

Where Local Kings Rule: Long-Term Impacts of Precolonial Institutions and Geography on Access to Public Infrastructure Services in Nigeria (Working Paper)*

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Abstract

Though previous works have discussed the benefits of precolonial ethnic state centralization for development in Africa, the findings, of a positive relationship between centralization and development and the mechanisms provided, of local accountability of ethnic state leaders, do not explain the heterogeneity in outcomes, reflected in the unequal distribution of access to public services among formerly centralized states today. New results here show that centralization has had a negative effect on access to federally administrated, high state control goods when cooperation failed between ethnic state and autocratic federal government leaders. Using new survey data from Nigeria, I find a significant negative effect of centralization on access to high federal state control goods for centralized regions whose leaders failed to cooperate with the autocratic military regime, and whose jurisdictions were subsequently subject to a punishment regime, typified by underinvestment in public services, with lasting impacts till today. The long-term effects of this punishment can be seen in the relatively lower reported trust in institutions of federal authority over traditional institutions today from respondents from these historically punished areas. The results are robust to a number of controls and instrumenting for centralization with an ecological diversity index.

JEL classification: O10, O13, O43, N27, P48

Keywords: Africa, Development, Precolonial Institutions, Ethnicities, Environment, Inequality, Nigeria

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1 Introduction

Recent studies on the origins of African economic development have documented a positive relationship between precolonial institutions, particularly precolonial ethnic state centralization, and modern development outcomes (Michalopoulos and Pappaioanou, 2012; Gennaoili and Rainer, 2007; Osafo-Kwaako and Robinson, 2013; Alsan, 2015). The mechanisms through which this positive association operates remain weakly understood. Additionally, there are no studies to date which explain the heterogeneity in current outcomes of formerly centralized precolonial states. The results of this paper suggest a nonlinear relationship between precolonial state centralization and current public service provision due to the interaction of precolonial centralization with the colonial and postcolonial governments under the so-called cooperative federalist political structures that defined much of colonized Africa. Specifically, the results of this paper show that the relationship between precolonial ethnic state leaders and autocratic federal state leaders in the colonial and postcolonial eras determines public service access outcomes today. When cooperation was the equilibrium outcome between centralized precolonial ethnic state leaders and autocratic federal leaders, then public services were provided in centralized ethnic states through patronage relationships. When cooperation failed between parties, then ethnic state leaders were punished through underinvestment in goods and services whose allocation autocratic federal governments could control.

This study uses evidence from Nigeria, the most populous country on the continent, to explain why the homelands of some centralized former precolonial states (for example in the current Borno and Yobe areas shown in Figure 4 below) have some of the worst economic development and public service access rates in the country today, going against the prevailing narrative of a positive relationship between precolonial state centralization and current public service provision and development outcomes. In contrast with the current literature, results show that the mechanism through which precolonial state centralization (c. 1850) impacts current public service provision is not 'local accountability' as has been posited in previous research (Gennaoili and Rainer, 2007; Herbst, 2000) but through payoffs from cooperation in a bilateral bargaining

with cooperation 'game' between ethnic state leaders and federal autocratic regimes. Federal autocratic regimes first take on the identity of the British colonial officials between 1885-1960 and then in the form of the military government between 1966-1999. When cooperation was the equilibrium outcome between centralized ethnic state leaders and autocratic federal authorities, public service provision was positive for centralized states for federally administrated public services. When cooperation broke down, as it did between certain centralized ethnic state leaders and the military government, the federal military government enacted a punishment regime leading to a negative relationship between centralization and access to federally administrated, high state control public infrastructure services.

The results of this paper confirm two main hypotheses, which are summarized below:

- Hypothesis C: Precolonial state centralization has, on average, a positive effect on federally administrated (medium and high federal state control) goods, or goods for which cooperative centralized ethnic state leaders were better positioned then and today to bargain for access with federal authorities (patronage relationships). There is no effect of precolonial ethnic state centralization on locally administrated (low federal state control) goods where there is multilateral bargaining among different Local Government Area (LGA) actors and no involvement of centralized ethnic state-leaders in good provision.
- Hypothesis 1: The main hypothesis is that the effect of centralization on access to federally administrated, high federal state control goods is negative for non-cooperative ethnic state leaders subject to a subsequent punishment regime by autocratic federal military governments. I test the specification presented in the Results section below where, following the Nigerian historiography, my constructed supermajority Muslim indicator (measured as administrative states with Muslim populations of greater than 70% of the total state population as of 1952) is a proxy for, what I term, pre-independence centralization and subsequent non-cooperation of the centralized ethnic state with the military regime post a 1976 policy change. The policy change is the 1976 dismantling of the 'ethnic state leader/traditional leader' system in favor of a democratically elected Local Government Area (LGA) sys-

tem (more on the history is covered in subsequent sections and in the Appendix). I test the results in Hypothesis C and Hypothesis 1 with an OLS and IV specification, adapting Fenske's ecological diversity index (Fenske, 2014) as an instrument for precolonial state centralization in the IV case; results remain significant in both. As a supplement to this, I test and find that the 'punishment' is worse in centralized, non-cooperating ethnic states not favored by the military.

These effect signs are summarized in Figure 1, showing the possible combinations of pre-colonial ethnic states: centralized and cooperative with the federal autocratic regime, centralized and non-cooperative, non-centralized and cooperative and non-centralized and non-cooperative in the properly specified model of the relationship between precolonial centralization and public service provision. Figure 2 in contrast shows the misspecified model, masking the heterogeneity in outcomes of centralized precolonial ethnic state.

Precolonial Centralization/ Cooperation Decision of Ethnic State Leader	β Cooperative	β Not Cooperative
Centralized	+	-
Not Centralized	0	0

Figure 1: Effect signs in the correctly specified model: Negative effect of precolonial centralization on access to federally administrated, high federal state control goods for non-cooperative ethnic states

Precolonial Centralization of Ethnic State Leader	β
Centralized	+
Not Centralized	0

Figure 2: Effect signs and masked heterogeneity: Positive average effect of precolonial centralization on access to federally administrated goods

Using Afrobarometer data shows that individuals from centralized, supermajority mus-

lim (non-cooperative) states where the punishment regime was enacted during the 1976-1999 period of federal military rule are less likely to report 'trust' in federal institutions than their non-punished counterparts in centralized areas. This result suggests that one consequence of the punishment regime was a negative impact on social capital between the federal government and individuals from punished areas. On average, precolonial centralization is estimated to be strongly associated with increased access to federally administrated goods, accounting for a 4% increase in grid-based electricity, an almost 52% increase in health professional density, and a 7% and almost 5% increase in yellow fever immunization and meningitis immunization respectively. In contrast to their centralized, cooperative counterparts, centralized non-cooperative states experience a statistically significant decrease in access to grid based electricity by 1%, and decline access to flush toilets by 2%. This negative effect, identified as the 'punishment' here, is magnified for 'non-favored' states, defined as states from which a military president did not originate. The effect of being a centralized, non-cooperative and non-favored state is a decrease in access to grid-based electricity by about 4% and a decrease in access to flush toilets by around 3%. Being a centralized, cooperative state on the other hand is strongly associated with a 7% - 14% increase in access to grid based electricity and a 3% to almost 8% increase in access to flush toilets depending on favored status.

