms are on average 6% more likely to be lit. Similarly, the likelihood that a pixel is lit is 9 percentage points higher if it falls in the homeland of groups that had complex centralized institutions at the time of colonization. These magnitudes are not negligible, since only 17% of populated pixels are lit across Africa.[19]

In Panel B, we flexibly estimate the relationship between pre-colonial political organizational forms and contemporary development. The estimates show that differences in development become economically and statistically significant when one compares paramount chiefdoms to stateless societies or groups organized as petty chiefdoms. Contemporary development is even higher in areas populated by societies that were part of pre-colonial states. The most conservative estimates imply that the likelihood that a pixel is lit is approximately 8 percentage points higher when one moves from the homeland of stateless ethnicities to regions with ethnic groups that pre-colonially were part of a centralized state. Examples from Botswana illustrate the point estimates. The Naron and the Kung are two stateless societies, whereas the (Ba)Ngwato (a traditional Sotho-Tswana tribe) and the Ndebele (which originate from the Zulus, the dominant ethnic group of one of the largest pre-colonial states in Southern Africa) are centralized groups. On average, 27.8% of the homeland of the Ndebele and the Ngwato is lit, while only 5.4% of the homeland of the Naron and the Kung is lit.

In columns (6)–(10) of Table V, we report otherwise identical to columns (1)–(5) least squares specifications using as the dependent variable the log of

[18]Note that not all pixels have the same surface area since pixels by the coast, lakes, and ethnic boundaries are smaller.

[19]The results are similar using the Gennaioli and Rainer (2006, 2007) binary index of political centralization (see Table A.VI).

luminosity, adding a small number (0.01). The coefficient on the jurisdictional hierarchy index is more than two standard errors larger than zero across all permutations, which shows that our results at the ethnic homeland level were not driven by the transformation of luminosity.

4.2. *Contiguous Ethnic Homeland Analysis*

Approach and Empirical Specification

In spite of employing a rich conditioning set, one may still be worried that some unobservable local geographic feature is driving the results. To mitigate such concerns, we focus on contiguous ethnicities with a different degree of pre-colonial political centralization, and exploit variation in luminosity and historical institutions across adjacent ethnicities in the same country. In some sense this approach extends the pioneering case study of Douglas (1962), who attributed the large differences in well-being between the neighboring Bushong and the Lele in the Democratic Republic of Congo to their local institutions and the degree of political centralization in particular.[20]

We first identified contiguous ethnic homelands, where groups differ in the degree of political centralization, using the Gennaioli and Rainer (2007) binary classification. There are 252 unique adjacent ethnic pairs comprising a centralized and a noncentralized ethnicity. Figure 4 illustrates this using the Lala and the Lamba. The Lala were organized as a petty chiefdom at the time of colonization; as such, the binary political centralization index equals zero. The Lamba are classified as a paramount chiefdom and therefore as politically centralized. When a group is adjacent to more than one ethnicity with different pre-colonial centralization in the same country, we include all pairs.[21] Then we examine whether there are systematic differences in development within contiguous ethnic homelands in the same country running specifications of the form

$$y_{p,i(j),c} = a_{i(j),c} + \delta\,\mathrm{IQL}_i + \lambda\,\mathrm{PD}_{p,i,c} + Z'_{p,i,c}\Psi + \zeta_{p,i(j),c}.$$

The dependent variable takes on the value of 1 if pixel p is lit and zero otherwise. Every pixel p falls into the historical homeland of ethnicity i in country c that is adjacent to the homeland of ethnicity j in the same country c (where ethnicities i and j differ in their degree of pre-colonial political centralization). Since we now include country-specific, ethnicity-pair fixed effects, $a_{i(j),c}$, the coefficient on the jurisdictional hierarchy beyond the local community index, δ,

[20] We are thankful to Jim Robinson for providing us with this reference.

[21] For example, the Dagomba in Ghana, a centralized group (the jurisdictional hierarchy index equals 3) is adjacent to two noncentralized groups in Ghana, the Basari and the Konkomba. In such cases we include both pairs. The median (average) distance between the centroids of neighboring ethnicities is 179 km (215 km).

captures whether differences in pre-colonial ethnic institutions translate into differences in light density across pixels within pairs of contiguous ethnicities in the same country.

