The modern impact of precolonial centralization in Africa

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Abstract   We empirically assess the possibility, stressed by African scholars, that stronger precolonial political institutions allowed colonial and postcolonial African governments to better implement modernization programs in rural areas. Using anthropological data, we document a strong positive association between the provision of public goods such as education, health, and infrastructure in African countries and the centralization of their ethnic groups' precolonial institutions. We develop an empirical test to distinguish among alternative explanations for this finding. The evidence supports the view that precolonial centralization improved public goods provision by increasing the accountability of local chiefs. Our results stress the importance for developing countries to create mechanisms to monitor local administrators of public projects. These mechanisms should be consistent with these countries' preexisting and informal arrangements.

Keywords   Africa · Precolonial institutions · Centralization · Modernization

1 Introduction

The economic literature on institutions holds that colonizers' strategies of conquest and rule are main determinants of the observed variation in the quality of government among former European colonies (e.g., La Porta et al. 1999; Acemoglu et al. 2001). Yet, several scholars stressed the importance of the precolonial institutions found by colonizers upon their arrival, and did so especially for Africa (e.g., Bates 1983; Boone 2003). In this continent, the impact of precolonial institutions was enhanced by the weakness of the colonial and postcolonial national state, which found it hard to broadcast its power into rural areas. For example, Herbst (2000, p. 175) notices how "African states came to independence with almost no local

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structures besides those that were intertwined with traditional authorities". Unable to create entirely new institutions, colonial powers and postcolonial leaders needed to deal with and exploit the precolonial ones.

African history—which we review in Sect. 2—confirms that precolonial institutions shaped the ability of African societies to undertake modernization programs at the local level, especially in colonial but also in postcolonial years. Several historians stress that the key dimension of precolonial institutions was their degree of *political centralization*. In areas inhabited by *centralized* ethnic groups, the existence of precolonial chiefly hierarchy made local chiefs accountable to higher-level traditional authority. By bargaining with senior traditional leaders, colonial and postcolonial governments could foster policy coordination and implementation in those areas, leading to faster adoption of European policies and technologies (e.g., Schapera 1970). By contrast, in areas inhabited by politically *fragmented* groups the presence of too many traditional power holders rendered such bargaining very costly or infeasible. As a result, in those areas unrestrained local chiefs were often allowed to follow parochial and personalistic policies, leading to tyranny, disorder and ultimately halting modernization (e.g., Tosh 1978).

This paper assesses the role of precolonial centralization in Africa. Using anthropological data on precolonial institutions and data on public goods across African countries for the 1960–2000 period, we find a strong and positive association between the share of a country's population belonging to ethnic groups with *centralized* (rather than *fragmented*) precolonial institutions and its provision of public goods such as health, education and infrastructure. This association is strongest in the 1960s and in the 1970s but persists until more recent years. Indeed, precolonial centralization should have been especially important in colonial and immediate postcolonial years, when the hold of traditional institutions on rural areas was presumably the strongest.

Although these results confirm that centralized ethnic groups had an advantage in modernizing their economies, they do not—by themselves—validate the above mentioned "local accountability" hypothesis whereby precolonial centralization fostered public goods provision by improving the ability of colonial and postcolonial African states to control *local chiefs*. In fact, two alternative hypotheses can also explain our empirical findings. First, it might be that centralized groups were just socioeconomically more "advanced" (e.g., Claessen and Skalnik 1978), thus being more effective at adopting western technologies. In this view, greater ability of centralized groups to provide public goods was not due to their institutions but to their being, for instance, richer or more literate. Second, even if precolonial centralization did matter, it might have done so by improving the behavior of *national* political elites (e.g., Mamdani 1996), not by increasing the accountability of *local* chiefs. For example, centralized ethnic groups may have been better able to organize politically and thus to restrain abusive national leaders, fostering democracy.

We try to disentangle these three hypotheses by following two strategies. First, we extensively control in our regressions for proxies capturing both the advancement of a group and national-level effects of precolonial centralization. Second, we test some nuanced predictions of the "local accountability" view that are unlikely to hold under the two alternative hypotheses.

In Sect. 4 we develop the first strategy. By using our anthropological dataset we build several indexes that, together with more traditional country-level measures, capture the key factors anthropologists view as attributes of socioeconomic advancement: urbanization and population density, easiness of transportation, use of writing, technological level, use of money, absence of slavery, fixity of residence, dependence on agriculture. As for national politics, we control for postcolonial national outcomes (such as constraints on the executive

and civil wars) as well as for colonial factors (such as the identity of colonizer and the year of independence). Consistent with the "local accountability" view, the results indicate that—as measured by our proxies—neither ethnic groups' socioeconomic advancement nor national politics can fully account for the positive impact of precolonial centralization on public goods in colonial and postcolonial Africa.

Section 5 proposes a test to further distinguish the "local accountability" view from the alternative hypotheses. The test is based on the historical evidence that, by increasing the accountability of local chiefs, precolonial centralization had two main benefits: it reduced local tyranny (i.e., the extent to which local chiefs could abuse their masses) and it fostered the coordination between the chiefs of different districts (e.g., Apter 1961; Tosh 1978). Thus, the "local accountability" view implies that the impact of precolonial centralization on public goods provision should depend on the severity of local tyranny and on the severity of the coordination problem.

As a proxy for the severity of local tyranny, we use another dimension of African ethnic groups coded in our anthropological dataset: the degree of social stratification at the local level. Absent the accountability mechanisms of precolonial centralization, it is precisely in stratified societies that local chiefs are likely to be tyrannical and hamper public goods provision. Thus, the "local accountability" view predicts that precolonial centralization should disproportionately boost public goods provision in stratified, as opposed to egalitarian, societies. The "local accountability" view further predicts that the extra benefit of precolonial centralization in stratified groups should be smaller for public goods for which the coordination problem is especially severe. Indeed, in the provision of such goods, centralization should greatly help both egalitarian and stratified societies.

We test these predictions and find that, consistent with the "local accountability" view, precolonial centralization boosts public goods provision more in stratified than in egalitarian groups. Crucially, precolonial centralization affects public goods depending on the severity of the coordination problem, which we proxy by the amount of geographic spillovers. For high spillovers goods, such as roads and immunization, centralization benefits both stratified and egalitarian groups. In contrast, for education and infant mortality, centralization benefits stratified groups, but not egalitarian ones. Because interdistrict coordination is much less important for the public goods behind these latter outcomes (local schools and clinics), centralization does not foster the provision of these goods in egalitarian groups (where local tyranny is small).

Not only these results are consistent with the "local accountability" view; they are also hard to reconcile with the two alternative views that centralized groups were simply more "advanced" or that their institutions only improved national politics. A general version of these views predicts that—either for their advancement or better national politics—centralized groups should *uniformly* enjoy more public goods, irrespective of local stratification. Although in more nuanced versions of these hypotheses local stratification may matter, they still cannot explain the different patterns obtained for high and low spillovers goods. In line with the "local accountability" view, the role of geographic spillovers signals that precolonial centralization helped colonial and postcolonial national governments to foster coordination among local chiefs.

In sum, our results indicate that *precolonial* centralization fostered modernization efforts in colonial and postcolonial Africa. At a broad level, our evidence echoes the finding that countries with a long tradition of statehood have better economic performance (Bockstette et al. 2002). Bockstette et al. (2002) argue that modern institutions work better when there are strong traditional institutions to build upon. Our results confirm this idea but further suggest, in the context of African centralized groups, that a key asset of strong traditional institutions is

the availability of mechanisms to hold local leaders accountable. In fragmented groups, where such accountability mechanisms were weak or absent, modernization gave unprecedented power to abusive local leaders, leading to tyranny and disorder.

With respect to the economic literature on institutions, our results suggest that not only the colonizers' strategies, but also preexisting political conditions affected the quality of government in Africa. In other words, the colonial experience did not simply mold, for better or worse, the institutions of the colonies (e.g., La Porta et al. 1999; Acemoglu et al. 2001), but was itself heavily influenced by the institutions that colonizers found upon their arrival. Beyond colonialism, this message warns against attempts to transplant the institutional "templates" of advanced market economies in developing countries. Institutional reform should focus not just on exporting "best practice" institutions to developing countries, but also on optimally adapting these arrangements to the receiving countries' preexisting and informal institutions. Section 6 concludes by drawing some implications of this insight for the debate on centralization in developing and transition economies.

2 Historical background and the "local accountability" hypothesis

This section discusses historical accounts of the role of precolonial centralization for the success of modernization efforts in both colonial and postcolonial Africa. To clarify the focus of our analysis, we start by discussing the colonial history of Uganda, which neatly illustrates the role of precolonial centralization during the colonial period. We then discuss the role of precolonial centralization in other African countries, in both the colonial and the postcolonial periods.

The interesting feature of Uganda is that this country displays a considerable variety of precolonial institutions *within* its borders. This allows us to compare the performance of regions inhabited by ethnic groups with different levels of precolonial centralization. Map 1 shows the regional distribution of Ugandan ethnic groups and their level of precolonial centralization. The South and the West of the country cover the territory of the precolonial kingdoms of Buganda, Bunyoro, Toro, and Ankole. These *centralized* ethnic groups have developed a form of government with large, territorially integrated political entities. In contrast, the North of Uganda is entirely populated by *fragmented* ethnic groups such as Lango, Acholi, and Karamoja. These groups have been traditionally organized in a multitude of small and fragmented political entities, often lacking any political integration above the local village. Finally, the East of the country is more mixed, with centralized Busoga chiefdoms as well as fragmented Teso and Bugisu societies.

Historians of colonial Uganda suggest that this variation in precolonial institutions shaped the success of modernization policies across Ugandan regions. The British, who colonized Uganda between 1890 and 1910, immediately understood the importance of native authorities for implementing their policies and heavily relied on traditional chiefs for building roads, organizing schools, improving sanitation, and many other activities (Pratt 1965). As a result, British rule in Uganda was characterized by a strong continuity of precolonial institutions. In turn, such continuity allowed precolonial institutions to affect the implementation of modernization policies.

In the areas inhabited by centralized groups, such as the kingdoms of Buganda, Toro, or Ankole, the British upheld (in exchange for tribute) the precolonial system of government based upon hierarchy of chiefs (Apter 1961). In traditionally fragmented districts, such as Lango or Teso, the British yielded power to local chiefs selected from men of local standing (village headmen, clan heads). In the absence of precolonial political hierarchy, these local
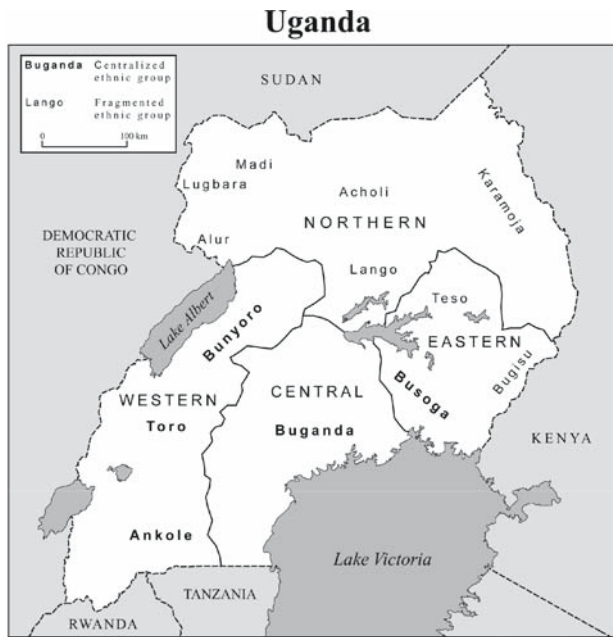
Map 1 Distribution of centralized and fragmented ethnic groups across Uganda regions

chiefs were directly subordinate to the Colonial Administration, but the paucity of European officers allowed them to exercise a good deal of unsupervised power (Low 1965). The direct consequence of this situation was that in Ugandan fragmented groups the local chiefs—accountable only to a distant colonial office—were relatively free to exploit their subjects. Indeed, Burke (1964, p. 37) reports that in Uganda arose "...*in the non-kingdom districts a system of effective but completely autocratic chieftainship. This contrasted with the situation in the kingdoms where the chiefs were restrained by the accountability of traditional authority*".

The greater accountability of local chiefs in traditionally centralized systems clearly emerges from many accounts on the Buganda, Bunyoro, Toro, and other centralized Ugandan groups (Apter 1961; Richards 1960; Burke 1964). For instance, in the Buganda kingdom local chiefs were abruptly dismissed by the Kabaka (the king) or other high-level traditional authorities if their performance was poor (Low 1971).[1]

Crucially, historians stress that traditional accountability mechanisms of centralized groups enabled the colonialists to foster modernization programs along two dimensions. First, by co-opting senior traditional leaders, the colonialists were able to control local chiefs and induce them to rule in the interest of their communities (Apter 1961), thereby fostering the introduction of new agricultural technologies (Richards 1960; Ehrlich 1965), religion and education (Low 1965), and modern health facilities (Pratt 1965). Second, preexisting

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[1] Historians discuss an interesting mechanism that further improved the accountability of local chiefs in centralized groups. For example, in the kingdom of Buganda there were significant chances of promotion from office to office (Apter 1961; Low 1971). Crucially, the competition for higher office was won by local chiefs with larger local political support, as they could better influence the king's appointment process through bribes, protest or by satisfying the king's need for soldiers. Since the size of his constituency determined a chief's status and his chance of being promoted, competition for office ultimately behooved local chiefs to rule in the interest of their communities (Apter 1961).

accountability mechanisms also helped the colonialists to improve coordination between local chiefs of different districts, who were all accountable to a common traditional authority. Perhaps unsurprisingly, this second effect boosted the ability of centralized groups to build roads (Pratt 1965) and to control epidemics (Low 1965).

In contrast, not only several historians document the meager performance of modernization programs in precolonially fragmented districts, but they also attribute it precisely to the lack of accountability of their local chiefs. Without a traditional hierarchy of government to rely upon and unable to build new institutions from scratch, the colonialists faced the huge problem of dealing with (and monitoring) many dispersed power holders.[2] In this context, Burke (1964) depicts the Teso local chiefs as absolute tyrants. Tosh (1978, p. 182) describes the abusive behavior of Lango chiefs, who "*exploited their office for personal or factional ends; and the ordinary population became alienated from the administrative structure*". He emphasizes that such behavior was a direct result of the fragmented nature of Lango traditional government and shows how it distorted reforms aimed at improving the rule of law, education, agricultural productivity, and infrastructure.

Thus, historical evidence suggests that Ugandan regions inhabited by centralized groups were more successful in providing modern public goods. Table 1 compares the quality of public goods across Ugandan regions using measures of infrastructure, health, and education around the year 2000. Consistent with historical evidence, Table 1 shows, *within* Uganda, a positive association between precolonial centralization and public goods provision. The Central and the Western Regions inhabited by centralized groups enjoy much more public goods than the North of the country inhabited by fragmented groups, while the "mixed" Eastern Region has intermediate values. Of course, many factors—not only precolonial centralization—may have contributed to the patterns of Table 1. Indeed, our goal is to assess the relationship between precolonial centralization and public goods across African countries using econometric methods.[3] Yet, Table 1 clearly illustrates the key prediction of the "local accountability" view that many historians have in mind.