The primary threat to validity of this analysis is that the precolonial centralization and non-cooperation/supermajority muslim variables might be capturing some unobserved effect, omitted in the empirical framework. While the study's results are based on outcomes from only 1 year of (cross-sectional) data from 2012, effects are strongly significant and statistically different from 0. Secondary support for the supermajority indicator as a measure of non-cooperation is provided in Section 2, with additional historical support provided in the Appendix as well. In alternate specifications, Fenkse's ecological diversity index (Fenske, 2014) is adapted for the Nigeria case study and used as an instrument for precolonial centralization as well. Precolonial centralization is also tested and shows strong positive correlation with satellite night lights data, in line with the main results from Michalopoulos and Pappaioanou (2012). These findings provide strong evidence for the persistent, heterogenous effects on precolonial centraliza-

tion on current economic development through the mechanism of cooperation/patronage and non-cooperation/punishment relationships between ethnic state leaders and federal autocratic regimes. Figure 3 below shows a schematic of the classification of public service types covered in this paper by federal administrated vs. locally administrated and by level of federal state control of the good, where medium and high federal state control goods are federally administrated and low state control goods are locally administrated. Note, the division of goods into federally and locally administrated categories reflects policy choices made by the federal government rather than any technological capacity for provision of the public service at the local or federal levels. The schematic captures a snapshot of administration and control of goods in the 2012 period for which the survey data was conducted. The classification of 'medium' or 'high' for federally administrated goods reflects direct investments made and the length of time the good has spent under federal state control. So high state control goods like grid based power access reflect investments made from starting in 1886 and largely in 1950 through the present and flush toilet access reflects investments made largely around 1977 through the 1980s in Nigeria by the federal, most notably military, regime. On the other hand medium federal state control goods like immunization availability have been mostly administrated by the local government (LGA), with exceptions; a notable one being in 2012, the year of our survey data, where the federal government spearheaded administration of immunization availability with the first ever national vaccine summit hosted in this year (Johns Hopkins, 2012) and directly solicited ethnic state/traditional leaders' participation/cooperation in ensuring maximum availability of the vaccines. Locally administrated goods like pit latrine access and most water access at public primary schools have generally been under the responsibilities of the LGA in Nigeria and offgrid access at public primary schools, our primary unit of observation would also fall under the general purview of the LGA authority as well. Understanding the drivers behind the negative results for formerly centralized states and the historical mechanisms through which unequal access to public services in the country have manifested is a crucial first step for an assessment of ways to solve these inequities, and potentially stem much of the violence erupting in those regions in Nigeria today. The results of the paper highlight a point that has been made by economists (Ae-

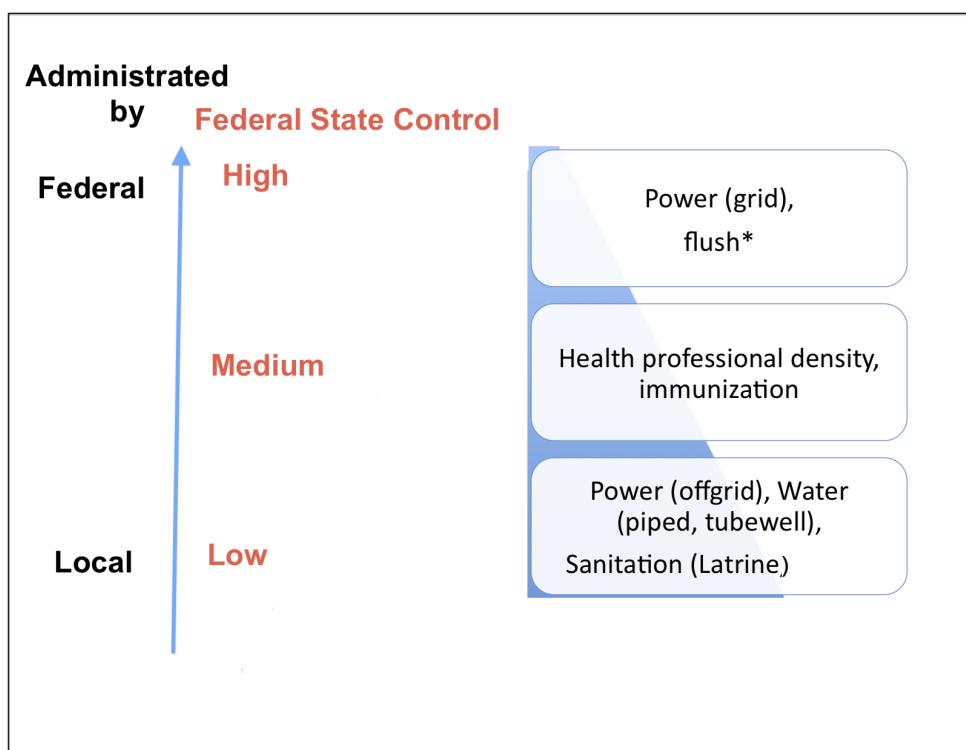


Figure 3: Schematic of the administration and extent of state control of public services mentioned in the paper.

moglu and Robinson, 2014; 2001), historians (Falola, Ogundiran, 2005), political geographers and ecologists (Agnew, 2008; Robbins, 2011) and political scientists (Herbst, 2000; Mamdani, 1996) on the long-term impacts of historical institutions and geography on current development outcomes and point to the need for a further reexamination of the current role of ethnic state or traditional leaders and the implications of their relationship with national entities on development outcomes in the country today.

The layout of the rest of the paper is as follows. Section 2 provides some historical background, briefly defining some of the terms used in this paper within the Nigerian context regarding cooperative federalism, dual authority, and centralization and presents an outline of the actors: ethnic states, current administrative states, local governments and federal governments, mentioned in this paper. Section 2.3, surveys the related literature on the long-term impacts of geography and institutions, highlighting the departure from and contribution to the literature by this paper. Section 3 provides a simple conceptual framework of the calculus of non-cooperation for centralized ethnic states, with a more detailed model outlined in the Appendix. Section 4, describes the data, methods and empirical specification used in this study, focusing on the results of the OLS specifications. Section 4.5 includes robustness checks for omitted variable bias using an instrumental variable approach and ecological diversity as an instrument for precolonial centralization. Section 5 examines the heterogenous effect of precolonial centralization on federally administrated goods. Section 6 concludes with a brief discussion on directions for future research and potential policy implications of this research.

2 Historical Background

2.1 The Actors: Ethnic States, Administrative States, LGAs, LGA-Ethnic Areas and Government Structure in Nigeria

Nigeria is a federation made up of a democratically elected federal government, 37 administrative 'states' or officially 36 administrative states¹ and a Federal Capital Territory (FCT) at Abuja. The

¹as mandated by the 1999 constitution

states can be further subdivided into 6 geopolitical zones, broadly amassed under the geopolitical North and the geopolitical South (see (a) in Figure 4) with zones strongly correlated with current and historic ethnic group location as shown in (b) of Figure 4 (so broadly the North-West is dominated by the Hausa and Fulani ethnic groups, the North-East is largely populated by the Kanuri ethnic group and the South-West is dominated by the Yoruba ethnic group). The states can be further subdivided into 774 Local Government Areas (LGAs), the smallest administrative unit in the country (its equivalent is outlined in grey in (a)) which was created by federal military mandate in 1976 to replace the Ethnic state leaders as the official arm of local governance in the country. The other level of political geography this paper will discuss are the Ethnic states delineated in (c) in Figure 4 below, showing the ethnicity based state formations c. 1850. Nunn and Wantchekon (2011) have confirmed a strong correlation (about 0.55) between location of respondents to the Afrobarometer in 2005 (shown in (b) in Figure 4) and ethnic group location as identified in the Murdock map (shown in (a) in Figure 4). The Murdock map is George Murdock's (1967) Ethnographic Atlas shows the spatial distribution of ethnicities across Africa around the mid/late 19th century (Michalopoulos, 2012). In this paper, leaders of ethnic states as defined in the 1850 Murdock map will be referred to interchangeably as ethnic state leaders, ethnic state kings/chiefs, and as we approach the period from 1885-1999, 'traditional leaders' and 'Native Authorities'. The federal regime is the British colonial regime during the 1885-1960 period, and is the military government during the 1966-1999 period (Elaigwu, 2002).