Validation

Before we present the results, we examine whether there is a systematic correlation between pre-colonial institutions and various characteristics within adjacent ethnic pairs in the same country. To do so, we run ethnic-pair–country fixed effects specifications (with $a_{i(j),c}$) associating the jurisdictional hierarchy index with natural resources (presence of diamond mines or petroleum fields), location (distance to capital, to the sea, and the national border), and geography (elevation, presence of lakes/rivers, soil quality for agriculture, and the malaria stability index). These regressions, reported in Table VI, yield statistically and economically insignificant estimates, suggesting that by focusing on neighboring ethnic areas, we neutralize the role of local (observable) geographic and location factors.

Results

Table VII reports the results of the contiguous-ethnic-homeland analysis. The estimate in (1) shows that within country, within pairs of contiguous ethnic homelands, luminosity is significantly higher in the historical homeland of ethnicities with more complex political institutions. In column (2), we condition on pixel population density. The coefficient on the jurisdictional hierarchy beyond the local community index falls, though it becomes more precisely estimated. In column (3), we control for the rich set of pixel-level geographic variables. While some of these variables enter with significant estimates, given their minimal correlation with the jurisdictional hierarchy index (shown in Table VI), this has a negligible effect on the estimate. The coefficient in column (3) implies that the likelihood that a pixel is lit is approximately 2.5 percentage points higher if one moves from the homeland of a stateless group to the neighboring homeland in the same country of an ethnic group that was organized as a paramount chiefdom. In columns (4)–(6), we restrict our analysis to pairs of contiguous ethnic homelands with large differences (two levels or greater) in the jurisdictional hierarchy index; this is helpful not only because we now focus on sharper discontinuities, but also because we can account (to some degree) for measurement error in Murdock's classification of pre-colonial political organization. The estimate on the pre-colonial ethnic institutions index retains its statistical and economic significance. In columns (7)–(9), we require that one of the two adjacent ethnic groups was part of a pre-colonial state. Thus, in these models, in each pair of adjacent ethnicities, we compare a group that had been either stateless or part of a petty chiefdom (the Gennaioli and Rainer (2007) index equals zero) to an ethnicity that was organized as a state at the time of colonization. There is a strong positive correlation between differences

TABLE VI

PRE-COLONIAL ETHNIC INSTITUTIONS AND GEOGRAPHIC CHARACTERISTICS WITHIN CONTIGUOUS ETHNIC HOMELANDS IN THE SAME COUNTRY[a]

	Dependent variable is:								
	Diamond Indicator	Oil Indicator	Water Indicator	Distance to the Capital	Distance to the Sea	Distance to the Border	Malaria Stability	Land Suitability	Mean Elevation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jurisdictional Hierarchy	0.0011	0.0063	−0.0058	−9.1375	9.4628	−3.7848	−0.001	−0.0059	21.3826
Double-clustered s.e.	(0.0008)	(0.0051)	(0.0077)	(20.1494)	(6.3349)	(10.0488)	(0.0181)	(0.0060)	(19.5522)
Adjusted R-squared	0.508	0.019	0.126	0.915	0.944	0.660	0.629	0.835	0.767
Mean of Dependent Variable	0.004	0.036	0.125	521.899	643.984	157.596	0.754	0.377	743.446
Observations	78,139	78,139	78,139	78,139	78,139	78,139	77,985	77,983	78,139
Adjacent-Ethnic-Groups Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a]Table VI reports OLS estimates associating various geographical, ecological, and other characteristics with pre-colonial ethnic institutions within pairs of adjacent ethnicities. The unit of analysis is a pixel of 0.125×0.125 decimal degrees (around 12×12 kilometers). Every pixel falls into the historical homeland of ethnicity i in country c that is adjacent to the homeland of another ethnicity j in country c, where the two ethnicities differ in the degree of political centralization.

The dependent variable in column (1) is a binary index that takes on the value of 1 if there is a diamond mine in the pixel; in column (2) a binary index that takes on the value of 1 if an oil/petroleum field is in the pixel; in column (3) a binary index that takes on the value of 1 if a water body falls in the pixel. In columns (4)–(6) the dependent variable is the distance of each pixel from the capital city, the sea coast, and the national border, respectively. In column (7) the dependent variable is the average value of a malaria stability index; in column (8) the dependent variable is land's suitability for agriculture; in column (9) the dependent variable is elevation. The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

TABLE VII

PRE-COLONIAL ETHNIC INSTITUTIONS AND REGIONAL DEVELOPMENT WITHIN CONTIGUOUS ETHNIC HOMELANDS IN THE SAME COUNTRY[a]