Further evidence confirms historical accounts of Uganda for other African countries. The colonial history of the Tswana of Botswana (Schapera 1970; Wylie 1990), the Sotho of Lesotho (Ashton 1967; Breytenbach 1975), the Swazi of Swaziland (Schapera 1956) and other centralized groups of Southern Bantu, testifies that, by increasing the accountability of local chiefs, precolonial centralization fostered modernization. Likewise, Boone (2003) documents that in Senegal the centralized Wolof of the groundnut basin better supported the coordination and local implementation of development projects than the fragmented Diola of Lower Casamance, where the colonial (and later national) government had lesser ability to control the abusive behavior of local chiefs. A similar picture emerges from the history of fragmented groups of southern Cote d'Ivoire such as Baoule, Bete or Guru (Boone 2003).

While the impact of precolonial centralization was probably strongest in the colonial period, several historians argue that precolonial institutions remained important also after independence. Some African countries, such as Botswana or Swaziland, reveal a clear continuity between postcolonial political leaders and precolonial rulers, as traditional patterns of politics influenced the nature of the postcolonial state itself (Potholm 1977; Picard 1987). Elsewhere,

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[2] The British sometimes rearranged territorial entities, giving chiefs authority over wider regions than those they traditionally controlled. However, such reorganizations were neither extensive nor effective precisely because they were not built upon preexisting political structures (Low 1965).

[3] As argued by one referee, Uganda might be unusual because here—unlike in other places in Africa—the British did not interfere in local landowning by the natives, which may have enhanced the role of precolonial institutions. Our cross-country regressions, however, will later show that the role of precolonial institutions in Uganda was not exceptional.

Table 1 Precolonial centralization and public goods in Uganda

Region Precolonial institutions of ethnic groups	Central Centr	Western Centr	Eastern Mixed	Northern Fragm
% of roads paved in 2002	13.37	10.32	10.89	1.33
Infant mortality in 2001	71.9	97.8	89.3	105.9
% of children under five years with diarrhoea in 2001	14.5	16	23.3	26.7
Availability of sewerage system in 2000 (% of households)	15	14	9	6
Piped water inside house in 2000 (% of households)	10	10	8	5
Availability of latrine or human waste disposal service in 2000 (% of households)	96	86	77	67
Adult literacy rate in 1997	72	61	54	54
Adequacy of facility & equipment at primary schools in 2000 (% of households satisfied)	62	72	55	51

Sources: Uganda Bureau of Statistics (1999, 2003), Uganda Bureau of Statistics and ORC Macro (2001)

precolonial institutions continued to play an important role at the local level, where postcolonial African regimes (like their colonial predecessors) could not achieve their objectives without the cooperation of traditional power holders (e.g., Van Rouveroy van Nieuwaal 1987). This pattern emerges from the accounts of Senegal, Cote d'Ivoire and Ghana (Boone 2003), where precolonial institutions shaped the ability of the postcolonial state to coordinate and discipline local chiefs and thus to reach the periphery. Interestingly, Herbst (2000) observes that postcolonial heads of state often had to come to pacts with traditional authorities even in countries such as Mauritania, Niger, and Chad, where "*states abolished or marginalized chiefs after independence only to invite them back a few years later in the face of extraordinary difficulties to govern the rural areas*" (Herbst 2000, p. 177).

To sum up, African history shows a clear continuity of precolonial institutions, and stresses their crucial role in modernization. Historical accounts from both the colonial and the postcolonial periods support a "local accountability" hypothesis whereby precolonial centralization helped to improve the implementation of modernization programs in Africa by increasing the ability of colonial and postcolonial national governments to control local chiefs.[4] By exploiting an anthropological dataset, in the rest of the paper we provide econometric

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[4] The literature on federalism argues that *decentralization* may boost accountability of local administrators by fostering people's mobility (Tiebout 1956), improving voters' information (Besley and Case 1995) or enhancing voters' ability to replace misbehaving politicians (Seabright 1996). The latter two factors are irrelevant for fragmented African groups. As for migration, mobility costs are typically large in underdeveloped countries (Bardhan 2002). Our historical evidence also suggests that: (a) Hostile inter-village relations discouraged migration; (b) Chiefs skillfully manipulated people's incentive to move to their own advantage by banning or facilitating migration (Tosh 1978; Southwold 1964).

evidence on the association between precolonial centralization and public goods provision in Africa and test the importance of the "local accountability" view in explaining the observed patterns.

3 Precolonial centralization and public goods in africa: an empirical analysis

In this section we build a country-level index of precolonial centralization and assess the association between this index and public goods provision across African countries. As in the Uganda example, the analysis would ideally be performed at the ethnic-group level, but the lack of comparable subnational data on public goods prevents us from doing so.

3.1 The data

Between 1962 and 1967, the anthropological journal *Ethnology* published several install-ments of the *Ethnographic Atlas* (Murdock 1967), a database of around 60 variables describ-ing the social, economic and political traits of 1,270 ethnic groups around the world.[5] The data, coded by the Yale anthropologist George P. Murdock, summarize the information of a multitude of individual field-studies done between 1850 and 1950. Murdock pinpointed every ethnic group to the earliest period for which satisfactory data existed to avoid the accul-turative effects of contacts with Europeans. In Africa, Murdock's goal was to describe ethnic groups in the period immediately preceding the massive European colonization of the late 19th–early 20th century.[6] We thus call African indigenous institutions as measured by his data "precolonial". Clearly, in certain parts of Africa, earlier contacts with Europeans (e.g., the slave trade) took place before the 19th century, but we focus on the period following the introduction of European administrative rule because we believe that this period is crucial for understanding the interaction between traditional institutions and modernization.

To measure the degree of precolonial centralization of each African ethnic group, we use Murdock's *Jurisdictional Hierarchy* variable, which gives each ethnic group the number of jurisdictional levels transcending the local community. The variable attributes the value of 0 to groups "lacking any form of centralized political organization", 1 for "petty chiefdoms", 2 for "large paramount chiefdoms/small states" and 3 or 4 for "large states". For our purposes, we define "fragmented" an ethnic group falling into categories 0 or 1 and "centralized" a group scoring 2, 3, or 4 in Murdock's variable. Our "fragmented" category includes groups lacking any political integration above the local community, such as the Lango of Uganda or the Tonga of Zambia, and groups such as the Diola of Senegal and the Alur of Eastern Africa where petty chiefs rule over very small districts. Our "centralized" category comprises truly centralized kingdoms such as the Buganda of Uganda or the Swazi of Southern Africa as

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[5] The *Ethnographic Atlas* has been used in anthropology to study how certain social traits, such as polygyny and inheritance practices, covary across ethnicities (e.g., Hartung 1982). In economics, Werker et al. (2006) have recently used the *Atlas* to study the effects of male circumcision on AIDS in Africa.

[6] For 77 out of 308 African ethnic groups used in our empirical analysis the data comes from the field studies done in 1900 or earlier, for 174 groups from the field studies done between 1900 and 1930, and for 57 groups from the field studies done between 1930 and 1950. The explicit goal of all these anthropological studies (including the later ones) was to describe the African societies as they were on the eve of massive European colonization.

well as large but less centralized political entities such as the Yoruba city-states in Southern Nigeria and the Ashanti confederation in Ghana.[7]

Having classified more than 300 African ethnic groups, we matched them with the groups listed in the *Atlas Narodov Mira*, published in 1964 by the Miklukho-Maklai Ethnological Institute in the Soviet Union, which provides the most comprehensive division of the world population into ethnic groups.[8] We used the countries' ethnic composition from the Soviet Atlas to calculate the share of each country's non-European population belonging to centralized groups.[9] This share represents our country-level index of precolonial centralization and we call it "Centralization". Our sample consists of 42 countries in Sub-Saharan Africa.[10] Table A1 shows our Centralization index. The measure displays a wide cross-country variation, ranging from the value of 1 for Lesotho (both of its ethnic groups, the Sotho and the Zulu are centralized) to the value of 0 for Liberia (both the Kru and the Peripheral Mande are fragmented). Consistent with its variety of centralized and fragmented groups, Uganda takes the intermediate value of 0.634.

To study the role of precolonial centralization at the local level, we look at outcomes that are importantly determined by local authorities. These outcomes measure the country-level provision of local public goods such as education, health services, and basic infrastructure. Infant mortality and the percentage of infants immunized against DPT (diphtheria, pertussis and tetanus) represent our health outcomes. Adult illiteracy rate and average school attainment proxy for education. The percentage of roads paved (as a share of total roads) is our measure of infrastructure.[11] These variables are from the 1960 to 2002 period, depending on data availability. Because we are interested in the impact of precolonial centralization in both the colonial and the postcolonial periods, we use the time averages of each public good outcome as our main dependent variables. However, we also look at how the role of precolonial centralization evolved over time. Tables A2–A4 show descriptive statistics, pairwise correlations between our dependent variables and between Centralization and the controls we use. Our basic regression specification is:

$$Y_i = \alpha_0 + \alpha_1 {}^* Centralization_i + \varepsilon_i$$

Y_i is one of our outcome measures in country i and $Centralization_i$ is the value of our index for that country. Parameter α_1 captures the association between precolonial centralization and public goods.

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[7] Anthropologists (Fortes and Evans-Pritchard 1940) often label the same categories as "state/stateless". We avoid this terminology because the term "stateless" can misleadingly suggest that fragmented societies lack politics. The centralized/fragmented distinction better corresponds to the definition of the *Jurisdictional Hierarchy* variable we use.

[8] Easterly and Levine (1997) built their ethnolinguistic fractionalization index using the Atlas. Alesina et al. (2003) and Fearon (2003) criticize the Atlas, using alternative ethnic partitions. Their critique does not appear to be relevant for Sub-Saharan Africa, so we continue to use the Atlas for its better coverage of African ethnic groups.

[9] See Appendix 3 for more details. Notice that we exclude Europeans to focus on indigenous institutions, but their inclusion would not affect our empirical results.

[10] We dropped Mauritius, Seychelles, Cape Verde and Sao Tome and Principe from the sample created by Robert Bates. These islands, uninhabited before the slave trade and colonization, do not have truly precolonial institutions. Notice also that Bates' original sample excludes South Africa "because of its exceptional political system." For the purposes of our study, South Africa might also be unusual because of its very large number of European settlers. In footnote 16 we discuss that our results are robust to the inclusion of South Africa.

[11] We tried *life expectancy at birth* and, not surprisingly, all results were virtually identical to those for *infant mortality*. Using *percent of infants immunized against measles* (rather than DPT) also yields very similar results.

3.2 Basic empirical findings

The odd-numbered columns in Table 2 show the bivariate relationship between Centralization and different public goods outcomes; in even-numbered columns, we include initial per capita GDP to control for initial income differences across countries.[12] Figures 1–5 show the results graphically. Centralization is positively associated with the quality of infrastructure as measured by the percentage of roads paved (Columns 1 and 2), with the percentage of infants immunized against DPT (Columns 3 and 4) and with the average years of school attainment (Columns 9 and 10). Our centralization index has a negative impact on infant mortality (Columns 5 and 6) and adult illiteracy (Columns 7 and 8), confirming that precolonial centralization is positively associated with the quality of health and education. All these relationships are statistically significant and economically large. For example, a change from 0 to 1 in our index (i.e., a move from a country only populated by fragmented groups to a country only populated by centralized groups) is associated with 42 fewer infants (out of every 1,000) dying in the first year of life. This effect, equivalent to a reduction of 1.5 standard deviations in our sample, is twice as large as that of doubling initial GDP per capita. The magnitude of the association is similar for the other public goods, ranging from 1 to 2 standard deviations in the dependent variable and being larger than the effect of doubling initial GDP per capita.[13]

The comparison between the educational outcomes of Lesotho and Mali is instructive on the size of the correlation between Centralization and public goods. Lesotho had an average adult illiteracy rate of 25% in 1970–2002 and an average of 3.26 years of schooling in 1960–1990. Mali lies at the other extreme with an illiteracy rate of almost 83% and just 0.6 years of average schooling over the same time period. But while the Centralization index gives 1 for Lesotho, it only gives 0.115 for Mali, whose population is mostly from the politically fragmented Nuclear Mande and Voltaic ethnic groups. Thus, differences in precolonial centralization may capture more than a third of the observed differences in education between these two countries.[14]

We performed a sensitivity analysis to assess the robustness of our basic empirical findings. First, we checked for the presence of influential observations by computing the DFbetas from each regression in Table 2 (see, e.g., Belsley et al. 1980, p. 28). The only case of $abs(DFbeta) > 1$ is Comoros in road regressions. If we drop it, the coefficient is reduced to about 16, but remains 1% significant. If we more conservatively drop all observations with $abs(DFbeta) > 2/\sqrt{\#obs}$, the results become even stronger than those in Table 2.

As an additional sensitivity check, we evaluated the association between precolonial centralization and public good outcomes in alternative samples of countries. The results of this exercise are shown in Table 3. We first exclude Liberia and Sierra Leone from our baseline

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[12] In the paved roads regression of column 2 we use per capita GDP in 1986 (rather than in 1990) as a measure of initial income. This allows us to keep in the sample Djibouti and Liberia that have missing GDP data for 1990.

[13] This discussion refers to the estimated effects of a change from 0 to 1 in our Centralization index, which is an increase of about 3 standard deviations in this independent variable. Alternatively, it implies an improvement of 0.35–0.6 standard deviations in public good outcomes per one standard deviation increase in Centralization. This effect is larger than the effect of a one standard deviation increase in initial GDP per capita. For example, a one standard deviation increase in Centralization reduces infant mortality by 42.5*0.321 = 13.64 infants, while a similar increase in initial GDP per capita reduces it by only 23.8*0.456 = 10.85 infants.

[14] For adult illiteracy $-23.77*(1-0.115)/(25-83) = 0.363$; for schooling $1.24*(1-0.115)/(3.26-0.6) = 0.413$. These calculations are based on the coefficients for Centralization from columns 8 and 10 of Table 2, respectively.