2.2 Dual Authority, Cooperative Federalism, and Centralization in Nigeria 1850-1999

The mechanisms identified in this paper span across 3 periods: the precolonial period c. 1850, the British colonial period from 1885-1960 and the military autocratic regimes from 1966-1999. An understanding of the negative relationship between precolonial centralization and current public service provision argument requires an understanding of the continuities between periods in Nigerian history, a continuity that is often ignored in papers linking precolonial institutions to current development outcomes. Here, I will outline a brief description of the terms used by political scientists to describe the political structure of these periods namely: cooperative

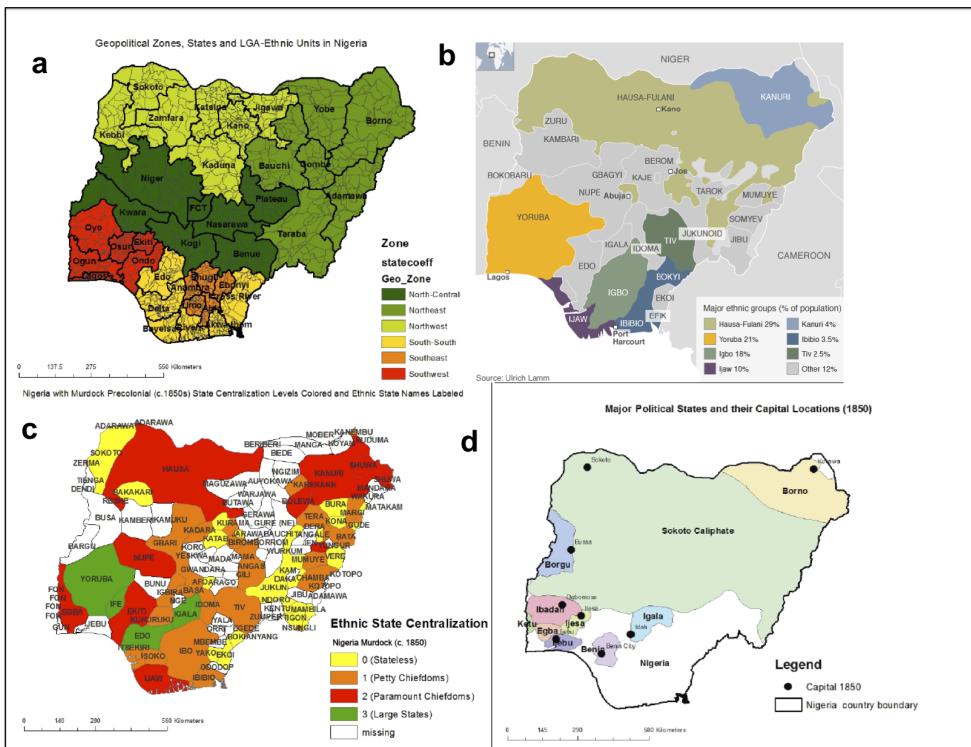


Figure 4: Nigeria: the actors 1850-Present

federalism, dual authority and centralization. I'll start with the first two.

Nigeria from 1885-1960 has been described as operating under a cooperative federalist system with dual authority structures (Suberu, 2009; Abebe, 2013). In essence, this statement refers to the fact that authority was distributed in the colonial and military regime periods between the federal government (British or military) as an overarching, virtually autocratic in the British colonial case and literally autocratic in the military regime case, authority and the subordinate 'local government' or subnational states in the form of local precolonial ethnic state 'kings'/leaders or 'traditional leaders'/Native Authorities (Elaigwu, 2002; Dudley 1968; Suberu, 2009; Abebe, 2013; Osaghae, 1990, Salami, 2011; Volden, 2004). This was the 'federalism' and 'dual authority' system of the colonial and military regimes. The 'cooperative' aspect, which is at the heart of this paper's thesis, comes in to emphasize the idea that cooperation was necessary between, first in the colonial period, the British colonials and the ethnic state leaders and in the following military regime, between the military officials and ethnic state leaders so that the latter, ethnic state leaders, could implement federal policies of the former, particularly as relating to tax collection. Later, during the military regime when the 1970s oil boom transformed the tax base for the federal government and rendered the role of local tax revenue 'obsolete' and the political autonomy of some centralized ethnic states a threat to military hegemony, cooperation with the federal government was typified by acquiescence with the turnover of local governance from the ethnic state leader led Native Authority system to the democratically elected Local Government Area (LGA) system in 1976. In return for their cooperation, ethnic state leaders were able to bargain for access to federally controlled resources in the form of public services administered by the federal government through patronage relationships. The big question here, again at the core of this paper, is the one asked by Roderick M. Hills in his well cited 1998 paper on cooperative federalism, paraphrased as 'what happens when the (autocratic) federal state and subnational/local govt. in the form of the centralized ethnic state leader, refuse to cooperate?' (Hills, 1998). Magaloni (2006) provides an answer, which forms the basis of the paper's thesis, in the form of 'punishment regimes' where these federal states punish opposition or non-cooperation by underinvestment in public services in the defectors' regions given that they are able to 'target the services' (i.e. for

high federal state control services) and monitor/identify the defectors (easily achieved for ethnic states with centralized systems of governance).

It's important to clarify what is meant by 'centralization' here, particularly since it's a term that has experienced a resurgence both in the long-term impacts of precolonial institutions in Africa political economy literature and the literature on public goods and decentralization, popular in the current political science literature. Within Nigeria, there are 2 periods of centralization as relating to ethnic states that occur and are relevant for the subsequent analysis presented here. First, there is the period of 'precolonial ethnic state centralization' where centralization here refers to ethnic state sovereignty on the eve of colonialism c. 1850. Here ethnic state sovereignty is the control of territory and people by acquiring and maintaining military force that was characteristic of this period in mid 19th century Nigerian history (Blench et al., 2006; Falola, 2005; Ogundiran, 2005; Ogbomo, 2005; Fenske, 2014). The measure of precolonial ethnic state centralization used here is from George Peter Murdock's (1967) Ethnographic Atlas, which coded ethnic states c.1850 with a 'Jurisdictional Hierarchy beyond the Local community level' index, described as an index of 'political complexity' and represented as an ordered variable from 0-4, where 0 indicates "stateless societies "lacking any form of centralized political organization" and 4 indicates groups that were part of large states and generally ruled by ethnic state leaders in the form of chiefs who had held successful military campaigns for control of territory in the mid-19th century as shown in (c) of Figure 4 (see Michalopoulos and Pappaioanou, 2012; Gennaioli and Rainer, 2007; Ogbomo, 2005). Here we delineate precolonial ethnic states into centralized and non-centralized where centralized states are states receiving a score above 0, or states with any level of political complexity above "stateless" as identified in the Murdock Atlas and subsequently states with any form of ethnic state leadership identified (from 'petty chiefs' to more powerful kings and monarchs). More on this variable will be discussed in Section 3 on Data used in this paper.