	All Observations			Difference in Jurisdictional Hierarchy Index > |1|			One Ethnic Group was Part of a Pre-Colonial State		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Jurisdictional Hierarchy	0.0253*	0.0152**	0.0137**	0.0280*	0.0170**	0.0151**	0.0419**	0.0242**	0.0178***
Double-clustered s.e.	(0.0134)	(0.0073)	(0.0065)	(0.0159)	(0.0079)	(0.0072)	(0.0213)	(0.0096)	(0.0069)
Adjusted R-squared	0.329	0.391	0.399	0.338	0.416	0.423	0.424	0.501	0.512
Observations	78,139	78,139	77,833	34,180	34,180	34,030	16,570	16,570	16,474
Adjacent-Ethnic-Groups Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population Density	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls at the Pixel Level	No	No	Yes	No	No	Yes	No	No	Yes

[a]Table VII reports adjacent-ethnicity (ethnic-pair-country) fixed effects OLS estimates associating regional development, as reflected in satellite light density at night with pre-colonial ethnic institutions, as reflected in Murdock's (1967) jurisdictional hierarchy beyond the local community index within pairs of adjacent ethnicities with a different degree of political centralization in the same country. The unit of analysis is a pixel of 0.125×0.125 decimal degrees (around 12×12 kilometers). Every pixel falls into the historical homeland of ethnicity i in country c that is adjacent to the homeland of another ethnicity j in country c, where the two ethnicities differ in the degree of political centralization. The dependent variable is a dummy variable that takes on the value of 1 if the pixel is lit and zero otherwise.

In columns (4)–(6) we restrict estimation to adjacent ethnic groups with large differences in the 0–4 jurisdictional hierarchy beyond the local level index (greater than one point). In columns (7)–(9) we restrict estimation to adjacent ethnic groups in the same country where one of the two ethnicities was part of a large state before colonization (in this case the jurisdictional hierarchy beyond the local level index equals 3 or 4). In columns (2), (3), (5), (6), (8), and (9) we control for $\ln(\text{pixel population density})$. In columns (3), (6), and (9) we control for a set of geographic and location variables at the pixel level. The set of controls includes the distance of the centroid of each pixel from the respective capital, its distance from the sea coast, its distance from the national border, an indicator for pixels that have water (lakes, rivers, and other streams), an indicator for pixels with diamond mines, an indicator for pixels with oil fields, the pixel's land suitability for agriculture, pixel's mean elevation, pixel's average value of a malaria stability index, and the log of the pixel's area. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

in luminosity and differences in the degree of pre-colonial political institutions. The estimates suggest that the probability that a pixel is lit is 5.5%–7.5% higher when one moves from the homeland of stateless societies to the areas of groups that formed large states before the colonial era.

A couple of examples are useful. In Uganda, 2% of the pixels falling in the homeland of the Acholi, a noncentralized group (jurisdictional hierarchy index equals 1), are lit, while 4.2% of the pixels are lit in the adjacent homeland of the Nyoro, an ethnic group that was part of the large Banyoro kingdom (jurisdictional hierarchy index equals 3). Similarly, 21.4% of the pixels are lit in the homeland of the Ganda, the central ethnic group of the powerful kingdom of Buganda that had a highly centralized bureaucracy under the kabaka/king, compared to only 6.7% lit pixels in the neighboring territory of the stateless Lango.

Further Evidence

To further assuage concerns that some local unobserved geographic feature is driving the results, we narrowed our analysis to pixels close to the ethnic boundary. This approach is similar in spirit to regression discontinuity type analyses that are becoming increasingly popular in institutional economics.[22] In our context, implementing a standard regression discontinuity design across ethnic boundaries, like the ones that are usually performed across the national border, is not advisable for several reasons. First, while national borders are accurately delineated, drawing error in Murdock's map on the exact location of ethnic boundaries is likely to be nontrivial. Second, since Murdock's map, originally printed in the end of his book on African ethnicities, is available at a small scale, its digitization magnifies any noise inherent to the initial border drawing. Third, Murdock assigned each part of Africa to a single dominant group, while -some- ethnicities -may- overlap; and naturally population mixing is higher closer to ethnic boundaries. Fourth, due to bleeding in the luminosity data (occurring from the diffusion of light) and since electricity grids cross adjacent regions within the same country, we may not be able to detect significant differences in luminosity in areas very close to ethnic borders.