Table 2 Precolonial centralization and public goods provision

	% of roads paved in 1990–2000		% of infants immunized for DPT in 2001		Infant mortality in 1960–2001		Adult illiteracy rate in 1970–2002		School attainment in 1960–1990	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Centralization	21.02***	21.53***	36.79***	36.08***	−35.24**	−42.5***	−18.74**	−23.77***	1.24**	1.24**
	(7.21)	(7.04)	(6.53)	(7.13)	(14.79)	(15.12)	(9.04)	(8.29)	(0.47)	(0.49)
Log of initial GDP/cap		4.95		0.9		−23.8**		−11.17**		0.36
		(3.38)		(2.5)		(9.26)		(4.56)		(0.61)
Constant	7.12**	−26.72	38.11***	33.22*	146.6***	306.72***	66.94***	145.63***	1.2***	−1.12
	(2.65)	(22.73)	(4.85)	(17.37)	(10.01)	(63.48)	(5.95)	(32.36)	(0.33)	(3.91)
Obs.	40	40	42	41	42	40	37	36	26	26
Rsq.	0.24	0.27	0.33	0.31	0.13	0.23	0.1	0.26	0.12	0.14

Notes: 1. OLS estimations
2. "Initial GDP/cap" refers to GDP/cap in 1960 for columns 6 and 10, in 1970 for column 8, in 1986 for column 2 and in 2001 for column 4
3. Robust standard errors are shown in parentheses
4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level
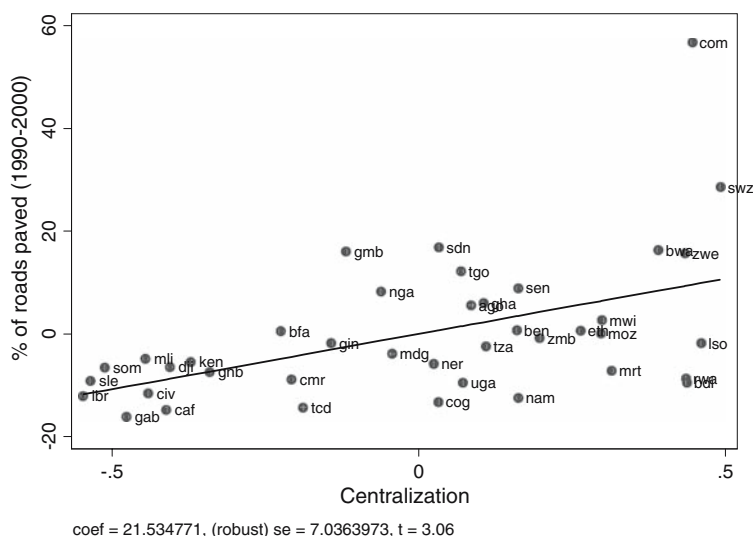
Fig. 1 Precolonial centralization and paved roads (partial relation controlling for log of GDP/cap in 1986)

sample. These countries have low values of the Centralization index, but were also settled by antislavery societies, which may distinguish them from the rest of the sample. However, Table 3 shows that our results are very robust to the exclusion of these countries from our sample. We then exclude from our baseline sample Lesotho and Swaziland, two small countries inhabited by centralized groups but also surrounded by South Africa. Again, our basic results are robust to the exclusion of these countries, except for the schooling regression which becomes only marginally significant (it should be noted though that for schooling we only have 24 observations). Finally, we include in our regressions North African countries.[15] We excluded these countries from our baseline analysis because of the intensity of their contacts with Europeans throughout history. Yet, once we include them in our regressions our basic results remain very strong.[16]

It is also interesting to see whether the correlation between precolonial centralization and public goods provision originated in the colonial or the postcolonial period. Unfortunately, we cannot perform a detailed analysis of the impact of precolonial institutions in these different periods as all our public goods data are from the postcolonial period. Yet, since our data series begin as early as in 1960 for schooling and infant mortality and in 1970 for adult illiteracy, we can check how the association between our Centralization index and these outcomes has evolved since immediate postcolonial years. Figures 6–8 report the evolution of the magnitude and statistical significance of α_1 over time.[17] The data show that the coefficient

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[15] We include Algeria, Egypt, Morocco, and Tunisia (with the corresponding values of 0.99, 0.99, 0.81, and 0.98 of our Centralization index). Libya (scoring 0.94 on Centralization) has missing GDP data and hence drops from our analysis.

[16] As mentioned in footnote 10, South Africa is also excluded from our analysis. If we include it, our basic regression results become slightly stronger. This is not surprising given that South Africa scores close to 1 on Centralization and enjoys a relatively high level of public goods provision. Even when we control for the number of European settlers in 1960, the inclusion of South Africa strengthens the corresponding results of Table 6 (where it is excluded). The regressions including South Africa are not shown but available upon request.

[17] We do not explicitly report full regression results for all years but they are available from the authors upon request.

coef = 36.07716, (robust) se = 7.1253938, t = 5.06

Fig. 2 Precolonial centralization and infant immunization (partial relation controlling for log of GDP/cap in 2001)

coef = -42.503394, (robust) se = 15.1238, t = -2.81
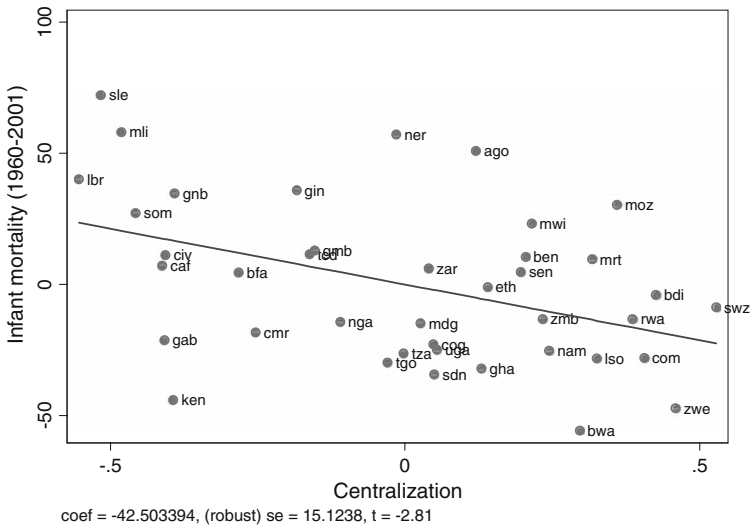
Fig. 3 Precolonial centralization and infant mortality (partial relation controlling for log of GDP/cap in 1960)

for Centralization index becomes smaller (in absolute value) and less significant as we move further away from the colonial period. Although strongest in immediate postcolonial years, the positive impact of precolonial centralization on public goods provision remains sizeable and significant long after independence. This evidence is consistent with historical accounts, which stress the importance of traditional institutions also in postcolonial Africa.

This suggests two observations. First, the persistent impact of precolonial centralization in late postcolonial years provides support to our strategy of using time averages of outcomes as our main dependent variables. Second, the fact that centralized African groups had
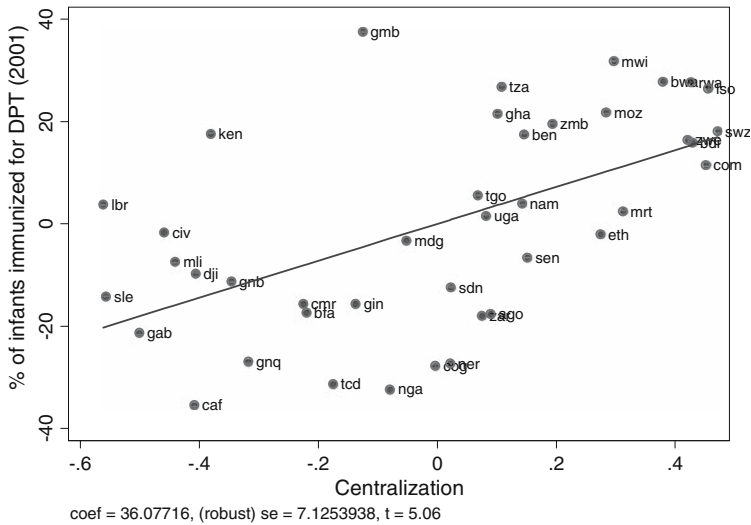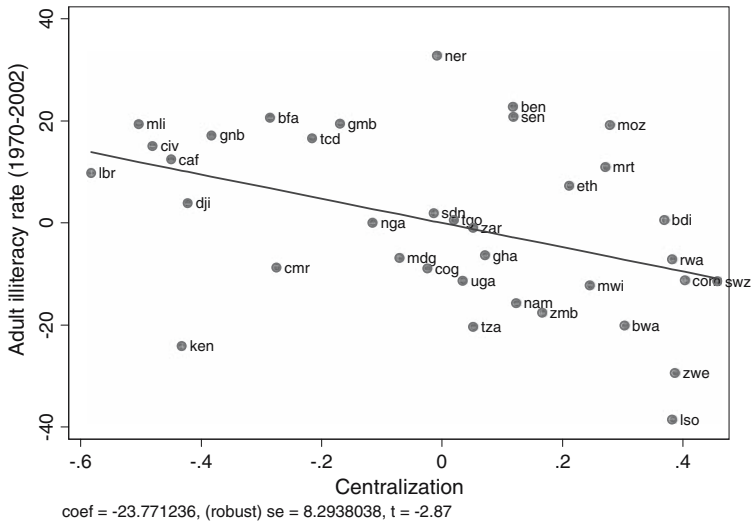
Fig. 4 Precolonial centralization and adult illiteracy (partial relation controlling for log of GDP/cap in 1970)
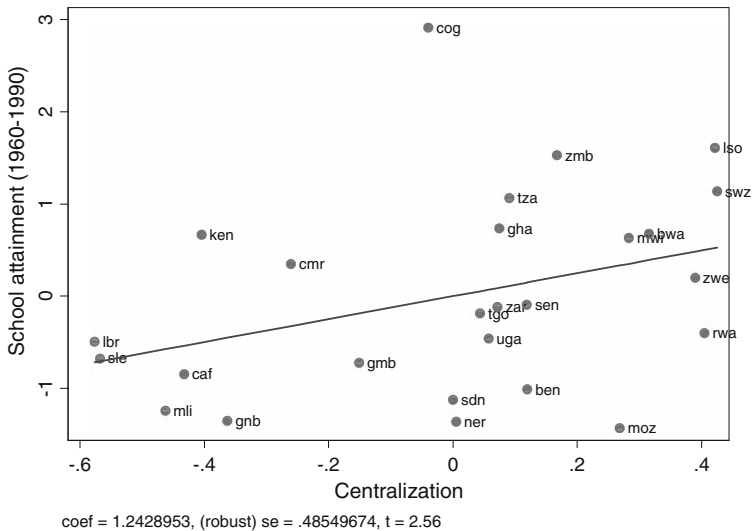
Fig. 5 Precolonial centralization and school attainment (partial relation controlling for log of GDP/cap in 1960)

already jumped ahead in terms of education, health and infrastructure by the 1960s points to the importance of precolonial institutions. Indeed, if precolonial institutions shaped the ability of African countries to adopt western policies and technologies, such effects probably originated in the formative colonial period when traditional institutions were very strong and the seeds of modernization were laid.

Table 3 Precolonial centralization and public goods provision: robustness to alternative samples of countries

Centralization results		Dependent variables			
	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
Samples of countries	(1)	(2)	(3)	(4)	(5)
Centralization	**21.54*** (7.04)**	**36.08*** (7.13)**	**−42.5*** (15.12)**	**−23.77*** (8.29)**	**1.24** (0.49)**
Main sample	[40]	[41]	[40]	[36]	[26]
Centralization	**21.86*** (7.8)**	**41.74*** (7.95)**	**−30.77* (15.61)**	**−24.64** (9.22)**	**1.34* (0.68)**
Excluding Liberia and Sierra Leone	[38]	[39]	[38]	[35]	[24]
Centralization	**20.32** (7.72)**	**34.51*** (7.82)**	**−43.28** (16.48)**	**−19.59** (8.7)**	**0.86 (0.5)**
Excluding Lesotho and Swaziland	[38]	[39]	[38]	[34]	[24]
Centralization	**31.16*** (7.41)**	**41.63*** (7.14)**	**−45.4*** (13.41)**	**−19.47** (7.35)**	**1.21*** (0.43)**
Including North African countries	[44]	[45]	[44]	[40]	[29]

Notes: 1. All regressions control for *Log of initial GDP/cap* from Table 2
2. Coefficients and robust standard errors for *Centralization* index are shown in bold
3. Number of observations is shown in squared brackets
4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level
5. North African countries include Algeria, Egypt, Morocco, and Tunisia

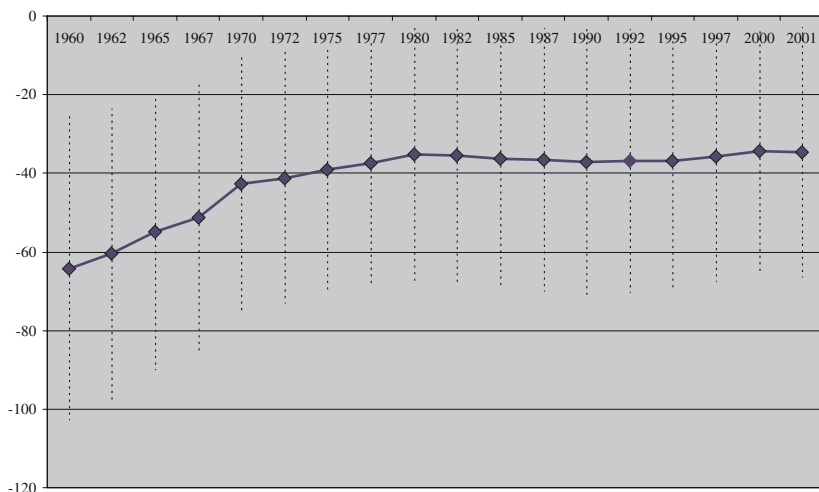**Fig. 6** Precolonial centralization and infant mortality: relationship over time. The chart shows the point estimates and the 95% confidence intervals of the coefficient for *Centralization* index from the OLS regressions of $InfantMortality_i = \alpha_0 + \alpha_1 * Centralization_i + \alpha_2 * \log(GDP/cap\_1960)_i + \varepsilon_i$, where infant mortality is measured in different years. The coefficient is significant at the 1% level between 1960 and 1967, and at the 5% level between 1970 and 2001. The regressions have 39 observations between 1960 and 1967, and 40 observations between 1970 and 2001

In sum, our econometric evidence shows that African countries inhabited by centralized groups have enjoyed a better provision of basic public goods over the last 40 years. Yet, this evidence neither demonstrates that precolonial centralization was directly responsible for such better performance, nor shows that it improved public goods provision by increasing the accountability of local chiefs, as argued by the "local accountability" view described in the historical section. In fact, our empirical findings are also consistent with two alternative hypotheses. First, it might be that centralized groups were just socioeconomically more "advanced". In this view, their greater ability to adopt western technologies for public goods provision was not due to their institutions but to their being, for instance, richer or more literate. Second, even if precolonial institutions did matter, they might not have done so by increasing the accountability of local chiefs. Instead, precolonial centralization could have improved *national* political outcomes, for instance by limiting the power of tyrannical colonial and postcolonial national leaders.[18]

To empirically distinguish the "local accountability" view from the views that centralized groups were more advanced or induced better national politics, we follow two strategies. First, in Sect. 4 we extensively control for proxies for our alternative hypotheses. Second, in Sect. 5 we develop distinctive predictions of the "local accountability" view that are unlikely to hold under the two alternative hypotheses and test them empirically.