The next period of centralization of ethnic states spans between 1885-1960 and refers to what can be termed 'pre-independence centralization'. This period of pre-independence centralization relates to the role of the British colonial regime in increasing the autonomy and con-

solidating power in the hands of the Northern Emirs overseeing highly muslim (supermajority muslim) populated areas in Nigeria. This process, replicated in different iterations throughout much of colonized Africa and known as 'indirect rule' has so far been largely neglected in the political economy and development economics literatures on the impacts of precolonial African institutions (which use the Murdock measure, and assume centralization is static), though it has been discussed extensively by historians and political scientists concerning Nigeria and Africa more generally (Mamdani, 1996; Dudley, 1968; Tonwe and Osomwota, 2013). Mamdani (1996) in particular, has referred to this pre-independence consolidation of political authority in the hands of the Emirs by the British colonial regime as creating a system of 'decentralized despotism' in these areas with Dudley (1968) quoting F.W. de St. Croix that the 'Emir quickly became an absolute ruler' during this period under the British system. This context is extremely important for the thesis outlined in this paper regarding the calculus of non-cooperation among these centralized, supermajority muslim states, and is explored further in the Appendix. Briefly, here, instances of non-cooperation with the military regime in particular for ethnic state leaders from supermajority muslim areas was regularly documented and remarked upon in the historical literature (Hickey, 1984). The determinants of the probability of cooperation are explored in Section 3. The smaller share of supermajority muslim ethnic state leaders in favor of the federal regime post the 1976 LGA policy along with the much increased expected benefits from withholding transfers to the military government due to accumulation of wealth under the British colonial regime raises significantly the probability of non-cooperation by centralized supermajority muslim ethnic state leaders in the conceptual framework. Qualitative reports from the historiography (see Appendix), also support this finding and lend credence to the use of the supermajority muslim indicator as a measure of non-cooperation in the sample.

2.3 Related Literature

A significant departure of this paper from the economics literature on precolonial centralization is its assertion that precolonial ethnic state centralization can lead to negative outcomes for public service provision when cooperation fails between ethnic state leaders and autocratic federal

authorities in the kind of cooperative federalist regimes that characterized much of colonized Africa, and Nigeria in particular during the colonial and military rule periods. This argument is in contrast with accounts from Gennaoili and Rainer (2007), Michalopoulos and Pappioanou (2012) and Green and Bandopadhyay (2012) who document a positive relationship between centralization and development outcomes without consideration for within state heterogeneity in the relationship. The paper also presents an alternate mechanism to motivate the relationship between precolonial centralization and public service provision, albeit one that does not rely on a notion of 'local accountability' of centralized ethnic state leaders to motivate the relationship (Gennaoili and Rainer, 2007). Instead the mechanism is grounded in the political science theory (Suberu, 2009; Hills, 1998; Magaloni, 2001) on the relationship between actors under cooperative federalist regimes and autocratic federal governments, the political geography literature (Agnew, 2008; Mann, 1984) on the relationship between state despotic power and state infrastructural power and evidence of the manifestation of these theories within the Nigerian context and from the historiographic literature (Falola, 2005; Ogundiran, 2005; Mamdani, 1996; Tonwe and Osomwota, 2013; Dudley, 1968; Blench et. al, 2006). Another departure is to view centralization as dynamic and consider the impact of British colonial policy in reshaping the precolonial ethnic centralization landscape, along with the implications of the resulting pre-independence centralization on subsequent relations between ethnic state leaders and military officials in the period following the colonial regime/independence.

An additional contrast with previous literature is the use of a novel survey dataset that aggregates point data at the LGA-Ethnic area level to measure outcomes for public service provision. Doing this enables the paper to overcome some of the criticisms of the night lights density data approach taken by previous authors (Michalopoulos and Pappioanou, 2012) regarding the estimates not properly accounting for population effects and the luminosity data being dominated by noise in less densely populated areas (Cognac and Dupraz, 2014). The results we find on the effect of centralization on federally administrated goods also contrast with Bandopadhyay and Green (2012) whose study does not find a relationship between centralization and so called 'public goods' in their Uganda sample.

The paper contributes to the growing body of economic literature on the impacts of ethnic inequality and precolonial/historical institutions on African development outcomes including Alesina et.al (2012), Alsan (2015), Bates(1983), Acemoglu and Robinson (2014), Nunn(2009), and Osafu-Kwako and Robinson (2013), Fenske(2009; 2014).

3 Conceptual Framework: Calculus of Non-cooperation by Centralized Ethnic State Leaders

Federal governments allocate federally administrated public services and high federal state control services to ethnic state areas subject to cooperation from centralized ethnic state leaders such that the expected payoff of non-cooperation for the precolonial ethnic state leader is kept at or below some reservation payoff (which, WLOG, can be specified at 0); one question here, is when do centralized ethnic state leaders choose non-cooperation? The calculus of non-cooperation for centralized ethnic state leaders can then be simplified follows. The autocratic federal government takes on the identity of the British colonial regime in one period and the military ruler in the postcolonial period. Cooperation between the precolonial ethnic state leader with either autocratic federal government entailed transfers from the ethnic state leader to the federal government in exchange for access to federally administrated public services. Transfers are in the form of some policy instrument, which can be taxes or some other means of transfer instituted by the federal regime. Punishment by the autocratic federal regime entailed withholding of access to some public service, whose allocation the federal autocratic regime can directly control. The presumption of control of the resource is important for the punishment as it allows the autocratic federal leader to target particular non-cooperative centralized leaders, whose cooperation or non-cooperation it can monitor. The probability of cooperation by an ethnic state leader depends on the share of the ethnic state leadership in favor of the federal regime, which in turn is a function of the magnitude of the transfers to the federal government along with the ethnic state leader's expectation of the magnitude of the punishment. The magnitude of the punishment for non-cooperative ethnic state leaders also varies with respect to their favored or non-favored status by the autocratic federal regime. If the expected benefits from non-cooperation and withholding

transfers from the autocratic federal government are estimated to be higher than the expected costs of non-cooperation, then the ethnic state leader will choose non-cooperation in the equilibrium outcome. A sketch of the optimal solution to the cooperation problem is outlined in the Appendix.