In spite of these limitations, we took the (heroic) additional step of estimating the role of local institutions close to the ethnic boundaries. In an effort to counterbalance the potential merits of focusing very close to the ethnic border and accounting for the aforementioned problems, we perform estimation in areas close to the ethnic boundaries, but excluding pixels that fall within 25 kilometers or within 50 kilometers from each side of the border. Essentially, this boils down to assuming that the ethnic border is "thick" (by either 50 km or 100 km). We perform the analysis within adjacent ethnic homelands

[22]See, for example, Dell (2010), Bubb (2012), and Michalopoulos and Papaioannou (2012), among others.

with different pre-colonial political institutions in the same country. In case of ethnic homelands having multiple neighbors with different pre-colonial centralization, we chose the largest in size bordering group.

Table VIII(A) reports LS regression estimates using three different bandwidths (100 km, 150 km, and 200 km) from the original ethnic border. In the most restrictive specification in column (1) of Panel 1, when we limit our attention to areas within 100 kilometers from the ethnic border (while excluding pixels within a 25-km range), the coefficient on the index of jurisdictional hierarchy beyond the local community is positive (0.019) and statistically significant at the 90% level. When we increase the bandwidth to 150 kilometers in column (2), the coefficient increases somewhat (0.023) and retains its statistical significance; further increasing the bandwidth to 200 kilometers (or more) has no impact on the coefficient, while due to the increase in the sample, the standard errors become tighter. Turning now to Panel 2, when we exclude pixels 50 kilometers from the ethnic border, the coefficient is 0.023 when we use the narrow bandwidth of 100 kilometers and 0.028 when we increase the bandwidth to 150 or 200 kilometers. In columns (4)–(6), we focus on pairs of ethnicities in the same country with sharp discontinuities in the strength of pre-colonial ethnic institutions. The estimates show that regional development is significantly higher in the homeland of societies with advanced pre-colonial institutions. Finally, in columns (7)–(9), we perform the analysis requiring that the centralized ethnic group has been part of a state before colonization. The estimates are somewhat larger, while the standard errors fall. Across all specifications, the coefficient on the jurisdictional hierarchy index is in the range of 0.020–0.035, quite similar to the estimates in Tables V and VII. This provides further evidence that our benchmark estimates were not driven by unobserved local features.

In Table VIII(B), we estimate locally linear regressions, including in the set of controls an RD-type fourth-order polynomial in distance to the "thick" ethnic border, allowing the coefficients on the distance terms to be different for the relatively high and the relatively low institutional quality ethnic homelands, respectively. Compared to the analogous estimates in Table VIII(A), this allows us to estimate the role of pre-colonial institutions exactly at the ethnic border. Across all specifications, the coefficient on the jurisdictional hierarchy index is positive, and, if anything, somewhat higher than the corresponding specifications in Table VIII(A), where we did not include the RD-type polynomial. While standard errors are somewhat larger, the estimates are statistically significant at the standard confidence levels in most specifications.

Figures 5(A) and 5(B) illustrate graphically the relationship between pixel luminosity and distance to the ethnic border for adjacent groups with large differences (two levels or greater) in the jurisdictional hierarchy index. Figure 5(A), which includes the boundary pixels, suggests that while overall light density is higher in the homelands of centralized ethnic groups, these differences become miniscule and are statistically indistinguishable from zero for

TABLE VIII

PRE-COLONIAL ETHNIC INSTITUTIONS AND REGIONAL DEVELOPMENT WITHIN ADJACENT ETHNIC HOMELANDS IN THE SAME COUNTRY: CLOSE TO THE ETHNIC BORDER[a]