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[18] Reverse causality, on the other hand, is unlikely to drive the results of Table 2. African ethnic institutions certainly evolved over history, but our Centralization index was predetermined at the late 19th – early 20th century when the massive European colonization began. Historians agree that the technologies for providing modern public goods were first introduced by European administrators, who built the first road and railway networks and, together with missionaries, developed the system of formal education and built public-health facilities (Bauer 1975; Duignan and Gann 1975). These developments laid the foundation for further improvements in the postcolonial period, which is the source of our outcome measures. It is then difficult to see how the latter could have affected the Centralization index.
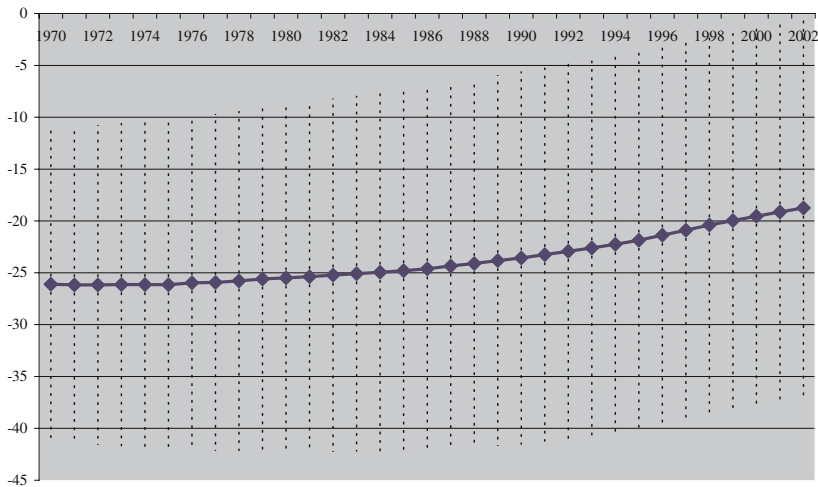
Fig. 7 Precolonial centralization and adult illiteracy: relationship over time. The chart shows the point estimates and the 95% confidence intervals of the coefficient for *Centralization* index from the OLS regressions of $AdultIlliteracy_i = \alpha_0 + \alpha_1 * Centralization_i + \alpha_2 * \log(GDP/cap\_1970)_i + \varepsilon_i$, where adult illiteracy is measured in different years. The coefficient is significant at the 1% level between 1970 and 1988, and at the 5% level between 1989 and 2002. All regressions have 36 observations
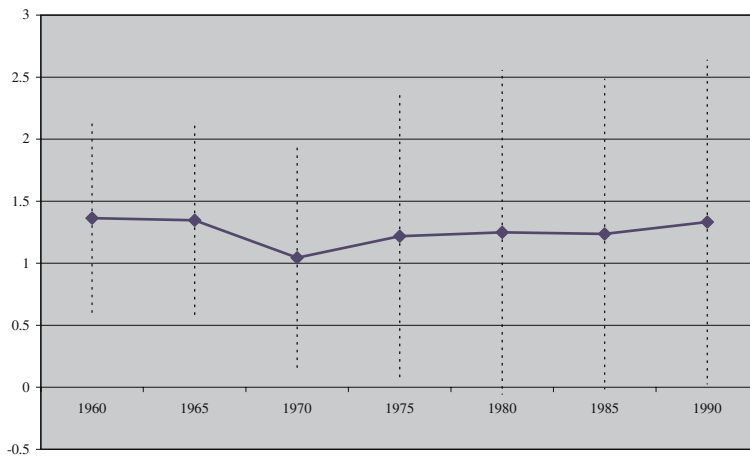
Fig. 8 Precolonial centralization and school attainment: relationship over time. The chart shows the point estimates and the 95% confidence intervals of the coefficient for *Centralization* index from the OLS regressions of $SchoolAttainment_i = \alpha_0 + \alpha_1 * Centralization_i + \alpha_2 * \log(GDP/cap\_1960)_i + \varepsilon_i$, where school attainment is measured in different years. The coefficient is significant at the 1% level in 1960 and 1965, at the 5% level in 1970, 1975, and 1990, and at the 10% level in 1980 and 1985. The regressions have 21 observations in 1960 and 1965, 23 in 1970, 24 in 1975, 25 in 1980, and 26 observations in 1985 and 1990

4 Evaluation of alternative hypotheses

We evaluate the robustness of the "local accountability" hypothesis by controlling for several proxies for our alternative hypotheses. We include these proxies one at a time in our baseline regressions where we also control for initial income so as to capture general cross-country differences in economic status and minimize possible omitted variable bias in the coefficient

on Centralization. Tables 4–6 report the value and the standard error of the coefficient on Centralization, as well as those for the relevant proxy.

4.1 First alternative hypothesis: socioeconomic advancement

It is important to be precise on what we mean by socioeconomic advancement. Centralization itself can be viewed as an index of advancement. Yet, anthropologists (e.g., Murdock and Provost 1973) identified eight other factors as indicative of a group's advancement: urbanization and density of population, easiness of transportation, use of writing, technological level, use of money, absence of slavery, fixity of residence, dependence on agriculture. In this section, we separate the effect of precolonial centralization by controlling for the effects of these other dimensions. Interestingly, although some of our controls are standard country-level measures, we built many of the proxies by aggregating ethnic-group level variables taken from the anthropological dataset (see Appendix 1 for details). This section has thus some independent interest because it exploits new sources of variation in the precolonial characteristics of African ethnic groups. Below we review the eight dimensions of "advancement" one by one.

– *Urbanization and population density*. Population density and urbanization do not only capture a group's economic advancement (and thus its ability to provide public goods), but they may also affect the likelihood of centralization. For instance, high population density may increase the pressure on resources, leading the rich to use centralization to keep their power. In addition, densely populated or urbanized areas may better afford the fixed cost of a centralized administrative apparatus.[19] We measure these factors using the country-level population density and the urbanization rate in 1960 (similar results are obtained by using population density in 1900). Because in some countries (e.g., Niger) a majority of the population may live in a small densely populated part of the country's territory, we control for population density both relative to total area and to arable land.
– *Easiness of transportation*. Transport costs affect "advancement" by shaping socioeconomic exchange, but they may also shape political organization (Polanyi 1957; Gluckman 1965; Lenski 1966). For instance, environments favorable to trade (e.g., harbors, rivers) may induce the establishment of centralized enforcement agencies to make trade prosper. Based on these theories, we picked these two controls: the landlocked dummy and the length of inland waterways.
– *Use of writing*. Groups using writing and written records are likely to better absorb and communicate the information involved in adopting new technologies. But writing may also help these groups to support centralization. We control for Murdock's *Writing and Records* variable, indicating whether a group had a precolonial system of writing and possessed written records.
– *Technological level*. Technologically more advanced groups are likely to better adopt modern technologies, as they may be richer or more skilled. The same factors may also affect a group's ability to centralize, so we control for this possibility using Murdock's *Metal* variable, indicating whether metalworking was present or absent in the precolonial economy of an ethnic group.

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[19] Acemoglu et al. (2002) argue that Europeans were more likely to set up extractive institutions in densely populated or urbanized areas. In this case, we would expect a *negative* spurious correlation between Centralization and public goods.

Table 4 Testing the "advancement" hypothesis: demography, trade, technology and slavery

Centralization results	Dependent variables				
Specifications	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
	(1)	(2)	(3)	(4)	(5)
Centralization	**21.53*** (7.04)**	**36.08**** (7.13)**	**−42.5*** (15.12)**	**−23.77*** (8.29)**	**1.24** (0.49)**
No "advancement" controls					
Centralization	**20.5*** (4.89)**	**31.13**** (8.39)**	**−43.6** (17.88)**	**−25.07*** (10.18)**	**1.41** (0.51)**
Population density in 1960	0.031 (0.15)	0.15 (0.096)	0.037 (0.152)	0.035 (0.083)	−0.009 (0.006)
Centralization	**21.62*** (7.34)**	**36.64**** (7.52)**	**−41.95*** (14.26)**	**−23.53** (8.97)**	**1.45** (0.58)**
Population density per arable land in 1960	−0.016 (0.014)	0.009 (0.034)	0.043 (0.048)	−0.02 (0.018)	0.004* (0.002)
Centralization	**22.76*** (7.84)**	**30.42**** (8.25)**	**−47.58*** (17.12)**	**−25.42** (11.12)**	**1.74** (0.65)**
% of urban population in 1960	0.096 (0.164)	−0.414 (0.316)	−0.65 (0.647)	−0.115 (0.357)	0.054 (0.037)
Centralization	**24.54*** (8.15)**	**36.26**** (7.8)**	**−44.23*** (15.79)**	**−22.93*** (8.37)**	**1.3** (0.56)**
Landlocked dummy	−6.26 (5.1)	−0.39 (5.85)	4.15 (9.38)	−2.11 (5.68)	−0.09 (0.42)
Centralization	**23.94*** (7.36)**	**38.1**** (8.14)**	**−43.72*** (15.6)**	**−23.93*** (8.48)**	**1.23** (0.52)**
Inland waterways	338.63* (176.08)	548.8 (575.73)	216.24 (350.4)	369.91** (159.41)	7.71 (25.74)
Centralization	**21.66*** (6.89)**	**34.83**** (6.87)**	**−39.7** (15.86)**	**−19.78*** (8.2)**	**1.04** (0.48)**
Writing	0.67 (4.87)	−16.78** (8.16)	22.99 (13.77)	23.47*** (8.5)	−1.8*** (0.5)
Centralization	**21.78** (8.1)**	**33.87**** (7.4)**	**−40.19** (15.31)**	**−20.8** (7.84)**	**1.08** (0.51)**
Metal	1.49 (10.64)	−13.76 (8.79)	20.69 (20.36)	19.07* (10.9)	−0.75 (0.56)

Table 4 continued

Centralization results

		Dependent variables			
	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
Specifications	(1)	(2)	(3)	(4)	(5)
Centralization	**23.61**** **(8.92)**	**33.26***** **(7.24)**	**−42.8***** **(15.03)**	**−21.27**** **(7.92)**	**1.16**** **(0.5)**
Money	7.18 (8.11)	−9.86 (6.92)	−1.19 (15.76)	9.83 (7.95)	−0.22 (0.81)
Centralization	**20.42**** **(8)**	**33.04***** **(7.59)**	**−33.52**** **(14.76)**	**−15.97**** **(7.38)**	**0.81*** **(0.46)**
Slavery	−4.59 (10.47)	−17.49 (10.42)	39.83** (18.92)	28.42*** (8.66)	−1.08** (0.44)

Notes: 1. The table shows coefficients and robust standard errors for *Centralization* index and "advancement" controls introduced one at a time

2. All regressions control for *Log of initial GDP/cap* from Table 2

3. All regressions have 40, 41, 40, 36, and 26 observations in columns 1 to 5, respectively, except those including *Population density per arable land* (39, 40, 40, 35, 26 observations) and those including *Inland waterways* (38, 39, 38, 34, 25)

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

Table 5 Testing the "advancement" hypothesis: fixity of residence and dependence on agriculture

Centralization results	Dependent variables				
	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
Specifications	(1)	(2)	(3)	(4)	(5)
Centralization	**21.53*** (7.04)**	**36.08*** (7.13)**	**−42.5*** (15.12)**	**−23.77*** (8.29)**	**1.24** (0.49)**
No "advancement" controls					
Centralization	**21.21*** (6.98)**	**35.91*** (7.14)**	**−42.44*** (15.39)**	**−23.38*** (8.39)**	**1.24** (0.5)**
Permanent settlements	2.52 (6.64)	12.06 (8.98)	−2.28 (16.71)	−5.31 (9.12)	0.6 (1.35)
Centralization	**21.5*** (7.11)**	**36.79*** (7.23)**	**−42.24*** (14.94)**	**−23.59*** (8.31)**	**1.48** (0.61)**
Dependence on agriculture	0.32 (1.14)	1.57 (1.98)	0.61 (3.72)	0.99 (1.88)	0.28 (0.22)
Centralization	**21.43*** (6.98)**	**36.65*** (7.03)**	**−41.52** (15.71)**	**−23.66*** (8.45)**	**1.15** (0.5)**
Water area	−15.48 (22.68)	94.32** (42.15)	39.27 (60.34)	4.32 (30.93)	−2.55 (1.92)
Centralization	**23.1*** (6.35)**	**32.2*** (8.59)**	**−40.19*** (19.38)**	**−21.69* (11.82)**	**0.97 (0.64)**
p-value for Land usage shares	[0.05]	[0.53]	[0.43]	[0.3]	[0.5]
Centralization	**18.25** (7.06)**	**33.51*** (10.29)**	**−31.67** (15.48)**	**−20.95** (9.48)**	**1.29 (0.78)**
p-value for Climate types	[0]	[0.1]	[0.07]	[0.51]	[0.08]
Centralization	**18.37** (7.82)**	**34.49*** (7.95)**	**−50.87*** (14.36)**	**−24.5*** (7.05)**	**1.49** (0.59)**
Latitude	33.07 (28.29)	15.4 (33.07)	80.9 (58.72)	7.99 (40.57)	−2.02 (3.39)
Centralization	**29.48*** (9.63)**	**32.7*** (8.78)**	**−29.04 (17.93)**	**−11.23 (8.6)**	**0.48 (0.61)**
Average elevation	−8.3* (4.33)	3.51 (4.7)	−14.58* (7.74)	−13.44** (5.49)	0.77* (0.43)

Notes: 1. The table shows coefficients and robust standard errors for *Centralization* index and "advancement" controls introduced one at a time

2. All regressions control for *Log of initial GDP/cap* from Table 2

3. All regressions have 40, 41, 40, 36, and 26 observations in columns 1 to 5, respectively, except those including *Land usage* (39, 40, 40, 35, 26 observations)

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

5. *p*-Values for *Land usage* shares and *Climate* types refer to the *F* tests of joint significance

Table 6 Testing the "national politics" hypothesis: colonial and postcolonial factors

Centralization results		Dependent variables			
Specifications	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
	(1)	(2)	(3)	(4)	(5)
Centralization	**21.53*** (7.04)**	**36.08*** (7.13)**	**−42.5*** (15.12)**	**−23.77*** (8.29)**	**1.24** (0.49)**
No colonial or postcolonial controls					
Centralization	**15.86*** (4.8)**	**36.57*** (7.55)**	**−40.42** (16.27)**	**−24.26** (8.96)**	**0.55 (0.71)**
% of European descent in1960	−46.74 (51.07)	−20.13 (48.64)	−45.65 (147.98)	−109** (52.24)	76.42 (46.52)
Centralization	**26.7*** (7.31)**	**36.71*** (6.69)**	**−35.74** (15.59)**	**−18.33** (8.87)**	**0.7 (0.68)**
Catholics	−0.15 (0.16)	−0.07 (0.18)	0.34 (0.39)	0.4 (0.24)	−0.02 (0.03)
Muslims	0.14 (0.13)	0 (0.16)	0.5* (0.25)	0.52** (0.19)	−0.04* (0.02)
Other religions	0.11 (0.15)	0.29 (0.19)	0.27 (0.32)	0.42 (0.25)	−0.04 (0.03)
Centralization	**22.22*** (8.34)**	**28.92*** (7.63)**	**−42.52** (16.04)**	**−14.75** (7.54)**	**1.02** (0.47)**
English colony	9.61** (4.61)	11.82 (7.87)	−32.67*** (10.04)	−19.22*** (5.5)	1.04** (0.4)
French colony	7.78 (6.45)	−5.47 (6.88)	−20.69* (10.25)	0.01 (5.34)	0.65 (0.58)
Centralization	**20.66*** (6.87)**	**39.62*** (7.36)**	**−42.99** (17.53)**	**−22.75** (9.32)**	**1.51** (0.57)**
Year of independence	0.19 (0.38)	0.21 (0.26)	0.33 (0.72)	−0.57 (0.35)	−0.04 (0.04)
Centralization	**21.58*** (7.28)**	**37.84*** (7.38)**	**−44.71*** (14.65)**	**−24.77*** (8.15)**	**1.6*** (0.45)**
Civil wars in 1970–1992	−1.13 (8.46)	−17.6 (12.03)	31.92 (26.55)	13.33 (16.24)	−3.12*** (0.91)
Centralization	**19.95*** (7.73)**	**32.03*** (8.13)**	**−37.65*** (15.07)**	**−24.05*** (8.99)**	**1.29** (0.52)**
Democracy in 1970–1994	1.09 (0.95)	2.39* (1.29)	−2.73* (1.61)	−0.6 (1.03)	−0.03 (0.05)

Table 6 continued

Centralization results

			Dependent variables		
Specifications	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
	(1)	(2)	(3)	(4)	(5)
Centralization	**20.25** (7.57)**	**−33.23*** (8.04)**	**−38.41** (15.33)**	**−23.82** (8.86)**	**1.24** (0.5)**
Constraints on the executive in 1970–1994	1.64 (1.6)	3.17 (2.06)	−4.08 (2.44)	−1.76 (1.65)	−0.01 (0.07)
Centralization	**18.45*** (3.73)**	**−36.17*** (9.38)**	**−41.24** (17.4)**	**−22.46** (11.01)**	**1.08 (0.72)**
Ethnolinguistic fractionalization	−7.08 (10.57)	0.18 (8.76)	2.74 (13)	2.3 (10.09)	−0.34 (1.03)
Centralization	**15.92*** (4.95)**	**−36.39*** (7.99)**	**−39.47*** (16.68)**	**−22.71** (9.37)**	**1.07** (0.51)**
Ethnic clustering	−0.41 (15.06)	−26.51 (17.54)	12.1 (28.33)	−14.59 (18.93)	0.26 (1.19)

Notes: 1. The table shows coefficients and robust standard errors for *Centralization* index and colonial or postcolonial controls introduced one at a time

2. All regressions control for *Log of initial GDP/cap* from Table 2

3. All regressions have 40, 41, 40, 36, and 26 observations in columns 1 to 5, respectively, except those including *% of Europeans* (39, 40, 39, 35, 26 observations), those including *Democracy* or *Constraints on the executive* (39, 39, 40, 35, 26) and those including *Year of independence* or *Ethnic clustering* (38, 39, 38, 34, 25)

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

– *Use of money*. Money is also a technology, facilitating economic exchange. Thus, for the reasons mentioned above, we control in our regressions for Murdock's *Money* variable, indicating whether an ethnic group used money as a medium of exchange in its precolonial economy.