4 Data Construction and Empirical Framework

4.1 Data on Precolonial State Centralization and Pre-independence Centralization/Non-cooperation

The data on precolonial ethnic state centralization used here comes from George Murdock's (1967) Ethnographic Atlas showing the spatial distribution of ethnicities across Africa around the mid/late 19th century (Michalopoulos, 2012). Murdock's map includes 843 ethnic areas, 117 of which are contained within the boundaries of present day Nigeria. Michalopoulos and Wantchekon (2011) have confirmed a strong correlation (about .62) between location of respondents to the Afrobarometer in 2005 and ethnic group location as identified in the Murdock map. We intersect the location of Nigeria's 774 LGAs with Murdock's ethnic state partitions to create 1415 new LGA-Ethnic state partitions. Murdock's atlas includes 60 variables capturing cultural, geographical and economic traits of 1270 ethnicities around the world. Following Michalopoulos (2012) and Gennaoli and Rainer (2007), precolonial political institutions are proxied using Murdock's (1967) "Jurisdictional Hierarchy Beyond the Local Community Level", with what he terms an index of "political complexity" (the centralization index) which assigns a score between 0 to 4 to each ethnic state unit and describes the number of political jurisdictional hierarchies above the local level for each unit. The score is defined as follows: 0: so-called stateless societies, "lacking any form of political organization" 1 and 2: petty and larger paramount chiefdoms 3 and 4: large, more organized states.

Precolonial centralization data is available for 61 of the 117 ethnic states within Nigeria, or 945 LGA-Ethnic state units in the country and the maximum centralization score within Nigeria is a 3, represented by large states like the Yoruba and the Edo. Michalopoulos (2012) has provided a cross-validation of Murdock's Centralization index in Africa through a reading of

African history and we confirm the same through a survey of the Nigerian historiography on levels of political complexity among precolonial ethnic states (Falola, 2005; Ogundiran, 2005). For example, the Yoruba and Edo, who score a 3 on Murdock's index are consistently identified as large, centralized groups in the late 19th century period. The Igbo, who score a 1 on the Murdock indicator with low levels of centralization are identified as having sub-states with more centralized systems, like the trading states of the Aro oligarchy in the 17th-18th centuries (Okpoko, Obi-Ani, 2005). Addressing the peculiarities of centralization in Nigeria, particularly in the status of the Igbo, we create a modified index of the one used by Gennaoili and Rainer that is an indicator that assigns a score of 0 to '0' coded societies in the Murdock specification and 1 to any ethnic states with scores above 0 that captures any degree of precolonial centralization in the sample. Our results are robust to alternate specifications of the centralization index, using our binary variable or the full index from Murdock (1967).

For the measure of pre-independence centralization and subsequent non-cooperation, following the historiography I use the percentage of the Muslim population in each administrative state as of 1952 (Ostien, 2012) to create a supermajority Muslim indicator where states are assigned a score of 1 if they have a population of greater than 70% at the upper quartile of the percentage Muslim distribution. In alternate specifications I include an indicator for 'no military president' that assigns 1 if no military president originated from the state between the 1976-1999 period of the punishment regime as a measure of non-favored status (denoted by $f_2 = 0^2$).

4.2 Dependent Variables: Measures of Infrastructure Access, Public Health and Trust

In an effort spearheaded by the Nigerian government, researchers from the Nigeria's Office of the Senior Special Assistant to the President on MDGs (OSSAP) in collaboration with the Sustainable Engineering Lab at Columbia University conducted extensive, comprehensive surveys of schools and health facilities at LGAs, attaining responses to questions concerning power, water and sanitation access, among other indicators over a 1 year period closing in 2012. The surveys

²where $f_j=0$ is non-favored status by federal regime with $j = 1$ for the British colonial regime and $j = 2$ for the military postcolonial regime

were collected from principals at 68,627 schools and over 30,000 health facilities across 764 of 774 LGAs in Nigeria (with the last 10 LGAs dropped due to unreliable data). Over 81% of the schools were public primary schools. The results remain largely unchanged when only the public primary school sample is used. For power access, respondents were asked True/False questions about both access and functionality. An aggregate power score of 0 or 1 was assigned to a school depending on if the respondent answered False or True, to the question of whether the respondent had access to functional power from the national grid, functional power from a generator or functional power from a solar system. Similarly, an aggregate sanitation score of 0 or 1 was assigned to a school depending on if the respondent answered False or True to the question of whether the respondent had access to improved sanitation in the form of a functional flush or improved pour flush toilet, or access to a functional improved ventilated latrine or access to a functional pit latrine with a slab. If the respondent responded True to any one of these improved sanitation options, they were assigned a sanitation score of 1, if they responded False to all of the aforementioned options, then they were assigned a sanitation score of 0. Lastly, for water access, which was potable water access, we assigned an aggregate potable water access score of 0 or 1 to a school depending on if the respondent answered False or True to the question of whether they had access to potable water in the form of functional piped water or functional borehole or tube well water.

Lastly, for each intersected LGA-Ethnic state area, the proportions of schools with individual Grid, Flush, overall Power, overall Water etc scores of 1 were calculated and used as the metric of overall Grid, Flush etc access. Note, that 'access' refers to available functionality though strong correlations with LGA-Ethnic mean Night-lights density data as shown in table x suggests that these metrics are a good indication of overall access for the country. Night light density per LGA-Ethnic area is included as a dependent variable and a check in alternate specifications. Available data on child health immunizations and health professional density were similarly calculated for each LGA-Ethnic area.

I also construct a new measure of Trust in federal institutions over traditional or ethnic state leaders or 'trust in police over traditional leaders' based on the 2012 Afrobarometer survey

(round 5) for Nigeria where respondents were asked to respond to the question 'If you were a victim of crime in this country, who if anyone, would you go to first for assistance? (Q12)' The measure is a difference between the proportion of respondents who say they would go to police and the proportion of respondents who say they would go to their traditional leaders, two of the top answers (including family members for the top 3), in the survey.

4.3 Control Variables and Ecological Diversity

As mentioned earlier, researchers from a diverse range of fields have highlighted the long-term impacts of geographic, disease covariates, population density and other ethnic group traits on access to public services. So a range of confounding variables are controlled for including:

- Population density in 2006- by LGA from the Nigerian National Bureau of Statistics: Since public infrastructure provision planning decisions are often made taking maximum coverage by population into consideration. Population density is indeed significant in most specifications and is controlled for in all specifications.
- Distance to the capital Abuja- to test that being closer to an area of concentrated economic and political influence translates to heightened access to public infrastructure services. Distance is measured as the distance from the centroid of the LGA-Ethnic Area to the capital.
- Mean elevation: calculated in km, and might be expected to impact the costs associated with the construction of certain infrastructure and the ease of creating centralized groups and hence is controlled for here as well.
- Slavery- an indicator for the presence of slavery, based on the V70 variable from the Murdock (1967) Ethnographic atlas, following Michalopoulos' (2012) specification. There's been previous research conducted on the long-term effects of the slave trade on modern development outcomes (Nunn, 2008) so it is included as a control here.
- Petrol- an indicator for the presence of petroleum resources, to control for the presence of resource wealth on public service provision, based on data from 'The Petroleum Dataset'.

- Land suitability for agriculture- Ecological feature to test that centralization of groups was driven by their location in more favorable areas for crops and pasture. Data from the FAO.
- Ruggedness- Following (Fenske, 2014) and Nunn and Paguda (2007) control for ruggedness of the terrain which was related to the cost of capturing slaves using data sourced from Fenske (2014).
- Malaria- Disease control using climatic suitability for malaria transmission from Adjuik et. al (1998) to address the various hypotheses in the literature on the negative impacts on malaria on African development outcomes (Gallup and Sachs, 2001).