	All Observations Adjacent Ethnicities in the Same Country			Difference in Jurisdictional Hierarchy Index > |1|			One Ethnic Group Was Part of a Pre-Colonial State		
	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Pre-Colonial Ethnic Institutions and Regional Development Within Contiguous Ethnic Homelands in the Same Country									
Pixel-Level Analysis in Areas Close to the Ethnic Border									
Panel 1: Border Thickness—Total 50 km (25 km from each side of the ethnic boundary)									
Jurisdictional Hierarchy	0.0194*	0.0230**	0.0231**	0.0269***	0.0285***	0.0280***	0.0240***	0.0297***	0.0300***
Double-clustered s.e.	(0.0102)	(0.0106)	(0.0102)	(0.0092)	(0.0088)	(0.0084)	(0.0090)	(0.0067)	(0.0069)
Adjusted R-squared	0.463	0.439	0.429	0.421	0.430	0.434	0.485	0.500	0.501
Observations	6830	10,451	13,195	3700	5421	6853	2347	3497	4430
Panel 2: Border Thickness—Total 100 km (50 km from each side of the ethnic boundary)									
Jurisdictional Hierarchy	0.0227**	0.0278**	0.0274**	0.0318***	0.0331***	0.0312***	0.0317***	0.0367***	0.0350***
Double-clustered s.e.	(0.0114)	(0.0117)	(0.0108)	(0.0094)	(0.0083)	(0.0076)	(0.0092)	(0.0057)	(0.0068)
Adjusted R-squared	0.467	0.433	0.423	0.458	0.451	0.452	0.525	0.526	0.521
Observations	4460	8081	10,825	2438	4159	5591	1538	2688	3621

(*Continues*)

TABLE VIII—*Continued*

	All Observations Adjacent Ethnicities in the Same Country			Difference in Jurisdictional Hierarchy Index > |1|			One Ethnic Group Was Part of a Pre-Colonial State		
	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel B: Pre-Colonial Ethnic Institutions and Regional Development Within Contiguous Ethnic Homelands in the Same Country Pixel-Level Analysis in Areas Close to the "Thick" Ethnic Border Controlling for a Fourth-order RD-Type Polynomial in Distance to the Ethnic Border									
Panel 1: Border Thickness—Total 50 km (25 km from each side of the ethnic boundary)									
Jurisdictional Hierarchy	0.0473***	0.0427***	0.0433***	0.0482**	0.0528***	0.0482***	0.0414*	0.0423*	0.0387**
Double-clustered s.e.	(0.0155)	(0.0151)	(0.0151)	(0.0221)	(0.0191)	(0.0187)	(0.0222)	(0.0223)	(0.0193)
Adjusted R-squared	0.465	0.441	0.431	0.423	0.432	0.436	0.489	0.504	0.504
Observations	6830	10,451	13,195	3700	5421	6853	2347	3497	4430

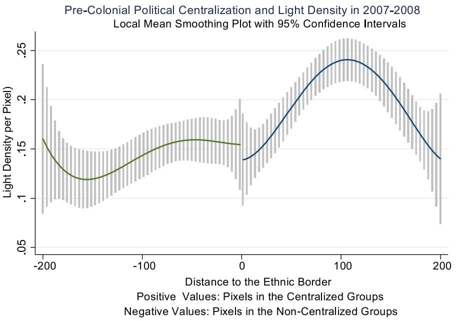
(*Continues*)

TABLE VIII—*Continued*

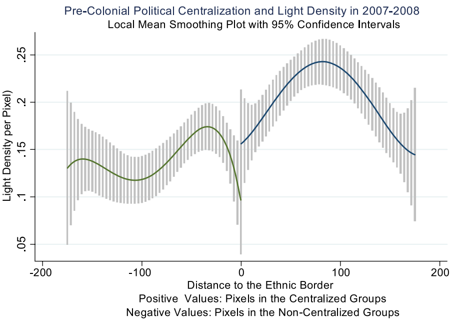
	All Observations Adjacent Ethnicities in the Same Country			Difference in Jurisdictional Hierarchy Index > |1|			One Ethnic Group Was Part of a Pre-Colonial State		
	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border	< 100 km of ethnic border	< 150 km of ethnic border	< 200 km of ethnic border
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel 2: Border Thickness—Total 100 km (50 km from each side of the ethnic boundary)									
Jurisdictional Hierarchy	0.0491***	0.0342**	0.0349***	0.0539***	0.0430***	0.0368***	0.0506**	0.0240	0.0141
Double-clustered s.e.	(0.0178)	(0.0153)	(0.0125)	(0.0178)	(0.0117)	(0.0103)	(0.0237)	(0.0182)	(0.0206)
Adjusted R-squared	0.469	0.435	0.424	0.460	0.453	0.453	0.530	0.530	0.525
Observations	4460	8081	10,825	2438	4159	5591	1538	2688	3621
RD-type polynomial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjacent-Ethnic-Groups Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls at the Pixel Level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a]Table VIII(A) and Table VIII(B) report adjacent-ethnicity (ethnic-pair-country) fixed effects OLS estimates associating regional development with pre-colonial ethnic institutions, as reflected in Murdock's (1967) jurisdictional hierarchy beyond the local community index within pairs of adjacent ethnicities. The unit of analysis is a pixel of 0.125×0.125 decimal degrees (around 12.5×12.5 kilometers). Every pixel falls into the historical homeland of ethnicity i in country c that is adjacent to the homeland of another ethnicity j in country c, where the two ethnicities differ in the degree of political centralization. The dependent variable is a dummy variable that takes on the value of 1 if the pixel is lit and zero otherwise. All columns report local-linear-regression estimates restricting estimation to pixels close to the ethnic border. In columns (1), (4), and (7) we focus on pixels within 100 kilometers on each side of the national border. In columns (2), (5), and (8) we focus on pixels within 150 kilometers from the ethnic border. In columns (3), (6), and (9) we focus on pixels within 200 kilometers from the ethnic border. To account for population mixing in the areas along the ethnic boundary, measurement error on Murdock's map, and bleeding/blooming in the luminosity data, we exclude from the estimation pixels very close to the ethnic border. In Panel 1 we exclude areas 25 km from each side of the ethnic border (total 50 km). In Panel 2 we exclude areas 50 km from each side of the ethnic border (total 100 km).