– *Slavery*. History of slavery and slave trade could impede the formation of centralized political systems, but it could also lead to a lower quality of government and a lower level of public goods provision (Nunn 2005 Unpublished). We control for this possibility by using Murdock's *Slavery* variable indicating the prevalence of slavery in precolonial times for each ethnic group.

Table 4 shows the results for urbanization and population density, easiness of transportation, use of writing, technological level, use of money, and slavery. The effect of Centralization remains large and significant, while the proxies we introduce do not generally have a strong predictive power.[20] We now consider other proxies for socioeconomic advancement.

– *Fixity of residence*. It can be harder for nomadic groups to invest in socioeconomic advancement (or in schools, hospitals, or infrastructure that lead to it), but it may also be harder for them to build a centralized apparatus. To control for this effect, we use Murdock's *Settlement Pattern* variable, indicating, for each ethnic group, whether it is nomadic or has permanent settlements.

– *Dependence on agriculture*. In addition to being an indicator of advancement, agricultural productivity is also likely to favor centralization (Braudel 1972). Thus, we control for Murdock's *Share of Agriculture in Subsistence Economy* variable indicating, for each group, the importance of agriculture relative to animal husbandry, fishing, and hunting-gathering. We also control for country-level geographic variables like the area of water reservoirs (measuring water abundance), the average height of mountains (measuring the availability of agricultural lands and climate), patterns of land usage,[21] and measures of climate such as climate types and the absolute value of latitude. The latter variables also control for other theories of centralization such as Wittfogel (1957) "irrigation hypothesis" or Carneiro (1970) "geographical circumscription theory".

Table 5 shows the results for fixity of residence and dependence on agriculture. Once again, in the vast majority of specifications, the effect of Centralization remains large and significant, while the proxies we introduce do not generally have a strong predictive power (except for climate). Only controlling for a country's average elevation weakens our illiteracy and infant mortality results and drastically reduces the effect of Centralization on schooling. This is due both to the significant direct impact of elevation on these public goods and its high correlation (0.51) with centralization. Importantly, however, as we will see in Sect. 5, more nuanced predictions of the "local accountability" hypothesis are robust to the inclusion of elevation.

4.2 Second alternative hypothesis: national politics

Second alternative hypothesis holds that precolonial centralization only affected public goods provision by improving *national* political outcomes, not by increasing the accountability of *local chiefs*. This hypothesis can be formulated in two broad versions. The first deals with the possibility that—for reasons unrelated to the accountability of local chiefs—precolonial centralization affected the strategies of the colonizers. The second focuses on the potential

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[20] The negative association between precolonial writing and health or education is due to the fact that writing was more prevalent in Muslim areas (cross-country correlation of 0.72), which tend to have lower levels of these public goods.

[21] By including forests, the land usage proxy also controls for transport costs.

impact of precolonial centralization on the national politics of postcolonial African states. We now evaluate the importance of such possibilities.[22] The bottom part of Table A4 already suggests that these channels are unlikely to be important, as most of the correlations between our Centralization index and the proxies for national political outcomes are small and statistically insignificant. Yet, we still want to explicitly evaluate the validity of the "local accountability" view against these alternative stories by directly controlling for them in our regressions.

Colonial factors: Acemoglu et al. (2001) suggest that Europeans set up better institutions (probably leading to more public goods) in colonies where they could settle more easily. Centralized precolonial systems may have just facilitated European settlement, perhaps by allowing them to deal more effectively with indigenous population. To account for this possibility, we control in our regressions for the fraction of a country's population of European descent in 1960.

Second, centralized precolonial institutions may have facilitated or impeded the arrival of missionaries, who brought with them not only their credo but also efforts aimed at improving literacy and health conditions. Therefore, we control for the share of a country's population belonging to Catholic, Muslim, Protestant, or other religions. The results here must be interpreted with caution. The assimilation of religious values may itself be endogenous to education policies and depend on the impact of Centralization on the latter. Controlling for religion might bias the coefficient of Centralization downward, but we still want to see how it affects the results.

Third, our results may capture differences among colonizers in supplying funds for public goods provision. By coincidence or by choice, colonizers more resourceful or more willing to spend might have ended up administering centralized groups. Our basic regressions would then pick up the benefit of being colonized by a certain country, not that of centralization per se. To control for this possibility, we include in our regressions an English colony and a French colony dummies, with all other countries being in a third omitted group. This strategy allows us to control for differences between English and French colonies and between both of them, comprising the lion's share of African countries, and the rest of our sample (see Table A1 for the identity of each country's colonizer). Notice that this strategy also allows us to control for the effect of English legal origin which La Porta et al. (1999) find to be associated with better government.

Finally, precolonial centralization could have also improved public good outcomes by making it easier for African ethnic groups to organize resistance against expropriative colonial policies. As a proxy for the intensity of anticolonial resistance, we include in our regressions the year of a country's independence from colonial rule.

Table 6 confirms that our basic results are generally robust to the colonization stories. Only in schooling regressions is the coefficient of Centralization weakened when we control for the percentage of Europeans or religion shares, as countries with larger European settlements and/or with a larger share of Protestants attain better educational outcomes. Yet, we are reassured about the impact of Centralization on education by the results for adult illiteracy (for which we have a much larger sample), which are unaffected by the inclusion of those controls. Notice also that, consistent with the findings of La Porta et al. (1999), former English colonies

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[22] Notice that urbanization and population density can also be affected by centralization. For instance, the presence of decision-making centers may attract people from peripheries and boost urbanization. Thus, our previous robustness results can also be viewed as rejecting other indirect channels through which centralization might have worked.

fare better in health and education than other African countries. However, the coefficient of Centralization remains large and significant when we control for colonial dummies.[23]

Postcolonial factors: Civil wars are an important feature of African national politics. The risk of having a civil war may depend on precolonial centralization. For instance, the degree of interethnic military conflict can depend on the organization of the groups involved (Fearon and Laitin 1996). We control for this channel by including the frequency of a country's civil wars in our regressions.

Precolonial centralization may also have exerted a far-reaching impact on the political regime at the national level, as centralized groups could have provided mechanisms for political participation and representation after independence, putting constraints on the behavior of national political elites.[24] To account for this possibility, we include two standard measures of national checks and balances in our regressions: the indexes of Democracy and Constraints on the Executive. Notice that controlling for these measures of *national accountability* is especially important for us in order to empirically isolate the distinct "local accountability" benefits of precolonial centralization emphasized by the historical accounts discussed in Sect. 2.

Finally, being centered on ethnic groups' characteristics, our work is related to the literature on the effects of ethnic fractionalization (see Alesina and La Ferrara 2003, Unpublished for a review). Unlike the "local accountability" view that focuses on the effects of a group's political organization on its *intraethnic* economic interactions, this literature usually defines ethnicity based on language and attributes the costs of ethnic heterogeneity to cultural barriers in *interethnic* relations. Since precolonial centralization may have reduced the scope for distinctive cultural differences, we include the Ethnolinguistic Fractionalization index of Easterly and Levine (1997) in our regressions to control for this indirect channel.[25] The index of Ethnolinguistic Fractionalization has been recently criticized because it cannot capture how clustered are different ethnic groups in a country's territory. For example, it has been argued that ethnic relations are especially tense when groups are geographically clustered (i.e., segregated). As a result, we also control for the Ethnic Clustering (EC) index developed by Matuszeski and Schneider (2006, Unpublished).

Table 6 tends to reject the channels working through postcolonial national politics. We do not find any evidence supporting the role of Ethnolinguistic Fractionalization or Ethnic Clustering. The coefficients on Civil Wars, Democracy, and Constraints on the Executive generally have the expected sign but are not significant on a consistent basis. More importantly, the results for our Centralization index remain remarkably robust to the inclusion of these controls.

Overall, the evidence of this section corroborates our results from Sect. 3. First, the evidence tends to reject the hypothesis that centralized groups fared better just because they were more advanced. This suggests that precolonial institutions had a direct impact on public goods provision across African countries. Thus, colonial and postcolonial policies were not simply the result of institutional arrangements externally imposed by colonialists, as the

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[23] Our results change very little if we control for the English legal origin dummy. We also ran a regression with English, French, Belgian, and Portuguese colonial dummies, with one Spanish colony and two not colonized countries being in the fifth omitted group. Notice that this is a very restrictive test in our sample of 39 countries. The results are similar to the ones obtained by including only the English and the French dummies. The main difference is that our illiteracy regression becomes only marginally significant.

[24] Instead, Acemoglu et al. (2002) make an opposite argument. In their view, the centralized indigenous structure provided the basis for the establishment of extractive institutions by colonial and postcolonial elites.

[25] Scholars recently moved from language to other dimensions of ethnicity. Caselli and Coleman (2002, Unpublished) argue for the salience of physical differences as a determinant of ethnic conflict. Alesina et al. (2003) and Fearon (2003) proposed "identity" based definitions of ethnicity, which are hard to conceptualize into a specific operational criterion.

current economic literature suggests (e.g., La Porta et al. 1999; Acemoglu et al. 2001), but they also heavily depended on traditional precolonial institutions.

Second, the evidence that national-level political effects do not account for the benefit of precolonial centralization suggests that the "local accountability" view is likely to have played an important role. Clearly, the test of the "local accountability" view carried out in this section is very indirect, as it only relies on controlling for proxies of alternative hypotheses. In the next section we make a further step toward identification by developing specific theoretical predictions of the "local accountability" view and by testing them empirically.

5 Centralization, stratification and the empirical test of "local accountability"

Historical evidence suggests that, when local chiefs were given the power to implement modernization programs, the chiefs' lack of accountability in fragmented groups generated two political failures. First, local chiefs often used this power against the interests of their subjects. Second, with respect to policies having large geographic spillovers, local chiefs often failed to coordinate among themselves, which also led to large policy distortions.[26] The "local accountability" view can thus be tested by checking whether lower public goods provision in fragmented groups is indeed due to these two political failures. To implement such a test, we need a proxy for the extent of the conflict between local chiefs and masses, measuring the severity of the chiefly tyranny, and a proxy for the extent of geographic spillovers in public goods provision, measuring the severity of the coordination problem.

As a proxy for the extent of the conflict between local chiefs and masses, we use the *Class Stratification* variable from Murdock's *Ethnographic Atlas*. This variable measures the degree of social stratification at the local level and allows us to subdivide all the African ethnic groups into "stratified" and "egalitarian".[27] Intuitively, it is precisely in stratified (and fragmented) groups that unaccountable local chiefs should have been especially likely to abuse their power.

With respect to geographic spillovers, although there is no objective measure, it is possible to characterize with a certain confidence whether a given public good is closer to the ideal of "high spillovers" or to that of "low spillovers". Paved roads are clearly close to the ideal of high spillovers goods, as they facilitate mobility across districts. Conversely, the public goods behind educational outcomes such as illiteracy and schooling are closer to the low spillovers ideal, as confirmed by the empirical estimates of low external returns to education (Acemoglu and Angrist 2000). The classification of our health measures is less straightforward, but the following distinction seems reasonable. The infectious nature of diphtheria, pertussis and tetanus can create widespread epidemics, so that immunization against them is closer to the high spillovers ideal. But infectious diseases are only one cause of mortality.[28] Other diseases are less transmittable and the factors reducing their impact (e.g., availability

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[26] These two costs of decentralization have been also discussed in the context of federalism (e.g., Riker 1964; Oates 1972; Blanchard and Shleifer 2001).

[27] The *Class Stratification* variable codes, for each ethnic group, the degree of class stratification at the local level in five mutually exclusive categories. "Elite", "dual" and "complex" stratification indicate that the elite class derives its hereditary status from control over scarce resources (e.g., land), from ascribed nobility and from occupation, respectively. All three categories comprise groups with class distinctions, so we code them as "stratified". Other ethnic groups either do not have class distinctions or have only wealth distinctions, which are "not crystallized into distinct and hereditary social classes". Since social classes are absent under both definitions, we code these groups as "egalitarian".

[28] As shown in Table A3, the correlation in our sample between infant mortality and the DPT immunization rate is about 0.31, indicating that around 90% of the variation in infant mortality is associated with other factors.

of medical supplies, access to clean water, modern sanitation facilities) are more locality-specific. Thus, unlike immunization, public goods reducing infant mortality are presumably closer to the low spillovers ideal. Bardhan (2002) stresses the same distinction between the control of epidemics and the provision of general health facilities in terms of size of spillovers involved. We thus classify paved roads and infant immunization as high spillovers goods, and schooling, adult illiteracy and infant mortality as low spillovers goods.

Having found the proxies for the two political failures that may have plagued local politics of fragmented groups, what specific implications of the "local accountability" view should we bring to the data? First, because the tyranny of local chiefs against their masses must have been especially severe in stratified groups, we should expect—absent the accountability mechanisms of precolonial centralization—the underprovision of public goods also to be especially severe in these groups. Thus, the "local accountability" view implies that precolonial centralization should disproportionately improve public goods provision in stratified ethnic groups.

Second, the interaction between precolonial centralization and local stratification should also vary across public goods depending on their amount of geographic spillovers. Specifically, the "local accountability" view implies that the extent to which the benefit of precolonial centralization is larger in stratified groups should be smaller for public goods with large spillovers. Indeed, high spillovers goods should be severely underprovided in *all* fragmented groups, irrespective of their local stratification. For these goods precolonial centralization should therefore have a relatively uniform benefit across stratified and egalitarian ethnic groups.