In the IV empirical specification described in the section below, I instrument for centralization with an ecological diversity index based on the Fenske (2014) paper, which is a Herfindahl index that calculates the share s_g^e of each ethnic state e 's area that is occupied by each major ecological type g (with 7 of the 18 total in Africa found in Nigeria) and constructed as follows:

$$Ecological\ Diversity_e = 1 - \sum_{g=1}^7 (s_g^e)^2 \quad (1)$$

More on the index will be discussed in section 4.5 on robustness checks below.

4.4 Empirical Specifications

The baseline specification is an OLS model with an interaction term as described below:

To test Hypothesis C, of precolonial centralization's effect on federally administrated medium and high federal state control goods, I use the following specification:

$$Y_{l,e} = \alpha_0 + \alpha_1 Cent_e + X'_{l,e} \gamma + \epsilon_{l,e} \quad (2)$$

The dependent variable is the measure of survey-based infrastructure access or nationally led health access outcomes (yellow fever and meningitis immunization) in 2012, the year of the survey, in LGA l in ethnic state e from the survey data. $Cent_e$ is the binary precolonial

centralization indicator at the Ethnic state level. X is the vector of controls described in Section 4.3. Robust errors clustered by state are used in main results. In alternate specifications, satellite night-lights density is included as a dependent variable.

To test Hypothesis 1, the main hypothesis of the negative effect of precolonial centralization on access to federally administrated high federal state control goods for non-cooperative states, I test the following specification. The constructed supermajority muslim is a measure for pre-independence hyper-centralization' and non-cooperation of centralized precolonial ethnic states with the federal military regime post the 1976 military LGA order,

$$Y_{l,e} = \alpha_0 + \alpha_1 Cent_e + \alpha_2 S.Muslim_e + \beta Cent_e x S.Muslim_e + X'_{l,e} \gamma + \epsilon_{l,e} \quad (3)$$

In robustness checks for omitted variable bias using the OLS model, ecological diversity is used as an instrument for precolonial state centralization in a Two stage least squares (2SLS) specification. Note, unlike the other outcomes the exclusion restriction is unlikely to hold in the health immunization case since studies have documented an inverse relationship between disease risk and ecological (particularly species) diversity and it appears there is higher availability of immunization in areas that are less ecologically diverse and presumably have higher disease risk (Keesing et al., 2006). For other relevant dependent variables, the instrument remains valid and results from those specifications are presented here.

To further check the results from the OLS model, a multilevel, random slopes specification is employed, allowing the coefficient on precolonial centralization to vary spatially by administrative states s as follows:

$$Y_{l,e} = \alpha_0 + \sum_{s=1}^{37} \alpha_1 s Cent_e + X'_{l,e} \gamma + \epsilon_{l,e} \quad (4)$$

The negative coefficient in supermajority states can be confirmed visually and is mapped in Figure 7. The multilevel spatially varying coefficient model also allows precise identification of

which administrative state where the coefficient turns negative or where the punishment regime appears to have had the most effect on access to the aforementioned high federal state control goods, grid access and flush toilet access.

To test the supplement to Hypothesis 1 above that the sign becomes more negative in non-favored ($f_j = 0$) areas, I also test the alternate specification for the high federal state control goods with a 'no military president' (denoted as NoMil below) interaction as follows:

$$Y_{l,e} = \alpha_0 + \alpha_1 Cent_e + \alpha_2 S.Muslim_e + \alpha_3 NoMil_e + \beta_1 Cent_e \times S.Muslim_e + \beta_2 Cent_e \times NoMil_e + X'_{l,e} \gamma + \epsilon_{l,e} \quad (5)$$

Finally, to test the addendum on trust in police over traditional leaders being lower in supermajority muslim (punished), precolonial era centralized states, since most of the respondents were from precolonial centralized state areas (95% of the Afrobarometer sample), I analyze the split sample within centralized states and examine the responses of supermajority to non-supermajority muslim state respondents using first a chi-square test and then an OLS specification. Inference here are correlations, and given the small sample, the results should be interpreted with caution here. The OLS model was specified as follows:

$$Y_{l,e} = \alpha_0 + \alpha_1 S.Muslim_e | (Cent_e = 1) + X'_{l,e} \gamma + \epsilon_{l,e} \quad (6)$$

4.5 Instrumental Variables and Spatial Autocorrelation

Omitted variable bias is a concern with cross-sectional data, and there may be concerns of the potential endogeneity of the precolonial centralization variable. In alternate specifications, a Hirschman/ ecological diversity index adapted from Fenske's 2014 paper, which accounts for the probability that 2 or more different ecological zones are contained within a particular Ethnic state area, is used as an instrument for state centralization. Following Fenske's claim, from Bates (1983) that states on ecological boundaries were able to benefit from gains from trade which

then fueled higher levels of centralization, the study examines this correlation within the Nigeria region, made up of 7 different vegetation zones or major vegetation types (from White's 1983 historically reconstructed map) including forest, woodland, bushland and thicket, azonal vegetation and anthropic landscapes³ as shown in Figure 5 (See Fenske (2014) for further discussion). The ecological diversity index instrument is strongly positively correlated with precolonial centralization as shown in Figure 6 with mean ecological diversity higher in centralized areas (.28 vs .15, $p < .001$). Following Cameron et al. (2010), spatial autocorrelation and group-based correlations are addressed by clustering robust standard errors by state; Alternate specifications of a spatial error model with different spatial weight matrices and Conley standard errors were also tested with largely unchanged results (Conley, 2008). Results with clustered errors are presented in this paper. A test of the split sample to verify the confidence intervals for the negative coefficient on my interaction terms confirms that findings of a negative effect of centralization on the public service outcome variables in the non/cooperative/supermajority muslim subsample are significant and negative at the 90% confidence interval. To account for concerns about normally distributed residuals, skew in the power access variables is corrected with box-cox, yeo-johnson transformed versions of the variables with the results remaining unchanged.

5 Results

5.1 Precolonial Centralization, Cooperation, Punishment and Public Services

The results of the empirical specifications are presented and discussed below for each of the paper hypotheses, Hypothesis C (Result C), Hypothesis 1 (Result 1) and the addendum on trust. Summary statistics for all variables are listed in Tables 1 and 2 with correlation matrices for infrastructure access variables and night light density in Table 3 and night light density with health access variables in Table 4. The correlation between the night lights density data and grid-based electricity access is the second highest in the sample at about .616 after the correlation between night lights density and flush toilets access (at .689) and highly significant for both. This

³The full list of major types include forest, forest transitions and mosaics, woodland, woodland mosaics and transitions, bushland and thicket, azonal vegetation and anthropic landscapes. There are 15 sub-classified minor types including swamp forest, lowland rain forest, mangrove and the Jos Plateau mosaic