In all specifications we control for ln(pixel population density) and a rich set of geographic and location variables at the pixel level. The set of controls includes the distance of the centroid of each pixel from the respective capital city, its distance from the sea coast, its distance from the national border, an indicator for pixels that have water (lakes, rivers, and other streams), an indicator for pixels with diamond mines, an indicator for pixels with oil fields, the pixel's land suitability for agriculture, pixel's mean elevation, pixel's average value of a malaria stability index, and the log of the pixel's area. All specifications in Table VIII(B) include a fourth-order regression discontinuity type polynomial in distance of each pixel to the "thick" ethnic border, where we allow for the coefficients on the distance terms to be different for the relatively high and the relatively low institutional quality homelands. The Data Appendix in the Supplemental Material gives detailed variable definitions and data sources. Below the estimates, we report in parentheses double-clustered standard errors at the country and the ethnolinguistic family dimensions. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.



(A)



(B)

FIGURE 5.—(A) Border thickness: 0 km. (B) Border thickness: 25 km.

pixels exactly at the ethnic border.[23] Yet, as Figure 5(B) shows, when we just exclude 25 kilometers from each side of the ethnic border, then differences in pixel-level light density become significant.

5. CONCLUSION

In this study, we combine anthropological data on the spatial distribution and local institutions of African ethnicities at the time of colonization with satellite images on light density at night to assess the role of deeply rooted ethnic institutions in shaping contemporary comparative African development. Exploiting within-country variation, we show that regional development is significantly higher in the historical homelands of ethnicities with centralized, hierarchical, pre-colonial political institutions.

Since we do not have random assignment of ethnic institutions, this correlation does not necessarily imply causation. Unobservable factors related to geography, culture, or early development may confound these results. Yet, the uncovered pattern is robust to a host of alternative explanations. First, we show that the strong correlation between pre-colonial institutional complexity and current development is not driven by observable differences in geographic, ecological, and natural resource endowments. Second, the uncovered link between historical political centralization and contemporary development is not mediated by observable ethnic differences in culture, occupational specialization, or the structure of economic activity before colonization. Third, the positive association between pre-colonial ethnic political institutions and luminosity is present within pairs of adjacent ethnic homelands in the same

[23] In line with the visual illustration of Figure 5(A), when we do not exclude pixels close to the ethnic border (in Table VIII(A) and Table VIII(B)), the coefficient on the jurisdictional hierarchy loses significance in many permutations.

country where groups with different pre-colonial institutions reside. Our analysis, therefore, provides large-scale formal econometric evidence in support of the African historiography that dates back to Fortes and Evans-Pritchard (1940), emphasizing the importance of ethnic institutions in shaping contemporary economic performance.

The uncovered empirical regularities call for future research. First, our results imply that the literature on the political economy of African development should move beyond country-level features and examine the role of ethnic-specific attributes. Second, future research should shed light on the mechanisms via which ethnic institutional and cultural traits shape economic performance. Third, empirical and theoretical work is needed to better understand how local ethnicity-specific institutions and cultural norms emerge. Finally, our approach to combine high resolution proxies of development (such as satellite light density at night) with anthropological data on culture and institutions provides a platform for subsequent research, allowing, for example, one to investigate the interplay between ethnic traits and national policies.

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