To sum up, the "local accountability" view predicts that for low spillovers goods (such as education and infant mortality) precolonial centralization should benefit stratified groups *much more* than egalitarian ones, while for high spillovers goods (such as paved roads and infant immunization) it should uniformly benefit *both* stratified and egalitarian groups. These predictions of the "local accountability" view are not easily fulfilled under the alternative hypotheses that might otherwise explain the positive association between precolonial centralization and public goods. For instance, under the hypothesis that centralized groups were just more "advanced", so that they could naturally produce more public goods, centralized groups should fare better irrespective of stratification. A similar uniform effect should hold if precolonial centralization only improved the national government, irrespective of local conditions. Both views would thus be inconsistent with a larger benefit of centralization for stratified groups.[29]

5.1 Testing the "local accountability" hypothesis

We now test the empirical predictions of the "local accountability" view. By combining the new stratified-egalitarian distinction with our previous centralized-fragmented distinction, we allocate each African ethnic group to one of four possible types of precolonial political systems: centralized and stratified, centralized and egalitarian, fragmented and stratified, fragmented and egalitarian.[30] For every country in our sample, we find the share of its

[29] More nuanced versions of these views may claim that a group's advancement or its ability to support national politics is related to both its centralization and stratification. For instance, only centralized and stratified groups may be advanced. Yet, these alternative versions would still be inconsistent with the predictions of the "local accountability" view as they are unable to capture the more uniform benefit of precolonial centralization for goods with large spillovers.

[30] Incidentally, in line with the ideas of Fried (1967), our sample features a positive (but far from perfect) correlation of about 0.7 between centralization and stratification.

non-European population falling into each of the four groups. Table A5 shows the cross-country distribution of these shares. We then run, for each public good outcome, the following OLS regression:

$$Y_i = \beta_0 + \beta_1^* Centr\&Strat_i + \beta_2^* Fragm\&Strat_i + \beta_3^* Centr\&Egal_i + \varepsilon_i$$

Y_i is the value of the public good outcome in country i. $Centr\&Strat_i$, $Fragm\&Strat_i$, and $Centr\&Egal_i$ are the shares of centralized and stratified, fragmented and stratified, and centralized and egalitarian ethnic groups in country i. The share of fragmented and egalitarian ethnic groups is omitted from our regressions, so that β_1, β_2, and β_3 represent the quality of public goods in other precolonial political systems, *relative to that benchmark*.

The "local accountability" view can be tested by focusing on the sign and significance of the "difference-in-difference" coefficient $(\beta_1 - \beta_2 - \beta_3)$. This coefficient indicates whether precolonial centralization is more beneficial for stratified or egalitarian ethnic groups, as it subtracts the benefit of precolonial centralization in the latter (β_3) from that in the former groups $(\beta_1 - \beta_2)$.

The main prediction of the "local accountability" view is that for low spillovers public goods the benefit of precolonial centralization should be larger for stratified groups. Thus, in our regressions for schooling, illiteracy and infant mortality we expect a large and positive $(\beta_1 - \beta_2 - \beta_3)$, reflecting a large benefit of centralization in stratified groups (driven by $\beta_2 < 0$ for the effect of chiefly tyranny) and small (or zero) effect of centralization in egalitarian groups (i.e., $\beta_3 \approx 0$). Conversely, for high spillovers goods the "local accountability" view predicts a relatively uniform benefit of precolonial centralization across stratified and egalitarian groups. Thus, in our regressions for paved roads and immunization we expect $(\beta_1 - \beta_2 - \beta_3)$ to be small (or zero), driven by β_1 and β_3 which are positive and of similar magnitude.

Table 7 presents the results of our empirical exercise. To check whether actual provision patterns are consistent with our theoretical predictions, we report (in bold) the estimate and the standard error of $(\beta_1 - \beta_2 - \beta_3)$. For completeness, we also report estimates and standard errors of $(\beta_1 - \beta_2)$ and $(\beta_1 - \beta_3)$. Panel A reports these estimates when we do not control for initial income; Panel B shows the results obtained when initial per capita GDP is included. Because of the similarity of the results, we only focus our discussion on those reported in Panel B.

Columns 3, 4, and 5 show our findings for low spillovers goods: infant mortality, illiteracy rate, and schooling. In line with the "local accountability" view $(\beta_1 - \beta_2 - \beta_3)$ is highly significant and has the right sign, suggesting that centralization benefits stratified groups more than egalitarian ones. The estimates of $(\beta_1 - \beta_2)$, also large and highly significant (at the 1% level) for all three variables, support the view that the accountability benefit of precolonial centralization is especially large when the local distribution of power is highly unequal. Centralization reduces the number of infants who die by 100 (out of 1,000), cuts illiteracy by 57.65 percentage points and increases schooling by 3.18 years. All these effects are larger than 3 standard deviations. In contrast, the small and insignificant β_3 indicates that in egalitarian groups precolonial centralization does not have any effect on the provision of low spillovers public goods.[31]

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[31] Notice that the sign and significance of β_2 suggests that, consistent with our assumptions, introducing stratification into fragmented groups increases infant mortality by 74, the illiteracy rate by 36.39 percentage points and reduces average school attainment by 2.17 years. These effects are extremely large (equivalent to a change of about 2 standard deviations in our dependent variables) and confirm the presence of local tyranny in fragmented groups. The large adverse effect of stratification on education in fragmented groups suggests that local tyranny may be especially severe for this outcome. Chiefs are likely to be very reluctant to invest in mass education, as it can undermine their political power. For instance, missionary education often attempted to supplant African values with Western ones.

Table 7 Testing the "local accountability" hypothesis: precolonial centralization, class stratification and public goods provision

Panel A: No controls

		(1) % of roads paved in 1990-2000	(2) % of infants immunized for DPT in 2001	(3) Infant mortality in 1960-2001	(4) Adult illiteracy rate in 1970-2002	(5) School attainment in 1960-1990
	Strat / **Egalit**					
Centr β₁	β₃	**22.23*** (7.99) / **17.36** (8.02)	**37.73*** (7.48) / **40.06** (19.4)	**-33.54** (13.63) / **19** (27.91)	**-16.41* (8.87) / **5.08** (13.73)	**1.01* (0.54) / **-0.59** (1.08)
Fragm β₂	0	**5.1** (10.07) / 0	**11.17** (23.44) / 0	**75.89** (37.22) / 0	**45.67** (21.45) / 0	**-2.21** (0.95) / 0
β₁–β₂		17.13 (13.75)	26.56 (21.23)	-109.43*** (35.06)	-62.09*** (20.31)	3.22*** (0.83)
β₁–β₃		4.88 (11.07)	-2.33 (18.68)	-52.54* (28.63)	-21.5* (12.68)	1.59 (0.96)
β₁–β₂–β₃		**-0.22** (15.88)	**-13.5** (31.86)	**-128.43*** (46.33)	**-67.17** (25.44)	**3.8** (1.5)
Obs		40	42	42	37	26
Rsq		0.24	0.34	0.32	0.27	0.28

Table 7 continued

Panel B: Controlling for Log of initial GDP/cap

		% of roads paved in 1990-2000		% of infants immunized for DPT in 2001		Infant mortality in 1960-2001		Adult illiteracy rate in 1970-2002		School attainment in 1960-1990	
		(1)		(2)		(3)		(4)		(5)	
Strat	**Egalit**										
Centr β₁	β₃	**22.89*****	**22****	**37.18*****	**42.11***	**-37.2****	**10.4**	**-21.27****	**-2.89**	**1.01***	**-0.54**
		(7.72)	(8.4)	(8.56)	(21.86)	(14.31)	(28.55)	(8.58)	(16.95)	(0.55)	(1.16)
Fragm β₂	0	**10.03**	0	**12.7**	0	**74****	0	**36.39***	0	**-2.17*****	0
		(10.88)		(26.25)		(34.27)		(20.31)		(0.9)	
β₁–β₂		12.86	(14.61)	24.48	(22.83)	-111.2***	(31.57)	-57.65***	(18.74)	3.18***	(0.78)
β₁–β₃		0.88	(11.7)	-4.94	(19.93)	-47.6*	(27.58)	-18.38	(15.94)	1.55	(1.06)
β₁–β₂–β₃		**-9.15**	**(18.15)**	**-17.63**	**(36.69)**	**-121.6*****	**(44.66)**	**-54.76****	**(26.85)**	**3.72****	**(1.48)**
Obs		40		41		40		36		26	
Rsq		0.28		0.32		0.39		0.37		0.29	

Notes: 1. β₁, β₂ and β₃ refer to the OLS estimations of $Y_i = \beta_0 + \beta_1 *\text{Centr-\&-Strat}_i + \beta_2 *\text{Fragm-\&-Strat}_i + \beta_3 *\text{Centr-\&-Egalit}_i + X'_i\gamma + \varepsilon_i$

2. "Initial GDP/cap" refers to GDP/cap in 1960 for columns 3 and 5, in 1970 for column 4, in 1986 for column 1 and in 2001 for column 2

3. Robust standard errors are shown in parentheses

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

Columns 1 and 2 describe our findings for paved roads and DPT immunization. Again, the results are highly consistent with the prediction of the "local accountability" view for these high spillovers goods: $(\beta_1 - \beta_2 - \beta_3)$ is very insignificant, indicating that the benefit of precolonial centralization is indeed uniform across stratified and egalitarian groups. Moreover, β_1 and β_3 are large, statistically significant and of similar magnitude. They indicate a 22 percentage-point increase in paved roads and a 37 to 42 percentage-point increase in DPT immunization, associated with the greater coordinating ability of centralized polities.[32]

To summarize, the evidence presented in Table 7 is consistent with the "local accountability" view because: (1) for low spillovers goods (such as education and infant mortality) precolonial centralization is *more beneficial* for stratified than for egalitarian groups and (2) for high spillovers goods (such as paved roads and DPT immunization) centralization uniformly benefits *both* stratified and egalitarian groups. These results show that the positive association between precolonial centralization and public goods outcomes in Africa is likely to be due, at least in part, to the "local accountability" view. Omitted variables or indirect effects of precolonial centralization are not the whole story, as they are unlikely to fully explain the findings of this section.

5.2 Robustness of the empirical test

Tables 8 and 9 show the results of our test when we also include in our regressions the proxies for alternative hypotheses used in Sect. 4. We report the value and the standard error of the coefficient $(\beta_1 - \beta_2 - \beta_3)$. The evidence supports the "local accountability" view insofar as this difference-in-difference coefficient remains unaffected. The results show that the predictions of the "local accountability" view are remarkably robust to the inclusion of proxies for our alternative hypotheses: Centralization disproportionately benefits stratified groups for low spillovers goods (i.e., $(\beta_1 - \beta_2 - \beta_3)$ is generally large and significant), while generating a uniform benefit for high spillovers good (i.e., $(\beta_1 - \beta_2 - \beta_3)$ is small and insignificant).[33]

Thus, the data strongly support the "local accountability" view whereby precolonial centralization fostered the implementation of modernization programs in rural Africa by increasing the ability of the colonial and the postcolonial national state to control local chiefs.

6 Conclusions

We empirically assessed the view that precolonial centralization affected the ability of colonial and postcolonial African governments to implement modernization programs in rural areas. We document a positive association between the provision of modern public goods such as education, health, and infrastructure in African countries and the centralization of their precolonial political institutions. We present historical evidence supporting a "local

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[32] In columns 1 and 2 estimates of $\beta_1 - \beta_2$ are noisy, with low significance. Yet, β_1 and β_3 are similar in size and β_2 is not statistically different from 0, so we do not conclude that there is no coordination benefit in stratified groups.

[33] Land usage and climate types slightly weaken $(\beta_1 - \beta_2 - \beta_3)$ for adult illiteracy. Yet, in these regressions centralization continues to benefit stratified groups $((\beta_1 - \beta_2)$ is significant at the 5% level) but not egalitarian ones. Religion also weakens $(\beta_1 - \beta_2 - \beta_3)$ for educational outcomes. Yet, for adult illiteracy centralization still benefits stratified but not egalitarian societies $((\beta_1 - \beta_2)$ is 5% significant, while β_3 is zero). The full results are available from the authors. In addition, as noticed in Sect. 4, the results for education may be downward biased when we control for religion.

Table 8 Testing the "local accountability" hypothesis: robustness to "advancement" controls

Centralization-Stratification results ($\beta_1 - \beta_2 - \beta_3$)	Dependent variables				
"Advancement" controls	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
	(1)	(2)	(3)	(4)	(5)
No controls	−9.15 (18.15)	−17.63 (36.69)	−121.6*** (44.66)	−54.76** (26.85)	3.72** (1.48)
Population density in 1960	−11.03 (15.17)	−29.32 (36.4)	−125.99*** (46.13)	−60.11** (28.76)	3.79** (1.62)
Population density per arable land in 1960	−9.46 (18.53)	−19.88 (36.79)	−124.46*** (44.08)	−52.44* (27.5)	3.27*** (1.14)
% of urban population in 1960	−10.3 (18.11)	−11.94 (37.4)	−118.33** (45.73)	−54.72* (27.89)	3.22** (1.41)
Landlocked dummy	−8.11 (17.1)	−17.68 (37.01)	−121.64*** (44.16)	−54.57* (27.69)	3.71** (1.5)
Inland waterways	−1.85 (18.45)	−8.72 (35.46)	−128.33** (48.82)	−50.8* (29.63)	4.6** (1.86)
Writing	−9 (17.83)	−28.98 (32.47)	−113.19** (44.1)	−40.49* (23.74)	2.38 (1.67)
Metal	−9.64 (17.85)	−14.16 (37.3)	−120.28** (45.64)	−53.18* (28.23)	3.68** (1.53)
Money	−25.7 (17.69)	−2.4 (46.13)	−160.44*** (47.37)	−90.71*** (22.13)	4.63*** (1.42)
Slavery	−10.18 (19.26)	−20.72 (36.44)	−104.39** (45.56)	−41.71 (26.21)	3.22* (1.74)
Permanent settlements	−9.32 (18.37)	−23.59 (36.25)	−123.59*** (43.37)	−54.34* (27.87)	3.85** (1.72)
Dependence on agriculture	−9.03 (18.71)	−20.21 (37.02)	−121.86*** (44.87)	−56.61** (27.08)	3.55** (1.59)
Water area	−9.92 (18.29)	−13.09 (28.78)	−120.21** (46.87)	−55.32* (26.83)	3.64* (1.6)
Land usage shares	1.58 (16.16)	−26.74 (43.47)	−112.72* (54.84)	−50.06 (32.68)	3.67* (1.94)
Climate types	−6.33 (21.76)	−54.87 (38.1)	−102.05** (44.1)	−43.05 (32)	3.8* (2.12)
Latitude	−1.79 (19.07)	−16.24 (41.8)	−115.88** (45.6)	−61.01** (29.58)	3.65** (1.36)
Average elevation	−5.26 (17.44)	−18.97 (36.55)	−115.17*** (42.28)	−47.06** (19.71)	3* (1.51)

Notes: 1. The table shows coefficients and robust standard errors of $\beta_1 - \beta_2 - \beta_3$ from the OLS estimations of $Y_i = \beta_0 + \beta_1^*\text{Centr-\&-Strat}_i + \beta_2^*\text{Fragm-\&-Strat}_i + \beta_3^*\text{Centr-\&-Egalit}_i + X_i'\gamma + \varepsilon_i$, where "advancement" controls are introduced one at a time

2. All regressions control for *Log of initial GDP/cap* from Tables 2 and 7

3. All regressions have 40, 41, 40, 36, and 26 observations in columns 1 to 5, respectively, except those including *Population density per arable land* (39, 40, 40, 35, 26 observations), those including *Inland waterways* (38, 39, 38, 34, 25) and those including *Land usage shares* (39, 40, 40, 35, 26)