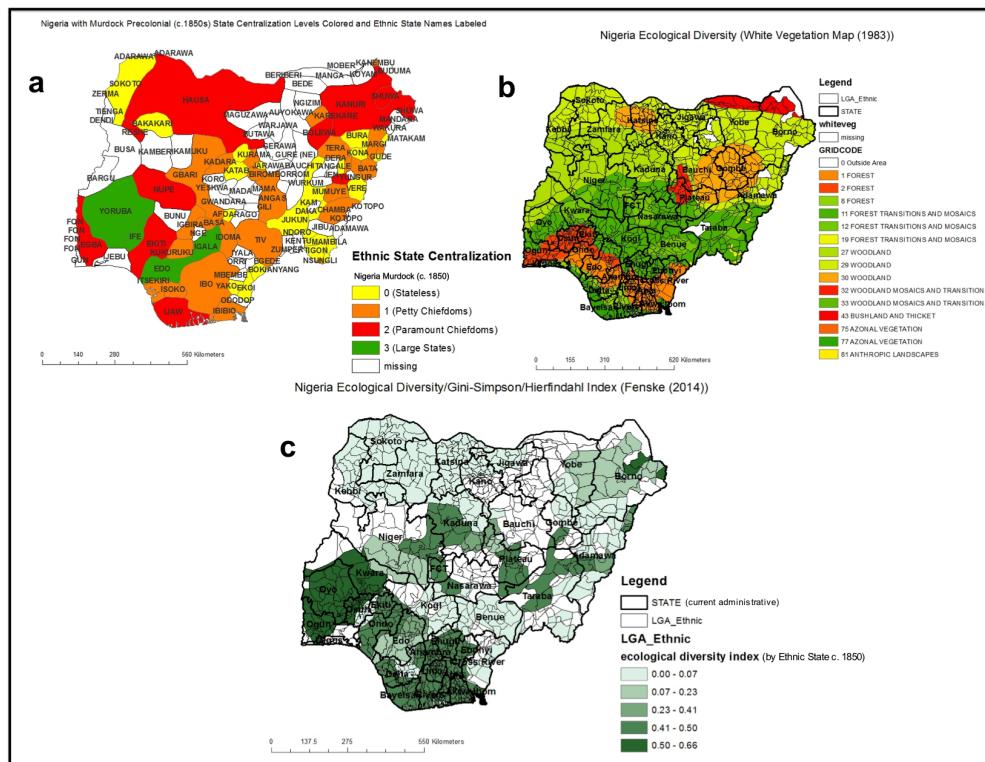


Figure 5: Nigeria Ecological Diversity Index

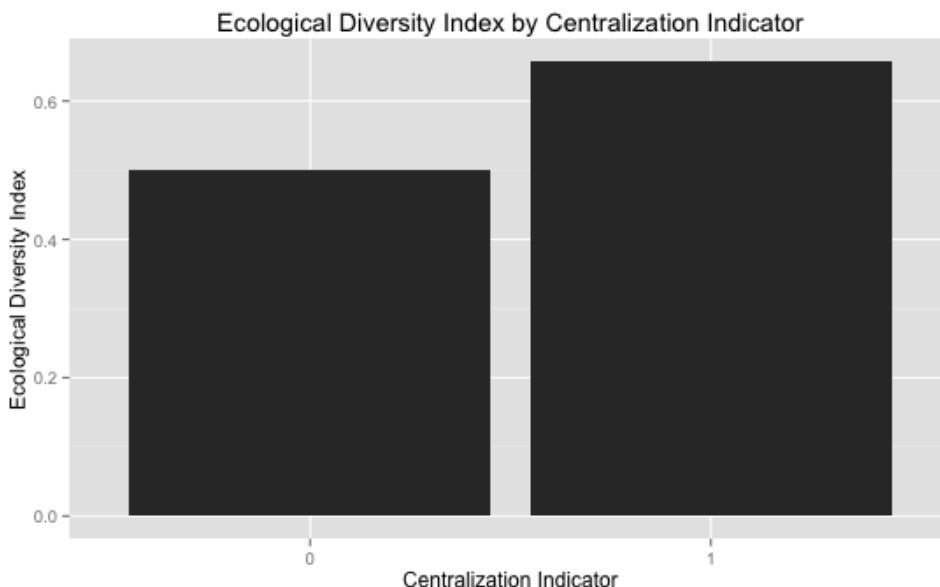


Figure 6: Ecological Diversity Index Range by Centralization Indicator

result acts as a check to show that though the data is from public schools, it appears to accurately capture the overall distribution of access to public services in the country.

- Result C: Precolonial state Centralization has had, on average, a positive effect on federally administrated (medium and high federal state control) goods, or goods for which cooperative centralized ethnic state leaders were better positioned then and today to bargain for access with federal authorities (the benefits of bilateral bargaining in the cooperative federalist structure). There is no effect of precolonial ethnic state centralization on locally administrated (low federal state control) goods where there is multilateral bargaining among different Local Government Area (LGA) actors and no involvement of centralized ethnic state-leaders in good provision.

Tables 5 show the OLS results where precolonial ethnic state centralization increases access to federally administrated goods. Precolonial centralization is strongly significantly associated with a .04 or 4% increase in grid-based power access in the un-interacted model, a .517 or about 52% increase in health professional density, and a .07 (7 %) and .047 (4.7%) increase in yellow fever immunization and meningitis immunization respectively and weakly associated with an increase in flush toilet access of .019 or about 2%. This results are very interesting, particularly in the case of public services, grid-based electricity and flush toilets where mean access to grid based electricity and flush toilets is only 13% and 12% in the public schools based survey sample. For locally administrated, low federal state control goods there is no effect at all of centralization on access to these services, including pit latrine and water access as depicted in Table 6 providing support for Hypothesis C above. Given that the mechanism through which centralization affects public services is, as posited in this paper, cooperation and patronage relationships between centralized ethnic state leaders and federal governments, the 0 effect size for local government administrated goods is not surprising, since the actors (the elected LGA officials) have no involvement in the cooperative relationship with the federal government described previously. In fact the lack of bilateral bargaining, and lack of the implicit monitoring that typifies the centralized ethnic state and federal government relationship creates opportunities for corruption where functional local services are not provided are the LGA level (more on this in the Appendix).

- Result 1: The effect of precolonial centralization on access to federally administrated, high federal state control goods is negative for non-cooperative ethnic state leaders subject to a subsequent punishment regime by autocratic federal governments. As an addendum to this, 'punishment' is worse in centralized, non-cooperating ethnic states not favored by the military.

Table 7 below illustrates Result 1 above, for high federal state control goods grid based electricity and flush toilet access where non-cooperation typified in the supermajority muslim interaction reduces access to the grid by a statistically significant, -.01 or 1% (shown in column (2)) and access to flush toilets by a significant positive -.02 points or 2%. Illustrating the addendum in R1, when we account for $f_2 = 0$ or being a non-favored by the military state, in the form of no military president originating from your state, the effect of precolonial centralization is on grid access and flush toilet access becomes even more negative, reducing grid access by -.041 or 4% and flush toilet access by -.031 or 3%. Robustness checks in the split sample indicate that the coefficients are significantly negative at the 90% confidence level in the sample. This significant negative effect of centralization on public service provision supports the historiography documenting the existence of a punishment regime enacted by the military government during the 1976-1999 period of military rule. The result also contradicts previous notions of precolonial ethnic state centralization always having a positive effect on public service provision. When precolonial centralization is allowed to interact with the events that happened during the colonial and postcolonial eras, specifically relating to the cooperation/patronage and non-cooperation/punishment structure that was at the heart of the cooperative federalist regimes that typified Nigeria and much of colonized Africa, the relationship between precolonial centralization and modern development outcomes in the form of public service provision is not always positive. Results for the interaction are largely insignificant for the medium state control goods, in line with our theory on the effects of the punishment regime for military era controlled and provided goods. Visualization of results from the multilevel model for grid access showing the administrative states where the coefficient on precolonial centralization turns negative are shown in (a) in Figure 7 below, along with a map showing the supermajority muslim areas in

darkest brown in (d) and a map showing the states from which the military presidents originated between the 1976-1999 punishment period provided in (c):