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

Table 9 Testing the "local accountability" hypothesis: robustness to colonial and postcolonial controls

Centralization-Stratification results ($\beta_1 - \beta_2 - \beta_3$)	Dependent variables				
	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
Colonial and postcolonial controls	(1)	(2)	(3)	(4)	(5)
No controls	−9.15 (18.15)	−17.63 (36.69)	−121.6* (44.66)	−54.76** (26.85)	3.72** (1.48)
% of European descent in 1960	−19.06 (14.48)	−16.66 (37.54)	−121.47** (45.21)	−52.42* (27.22)	3.41** (1.45)
Religion variables	12.83 (20.62)	−25.56 (36.83)	−106.07** (44.05)	−32.66 (21.92)	0.67 (2.08)
English and French colonial dummies	−2.372 (19.57)	−14.044 (32.47)	−139.86*** (43.74)	−57.65** (25.66)	4.48*** (1.51)
Year of independence	−11.157 (18.25)	−29.025 (37.71)	−135.42*** (43.63)	−52.03* (28.43)	3.97* (1.78)
Civil wars in 1970–1992	−9.37 (19.32)	−16.86 (37.47)	−122.33** (46.81)	−52.82* (27.51)	3.2** (1.33)
Democracy in 1970–1994	−5.58 (17.24)	−4.19 (34.11)	−127.5** (46.3)	−56.48* (28.9)	3.66** (1.48)
Constraints on the executive in 1970–1994	−4.89 (17.57)	−5.57 (35.57)	−133.52*** (44.34)	−60.3** (28.77)	3.78** (1.51)
Ethnolinguistic fractionalization	−11.695 (17.35)	−17.564 (37)	−122.36** (48.18)	−54.55* (27.45)	3.76** (1.54)
Ethnic clustering	−20.359 (14.56)	−14.741 (36)	−122.46** (46.91)	−55.62** (26.16)	3.92** (1.59)

Notes: 1. The table shows coefficients and robust standard errors of $\beta_1 - \beta_2 - \beta_3$ from the OLS estimations of $Y_i = \beta_0 + \beta_1^* \text{Centr-\&-Strat}_i + \beta_2^* \text{Fragm-\&-Strat}_i + \beta_3^* \text{Centr-\&-Egalit}_i + X_i' \gamma + \varepsilon_i$, where colonial and postcolonial controls are introduced one at a time

2. All regressions control for *Log of initial GDP/cap* from Tables 2 and 7

3. All regressions have 40, 41, 40, 36, and 26 observations in columns 1 to 5, respectively, except those including *% of Europeans* (39, 40, 39, 35, 26 observations), those including *Democracy* or *Constraints on the executive* (39, 39, 40, 35, 26) and those including *Year of independence* or *Ethnic clustering* (38, 39, 38, 34, 25)

4. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

accountability" view whereby precolonial centralization improved the provision of local public goods in colonial and postcolonial Africa by rendering local chiefs more accountable. We develop a strategy to test this view against alternative hypotheses. The data are broadly consistent with the "local accountability" view and inconsistent with alternative hypotheses, suggesting that precolonial centralization improved the ability of colonial and postcolonial African governments to control local chiefs.

From a normative standpoint, our results shed some light on the debate on institutional reform in transition and developing countries. It has long been argued that a critical determinant of the ability of these countries to effectively implement modernization programs rests on the proper working of the local government, especially on the incentives faced by local administrators (Bardhan 2002). Our analysis suggests that institutional reforms aimed at fostering modernization efforts in the periphery should be designed so as to optimally respond to local conditions and integrate preexisting local power structures into the implementation of government programs.

In Africa, this implies that in regions populated by fragmented groups the national state (or international institutions) may need to play a more direct role in the implementation of modernization programs, especially if the local community is very unequal: delegating public goods provision to these regions may simply exacerbate the costs of local tyranny and lack of coordination. On the other hand, the central state may follow a more hands-off, indirect approach in regions populated by centralized ethnic groups: delegating public goods provision to these regions may allow better adaptation to local conditions without undermining policy implementation.

More broadly, these observations relate to the ongoing debate on centralization. In policy circles, administrative decentralization is widely believed to make the local government more accountable and efficient. This idea has a long pedigree in economics (e.g., Tiebout 1956; Besley and Case 1995; Seabright 1996), but it ultimately rests on the assumption that the local political system is able to discipline local administrators. Yet, our analysis illustrates that in the presence of profound socioeconomic inequalities decentralization may allow local administrators to distort the implementation of public programs to their own advantage, disregarding the broad interest of their communities.[34] Our findings suggest—in parallel with Riker's (1964) classic study of federalism—that when the local political process is captured by powerful local groups, administrative *centralization* may help increase the accountability of local administrators and foster the implementation of socioeconomic reforms.

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[34] Evidence from around the world confirms that decentralization often allows local power holders to subvert policy implementation to their own advantage. See Shleifer and Treisman (1999) on Russia; Lieten (1996) and Mathew and Nayak (1996) on India; Fox (1990) on Latin America.

Appendix 1

Data and sources

Dependent variables

% of roads paved in 1990–2000   Average of roads paved (as percent of total roads) for the years 1990–2000. Paved roads are roads that have been sealed with asphalt or similar road-building materials. Scale 0–100.
Source: Based on World Bank World Development Indicators (2003).

% of infants immunized for DPT in 2001   Infant immunization measures the rate of vaccination coverage of children under one year of age. A child is considered adequately immunized against DPT (diphtheria, pertussis, or whooping cough, and tetanus) after receiving two or three doses of vaccine, depending on the immunization scheme. Scale 0–100.
Source: World Bank World Development Indicators (2003).

Infant mortality in 1960–2001   Average of infant mortality rate for the years 1960–2001. Infant mortality rate is the number of infants who die before reaching one year of age, per 1,000 live births in a given year.
Source: Based on World Bank World Development Indicators (2003).

Adult illiteracy rate in 1970–2002   Average of adult illiteracy rate for the years 1970–2002. Adult illiteracy rate is the proportion of adults aged 15 and above who cannot, with understanding, read and write a short, simple statement of their everyday life. Scale 0–100.
Source: Based on World Bank World Development Indicators (2003).

School attainment in 1960–1990   Average of school attainment for the years 1960–1990. Each value is an average of schooling years in the total population over the age of 15.
Source: Based on Barro and Lee (1994).

Main independent variables

Centralization   For each country measures the share of the non-European population that belongs to indigenously "centralized" ethnic groups. Scale is 0–1. An ethnic group is defined as "centralized" if it has 2, 3, or 4 jurisdictional levels above the local community according to Murdock (1967) *Jurisdictional Hierarchy* variable. (It is defined as "fragmented" if it has 0 or 1 levels)
Source: Constructed by the authors using Murdock (1967) and Atlas Narodov Mira (1964).

Appendix 1 continued

Data and sources

Centralization-Stratification shares

For each country measure the shares of the non-European population that belongs to precolonially centralized and stratified, fragmented and stratified, centralized and egalitarian, or fragmented and egalitarian ethnic groups. Scale is 0–1. An ethnic group is defined as "centralized" if it has 2, 3 or 4 jurisdictional levels above the local community according to Murdock (1967) *Jurisdictional Hierarchy* variable. It is defined as "fragmented" if it has 0 or 1 levels. An ethnic group is defined as "stratified" if Murdock (1967) *Class Stratification* variable indicates that the group is characterized by one of the following: (a) "elite stratification, in which an elite class derives its superior status from, and perpetuates it through, control over scarce resources, particularly land, and is thereby differentiated from a propertyless proletariat or serf class"; (b) "dual stratification into a hereditary aristocracy and a lower class of ordinary commoners or freemen, where traditionally ascribed noble status is at least as decisive as control over scarce resources" or (c) "complex stratification into social classes correlated in large measure with extensive differentiation of occupational statuses". A group is defined as "egalitarian" if according to the same variable it is characterized by (a) "absence of significant class distinctions among freemen, ignoring variations in individual repute achieved through skill, valor, piety, or wisdom" or (b) "wealth distinctions based on the possession or distribution of property present and socially important but not crystallized into distinct and hereditary social classes".
Source: Constructed by the authors using Murdock (1967) and Atlas Narodov Mira (1964).

Log of GDP per capita in 1960, 1970, and 1986

Logarithm of GDP per capita in constant 1985 dollars (international prices).
Source: Global Development Network Growth Database, based on Penn World Table 5.6.

Log of GDP per capita in 2001

Logarithm of GDP per capita in constant 1995 dollars (international prices).
Source: World Bank World Development Indicators (2003).

"Advancement" controls
Population density in 1960

Total population in 1960 divided by land area in square kilometers. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. Refugees not permanently settled in the country of asylum are generally considered to be part of the population of their country of origin. Land area is a country's total area, excluding area under inland water bodies. In most cases the definition of inland water bodies includes major rivers and lakes.
Source: Based on World Bank World Development Indicators (2003).

Population density per arable land in 1960

Total population in 1960 divided by arable land in square kilometers. Arable land includes land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow.
Source: Based on World Bank World Development Indicators (2003).

Appendix 1 continued

Data and sources	
% of urban population in 1960	Urban population is the midyear population of areas defined as urban in each country and reported to the United Nations. It is measured here as the percentage of the total population. Scale 0–100. *Source*: World Bank World Development Indicators (2003).
Landlocked	Dummy variable taking value 1 if a country is landlocked, 0 otherwise. *Source*: Parker (1997).
Inland waterways	Length of inland waterways (km) divided by land area (km sq). Land area is a country's total area, excluding area under inland water bodies. In most cases the definition of inland water bodies includes major rivers and lakes. *Source*: Based on Parker (1997) and World Bank World Development Indicators (2003).
Writing[a]	For each country measures the share of the non-European population that belongs to ethnic groups that had precolonial system of writing. Scale is 0–1. An ethnic group is defined as having a precolonial system of writing if according to *Writing and Records* variable of Murdock and Provost (1973): (a) it "has an indigenous system of true writing and possesses written records of at least modest significance" or (b) it "has an indigenous system of writing but lacks any significant accumulation of written records, or alternatively has long used the script of alien people". In contrast, a group is defined as lacking a precolonial system of writing if: (a) it "lacks true writing but possesses significant nonwritten records in the form of picture writing, quipus, pictorial inscriptions, or the like"; (b) "writing and significant records are lacking but the people employ mnemonic devices, e.g., simple tallies" or (c) "writing, records, and mnemonic devices in any form are lacking or unreported". *Source*: Constructed by the authors using Murdock and Provost (1973) and Atlas Narodov Mira (1964).
Metal[a]	For each country measures the share of the non-European population that belongs to ethnic groups that had metalworking (e.g., forging or casting of metal artifacts) activity present in their precolonial economy. Scale is 0–1. *Source*: Constructed by the authors using Murdock and Provost (1973) and Atlas Narodov Mira (1964).

Appendix 1 continued

Data and sources	
Money[a]	For each country measures the share of the non-European population that belongs to ethnic groups that used money as medium of exchange in their precolonial economy. Scale is 0–1. An ethnic group is defined as using money as medium of exchange if according to *Money* variable of Murdock and Provost (1973): (a) it "uses an indigenous currency in the form of metal coins of standard weight and fineness and/or their equivalent in paper currency"; (b) it "uses indigenous articles of token or conventional value, such as cowrie shells, wampum, or imitation tools, as an elementary form of money"; (c) it "lacks any forms of indigenous money but has long used the currency of an alien people" or (d) "true money is lacking but the society employs domestically usable articles, such as salt, grain, livestock, or ornaments, as a medium of exchange". In contrast, a group is defined as lacking medium of exchange if it "lacks any recognized medium of exchange, conducting mercantile transactions through the direct or indirect exchange of goods, e.g., barter. *Source*: Constructed by the authors using Murdock and Provost (1973) and Atlas Narodov Mira (1964).
Slavery	For each country measures the share of the non-European population that belongs to ethnic groups that had slavery in precolonial times. An ethnic group is defined as having slavery if according to Murdock (1967) *Slavery* variable it had: (a) "hereditary slavery present and of at least modest social significance"; (b) "slavery reported but not identified as hereditary or nonhereditary" or (c) "incipient or nonhereditary slavery, i.e., where slave status is temporary and not transmitted to the children of slaves". In contrast, a group is defined as not having slavery if it is characterized by "absence or near absence of slavery". *Source*: Constructed by the authors using Murdock (1967) and Atlas Narodov Mira (1964).
Permanent settlements	For each country measures the share of the non-European population that belongs to ethnic groups that indigenously have "permanent settlements". An ethnic group is defined as having "permanent settlements" if according to Murdock (1967) *Settlement Pattern* variable it is characterized by one of the following: (a) "complex settlements consisting of a nucleated village or town with outlying homesteads or satellite hamlets"; (b) "compact and relatively permanent settlements, i.e., nucleated villages or towns"; (c) "separated hamlets where several such form more or less permanent single community" or (d) "neighborhoods of dispersed family homesteads". In contrast, "nomadic" groups are described by the same variable as either: (a) "fully migratory or nomadic bands"; (b) "seminomadic communities whose members wander in bands for at least half of the year but occupy a fixed settlement at some season or seasons"; (c) "semisedentary communities whose members shift from one to another fixed settlement at different seasons or who occupy more or less permanently a single settlement from which a substantial proportion of the population departs seasonally to occupy shifting camps" or (d) having "compact but impermanent settlements, i.e., villages whose location is shifted every few years". *Source*: Constructed by the authors using Murdock (1967) and Atlas Narodov Mira (1964).
Dependence on agriculture	For each country measures a weighted average of "dependence on agriculture" of its ethnic groups. "Dependence on agriculture" for each group is from Murdock (1967) *Subsistence Economy* variable and is relative to its dependence on hunting-gathering, fishing, and animal husbandry. Scale is from 1–10. *Source*: Constructed by the authors using Murdock (1967) and Atlas Narodov Mira (1964).

Appendix 1 continued

Data and sources	
Water area	Water area (km sq) divided by land area (km sq). Land area is a country's total area, excluding area under inland water bodies. In most cases the definition of inland water bodies includes major rivers and lakes. *Source:* Based on Parker (1997) and World Bank World Development Indicators (2003).
Land usage shares	Identify the percentage of the land of each country that belongs to the four types of land usage: (1) Arable (2) Permanent crops, (3) Meadows and pastures and (4) Forest and woodland. The residual is called "Other land usage". The numbers are in percent (scale from 0–100). *Source:* Parker (1997).
Climate types	Climate types are tropical wet, tropical monsoon, tropical wet and dry, steppe (low latitude), desert (low latitude), subtropical humid, dry steppe wasteland, and highland. *Source:* Parker (1997).
Latitude	The absolute value of the latitude of the country, scaled to take values between 0 and 1. *Source:* La Porta et al. (1999), originally based on CIA World Factbook (1996).
Average elevation	Average elevation (th m). *Source:* Parker (1997).
Colonial and postcolonial controls	
% of European descent in 1960	% of population of European descent in 1960. "European" includes all whites. Scale from 0 to 1. *Source:* Morrison et al. (1989).
Religion shares	Identify the percentage of the population of each country that belonged to the three most widely spread religions in the world in 1980. The numbers are in percent (scale from 0 to 100). The three religions identified are Roman Catholic, Protestant, and Muslim. The residual is called "other religions". *Source:* La Porta et al. (1999), originally based on Barrett (1982), Worldmark Encyclopedia of Nations (1995), Statistical Abstract of the World (1995), United Nations (1995), CIA (1996).
English and French colonial dummies	Dummy variables taking value of 1 for former English and French colonies, respectively, and 0 otherwise. The residual includes former Belgian, Portuguese, and Spanish colonies, as well as non-colonized countries. *Source:* Constructed by the authors.

Appendix 1 continued

Data and sources

Year of independence
Year of a country's independence from colonial rule.
Source: Constructed by the authors.

Civil wars in 1970–1992
Percent of years for the period 1970–1992 in which a country experienced civil war. Scale from 0 to 1.
Source: Bates (2003), originally from Singer (1994).

Democracy in 1970–1994
Average of democracy for the years 1970–1994. Democracy is measured on an eleven-category scale, from 0 to 10, with a higher score indicating more democracy. Points are awarded on three dimensions: competitiveness of political participation (from 1 to 3); competitiveness of executive recruitment (from 1 to 2, with a bonus of 1 point if there is an election); and constraints on chief executive (from 1 to 4).
Source: Polity III dataset.

Constraints on the executive in 1970–1994
Average of constraints on the executive for the years 1970–1994. Constraints on the executive are measured on a seven-category scale, from 1 to 7, with a higher score indicating more constraints. Score of 1 indicates unlimited authority; score of 3 indicates slight to moderate limitations; score of 5 indicates substantial limitations; score of 7 indicates executive parity or subordination. Scores of 2, 4, and 6 indicate intermediate values.
Source: Polity III dataset.

Ethnolinguistic fractionalization
Average value of five different indices of ethnolinguistic fractionalization. Its value ranges from 0 to 1. Higher values are associated with higher ethnic diversity.
Source: La Porta et al. (1999), originally from Easterly and Levine (1997).

Ethnic clustering
An index of ethnic clustering. Related to the average entropy of the language shares of each area of the country, as normalized by the entropy of the language shares of the country as a whole. Higher levels are associated with higher levels of ethnic clustering (i.e., segregation).
Source: Matuszeski and Schneider (2006, Unpublished).

[a] For *Writing, Metal, and Money* variables the data are only available for 44 African ethnic groups, each representing a broader ethno-cultural province (Murdock 1968; Murdock and White 1969). We use this data to impute the values for all groups in the corresponding cluster.

Appendix 2

Table A1 Precolonial political centralization in Sub-Saharan Africa (Share of the Non-European population that had centralized political institutions before colonization)

Country	Centralization	Country	Centralization
Comoros (F)	1	Niger (F)	0.582
Lesotho (E)	1	Sudan (E)	0.576
Swaziland (E)	1	Congo Rep (F)	0.536
Burundi (B)	0.995	Madagascar (F)	0.505
Rwanda (B)	0.982	Nigeria (E)	0.478
Zimbabwe (E)	0.965	Gambia (E)	0.426
Botswana (E)	0.893	Guinea (F)	0.406
Malawi (E)	0.861	Chad (F)	0.384
Mauritania (F)	0.858	Burkina Faso (F)	0.338
Mozambique (P)	0.844	Cameroon (F)	0.316
Ethiopia (NC)	0.843	Guinea-Bissau (P)	0.214
Zambia (E)	0.743	Equatorial Guinea (S)	0.211
Benin (F)	0.695	Kenya (E)	0.172
Senegal (F)	0.694	Central African Rep (F)	0.144
Tanzania (E)	0.669	Djibouti (F)	0.133
Namibia (E)	0.664	Mali (F)	0.115
Ghana (E)	0.651	Cote d'Ivoire (F)	0.082
Congo Dem Rep (B)	0.649	Somalia (E)	0.034
Angola (P)	0.635	Gabon (F)	0.011
Uganda (E)	0.634	Sierra Leone (E)	0.008
Togo (F)	0.622	Liberia (NC)	0

Notes: Letters in parentheses indicate a country's colonizer. E stands for "England", F for "France", B for "Belgium", P for "Portugal", S for "Spain", and NC for "not a colony"

Table A2 Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Dependent variables					
% of roads paved in 1990–2000	40	18.528	14.018	0.8	73.763
% of infants immunized for DPT in 2001	42	57.881	20.403	23	96
Infant mortality in 1960–2001	42	127.658	31.405	73.856	195.389
Adult illiteracy rate in 1970–2002	37	56.062	17.893	24.377	89.561
School attainment in 1960–1990	26	1.918	1.1	0.467	5.015
Main independent variables					
Centralization	42	0.537	0.321	0	1
Centralized & Stratified	42	0.468	0.325	0	1
Centralized & Egalitarian	42	0.069	0.168	0	0.756

Table A2 continued

Variable	Obs.	Mean	Std. Dev.	Min	Max
Fragmented & Stratified	42	0.085	0.144	0	0.509
Fragmented & Egalitarian	42	0.378	0.318	0	1
Log of GDP/cap in 1960	40	6.559	0.456	5.549	7.49
Log of GDP/cap in 1970	41	6.751	0.567	5.69	8.217
Log of GDP/cap in 1986	42	6.758	0.544	5.743	8.302
Log of GDP/cap in 2001	41	6.027	0.873	4.459	8.384
"Advancement" controls					
Population density in 1960	42	20.163	26.175	0.753	114.525
Population density per arable land in 1960	41	197.614	112.153	59.783	617.5
% of urban population in 1960	42	12.843	9.643	1.8	49.6
Landlocked dummy	42	0.333	0.477	0	1
Inland waterways	40	0.003	0.007	0	0.04
Writing	42	0.181	0.312	0	1
Metal	42	0.902	0.194	0.109	1
Money	42	0.774	0.286	0.011	1
Slavery	42	0.85	0.277	0	1
Permanent settlements	42	0.852	0.261	0.036	1
Dependence on agriculture	42	5.399	1.242	1.195	7.38
Water area	42	0.043	0.068	0	0.289
Latitude	42	0.125	0.08	0	0.326
Average elevation	42	0.486	0.605	0.002	2.14
Colonial and postcolonial controls					
% of European descent in 1960	41	0.014	0.03	0.001	0.141
Catholics	42	23.457	22.22	0	78.3
Muslims	42	31.536	34.802	0	99.8
Protestants	42	13.812	14.886	0	64.2
Other religions	42	31.195	19.736	0.1	64.1
English colony	42	0.381	0.492	0	1
French colony	42	0.405	0.497	0	1
Year of independence	40	1964.23	7.259	1956	1990
Civil wars in 1970–1992	42	0.095	0.196	0	0.783
Democracy in 1970–1994	40	1.233	2.48	0	10
Constraints on the executive in 1970–1994	40	2.458	1.548	1	7
Ethnolinguistic fractionalization	42	0.615	0.282	0	0.89
Ethnic clustering	40	0.754	0.15	0.328	1

Table A3 Pairwise correlations of dependent variables

	% of roads paved in 1990–2000	% of infants immunized for DPT in 2001	Infant mortality in 1960–2001	Adult illiteracy rate in 1970–2002	School attainment in 1960–1990
% of roads paved in 1990–2000	1 (40)				
% of infants immunized for DPT in 2001	0.357** (40)	1 (42)			
Infant mortality in 1960–2001	−0.332** (40)	−0.309** (42)	1 (42)		
Adult illiteracy rate in 1970–2002	−0.268 (35)	−0.335** (37)	0.726*** (37)	1 (37)	
School attainment in 1960–1990	0.181 (25)	0.213 (26)	−0.576*** (26)	−0.78*** (25)	1 (26)

Notes: ***1. denotes significance at the 1% level, ** at the 5% level, * at the 10% level
2. Number of observations is shown in parentheses

Table A4 Pairwise correlations between precolonial political institutions and controls

	Centralization	Centr & Strat	Precolonial political institutions		
			Centra & Egalit	Fragm & Start	Fragm & Egalit
Income					
Log of GDP/cap in 1960	−0.21	−0.128	−0.145	−0.021	0.226
Log of GDP/cap in 1970	−0.203	−0.14	−0.114	−0.114	0.259
Log of GDP/cap in 1986	−0.068	0.049	−0.225	−0.183	0.152
Log of GDP/cap in 2001	−0.044	0.117	−0.301*	−0.212	0.144
"Advancement" controls					
Population density in 1960	0.414***	0.444***	−0.067	−0.097	−0.375**
Population density per arable land in 1960	−0.028	0.07	−0.186	0.099	−0.017
% of urban population in 1960	−0.453***	−0.326**	−0.236	−0.043	0.477***
Landlocked dummy	0.336**	0.263*	0.135	−0.085	−0.301*
Inland waterways	−0.144	−0.118	−0.049	0.444***	−0.058
Writing	−0.168	−0.216	0.097	0.142	0.105
Metal	−0.254	−0.304*	0.102	−0.083	0.295*
Money	−0.332**	−0.082	−0.476***	−0.199	0.426***
Slavery	−0.185	−0.232	0.094	0.263*	0.068
Permanent settlements	0.141	0.195	−0.107	0.001	−0.143
Dependence on agriculture	0.033	0.035	−0.004	0.087	−0.073
Water area	0.003	−0.152	0.299*	−0.011	0.002

Table A4 continued

| | Precolonial political institutions | | | | |
	Centralization	Centr & Strat	Centra & Egalit	Fragm & Start	Fragm & Egalit
Latitude	0.386**	0.306**	0.147	0.203	−0.482***
Average elevation	0.508***	0.48***	0.044	−0.152	−0.444***
Colonial and postcolonial controls					
% of European descent in 1960	−0.048	0.009	−0.106	−0.176	0.129
Catholics	0.134	0.171	−0.075	−0.39**	0.041
Muslims	−0.193	−0.221	0.059	0.426***	0.002
Protestants	0.171	0.168	0.001	−0.309**	−0.032
Other religions	0.061	0.071	−0.021	−0.079	−0.026
English colony	0.182	0.108	0.138	−0.059	−0.157
French colony	−0.262*	−0.172	−0.168	0.252	0.151
Year of independence	0.234	0.244	−0.028	−0.271*	−0.11
Civil wars in 1970–1992	0.083	−0.036	0.227	−0.224	0.018
Democracy in 1970–1994	0.187	0.244	−0.116	0.135	−0.257
Constraints on the executive in 1970–1994	0.164	0.208	−0.091	0.193	−0.26
Ethnolinguistic fractionalization	−0.473***	−0.524***	0.108	0.096	0.435***
Ethnic clustering	−0.033	−0.092	0.11	−0.139	0.097

Notes: *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level

Table A5 Precolonial centralization and class stratification in Sub-Saharan Africa

Country	Centr & Strat	Centr & Egalit	Fragm & Strat	Fragm & Egalit	Country	Centr & Strat	Centr & Egalit	Fragm & Strat	Fragm & Egalit
Angola	0.635	0	0	0.365	Lesotho	1	0	0	0
Benin	0.695	0	0.007	0.297	Liberia	0	0	0	1
Botswana	0.884	0.009	0	0.107	Madagascar	0.505	0	0.495	0
Burkina Faso	0.338	0	0.023	0.64	Malawi	0.105	0.756	0	0.139
Burundi	0.995	0	0	0.005	Mali	0.115	0	0.509	0.377
Cameroon	0.238	0.078	0.099	0.584	Mauritania	0.858	0	0.142	0
Central African Republic	0.144	0	0	0.856	Mozambique	0.318	0.526	0	0.156
Chad	0.384	0	0.098	0.518	Namibia	0.664	0	0	0.336
Comoros	0.983	0.017	0	0	Niger	0.135	0.447	0.286	0.132
Congo Dem Rep	0.559	0.09	0.012	0.34	Nigeria	0.466	0.012	0.052	0.47
Congo Rep	0.536	0	0	0.464	Rwanda	0.982	0	0	0.018
Cote d'Ivoire	0.082	0	0.026	0.893	Senegal	0.694	0	0.238	0.068
Djibouti	0.133	0	0	0.867	Sierra Leone	0.008	0	0.37	0.622
Equatorial Guinea	0.211	0	0	0.789	Somalia	0.034	0	0	0.966
Ethiopia	0.727	0.116	0.052	0.104	Sudan	0.083	0.494	0.047	0.376
Gabon	0.011	0	0	0.989	Swaziland	1	0	0	0
Gambia	0.426	0	0.462	0.112	Tanzania	0.591	0.078	0.091	0.24
Ghana	0.651	0	0.133	0.216	Togo	0.564	0.058	0	0.378
Guinea	0.406	0	0.259	0.335	Uganda	0.633	0.001	0.033	0.333
Guinea-Bissau	0.214	0	0.132	0.654	Zambia	0.56	0.184	0	0.257
Kenya	0.146	0.027	0	0.828	Zimbabwe	0.95	0.015	0	0.035

Appendix 3

This appendix provides more details about the construction of our country-level Centralization index. As explained in Sect. 3, we used the *Jurisdictional Hierarchy* variable of the *Ethnographic Atlas* (Murdock 1967) to classify into "centralized" and "fragmented" more than 300 African ethnic groups listed in Murdock's dataset. We then matched these groups with those listed in the Soviet *Atlas Narodov Mira*, which provides the ethnic composition of each African country. Our Centralization index is then calculated as the share of each country's non-European population belonging to centralized ethnic groups.

The main step in the construction of our index involved matching the ethnic groups listed in the *Ethnographic Atlas* with those listed in the Soviet Atlas. To make sure that we correctly matched the groups from the two sources, we used Murdock's *Africa: Its Peoples and Their Culture History* (Murdock 1959), which provides alternative names and spellings for the same or closely related ethnic groups. As an additional check, we used the latitude and longitude information on geographic location of the groups in the *Ethnographic Atlas* and compared Murdock's ethnic maps in his *Africa* book with the ethnic maps of the Soviet Atlas.

In most cases the matching was straightforward as there was a unique mapping between the ethnicities in the Soviet Atlas and those in the *Ethnographic Atlas*. For example, in Uganda the Baganda, Batoro, Banyankole, and Teso ethnic groups listed in the Soviet Atlas uniquely map into Ad7 Ganda, Ad48 Toro, Ad45 Nyankole, and Aj1 Teso of the *Ethnographic Atlas*.

Occasionally, the ethnic information of the *Ethnographic Atlas* was more detailed than the ethnic partition of the Soviet Atlas. In such cases, we had to attribute the population share of one Soviet Atlas group to more than one *Ethnographic Atlas* group. We did it by using population numbers for the latter groups provided by Murdock in the *Ethnographic Atlas* itself or in his *Africa* book. For example, according to the Soviet Atlas the Vanyika ethnic group represents about 4.2% of the population of Kenya. The *Ethnographic Atlas*, on the other hand, provides data for Ad30 Digo and Ad32 Giriama both belonging to the Nyika ethnic cluster. Given similar population size of Digo and Giriama (112,000 vs. 120,000 in the *Ethnographic Atlas*), we attributed to each group the population share of about 2.1%.

Sometimes, one ethnic group lied within a territory of more than one country. For each country, we then simply attributed the population share of that group from the Soviet Atlas to the ethnic characteristics of the corresponding group in the *Ethnographic Atlas*. For example, according to the Soviet Atlas the Azande ethnic group constitutes about 10.5% of the population of Central African Republic, 2.7% of the population of Sudan and 6% of the population of the Democratic Republic of Congo. Using the fact that Azande of the Soviet Atlas maps into Ai3 Azande of the *Ethnographic Atlas*, we assigned the ethnic characteristics of the latter to the corresponding population shares in each of the three countries.

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