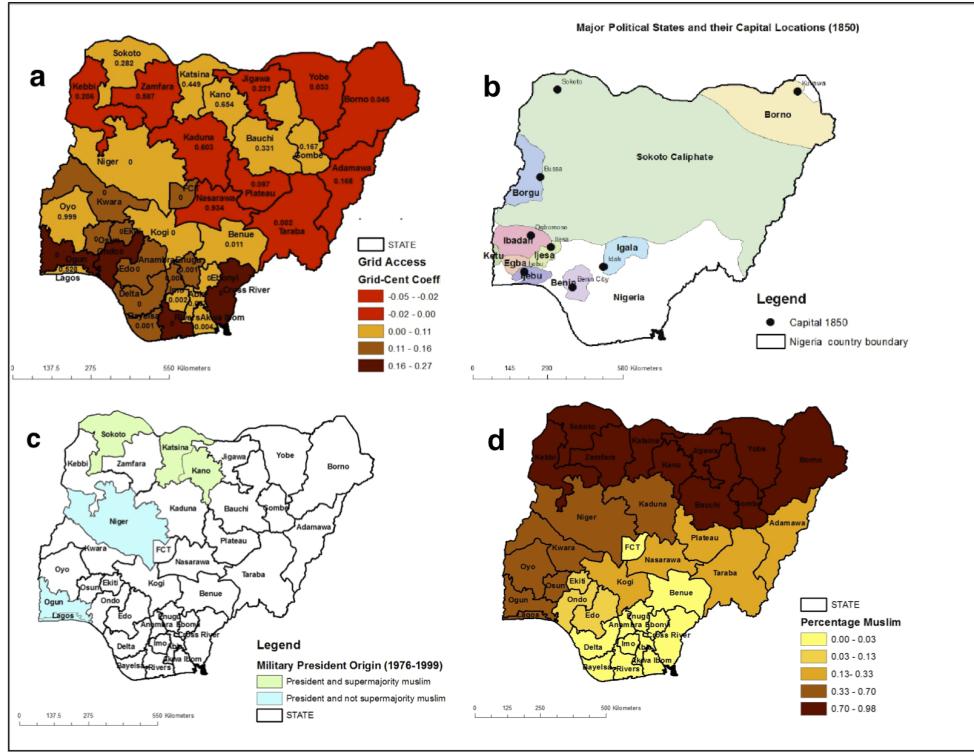


Figure 7: Current State Level Coefficients for Effect of Centralization on Grid Access with p-values Labeled (heterogeneity with multilevel model)

5.2 IV and Threats to Validity

One concern regarding the OLS results is that the precolonial centralization and supermajority muslim indicators are capturing some latent effect on public services through a variable unobserved in the model. One way to remedy this is through the use of an instrument satisfying validity and relevance requirements, in a 2SLS equation. The IV results qualitatively support the OLS results with Table 8 showing the first stage results and providing support for the strength of ecological diversity as an instrument for centralization. While the index performs well in the uninteracted model, note however, that the ecological diversity index, does not pass the F-statistic rule of thumb ($F > 10$) in one specification of the full model interaction case (column (3) in Table

8) though it passes in alternate specifications of the interacted model (columns (4) and (5) in Table 8). 2nd Stage IV results are shown in Tables 10 and Tables 9 below and again reinforce the OLS results on cooperation and punishment as described above, though the difference in magnitude between the OLS and IV second stage coefficients suggest cautious interpretation of the effect sizes in the IV specification. The difference in magnitude of the IV estimates could suggest the existence of measurement error in the centralization indicator, where the centralization indicator is an imperfect proxy for political complexity. There's also a possibility that the instrument validity case might be weak here, specifically in one specification of the interacted full model ((3) in Table 8) where the F statistic fails to reach the standard $F > 10$ cutoff. In alternate specifications of the full interacted model ecological diversity performs adequately as a valid instrument as shown in columns (4) and (5) in Table 8 and efficiency gains in model fitting as measured by the adjusted R^2 are minuscule between models (3), (4) and (5) as shown in Table 8 . An alternate potential instrument, Alsan's Tse Tse Fly Suitability Index (TSI) fails to predict pre-colonial centralization in the within Nigeria case, potentially due to lack of variation and missing data on TSI for certain large groups like the Hausa in the within Nigeria case. The ecological diversity index also appears to have stronger predictive power for precolonial centralization in the Southern geopolitical zone versus the Northern geopolitical zone in the country, weakening the predictive power of the index in the interacted model (see Figure 11 in the Appendix). Multiple instruments as a solution to this, including both zonal fixed effects and a zonal interaction with ecological diversity as instruments runs into issues concerning instrument exogeneity in the interacted model due to high collinearities between the supermajority muslim indicator and the zonal dummies. The relatively high F statistic in the uninteracted model, the uninteracted model including zonal fixed effects and the zonal interaction as additional instruments (see Table 13 in the Appendix) and alternate specifications of the interacted model lends support to ecological diversity index as a predictor of precolonial centralization as discussed in Fenske (2014). Due to the upward bias in magnitude in the second stage IV results, the main results from the OLS specifications are interpreted in this paper.

5.3 Cooperation, Punishment and Trust in Nigeria

There is a growing literature on the determinants of social capital among groups in Africa including Nunn and Wantchekon's work on the impact of the slave trade on trust (Nunn and Wantchekon, 2011). To illustrate the long-term effects on social capital between the federal government and individuals from punished areas, a simple Chi-square test on proportions shows that in the sample of centralized precolonial ethnic states, respondents to the 2012 Afrobarometer question of "Who would you go to first for help if you were the victim of a crime?" from centralized supermajority muslim states are less likely to go to police (a federal institution) over their traditional leaders (58%) versus respondents from centralized non-supermajority muslim states (73%) as shown in Figure 10 ($p < .1$). Results from the OLS specification are shown in Table 12 below. Given the small number of independent samples in the split sample approach, significance of the supermajority muslim indicator in the centralized state sample is unstable, though the coefficient is negative (sometimes significantly negative) with membership in centralized, supermajority states seeming to reduce the "likelihood" of going to the police over traditional leaders by a magnitude of about -.17 to -.24 in all specifications. This relatively lower trust in federal institutions like police over traditional leaders in punished areas versus non punished areas might suggest evidence of the persistent impacts of the punishment regime on social capital between punished areas and the federal government, though given the small sample size in the split sample approach, the results are significant correlations and the effect sizes should be interpreted with caution here. Evidence from the Nigerian historiography of the mechanisms and results presented is provided in the Appendix.

6 Concluding Remarks

This study finds evidence for a negative relationship between precolonial state centralization and public service provision as a development outcome under certain conditions unexamined in the previous literature. The results indicate that the heterogeneity in development outcomes for precolonial centralized ethnic states reflected in differential public service provision in much

of colonized Africa can be explained within the context of cooperative/patronage and non-cooperative/punishment relationships with a negative relationship between precolonial ethnic state centralization and current development found in some areas. The Nigeria case is examined as a quasi-natural experiment along with a novel survey dataset to investigate this heterogeneity in outcomes of precolonial ethnic states. The political theory, empirical analysis and historiographic evidence proffered above, all appear to point to the existence of a punishment regime, defined by not so benign neglect, under the autocratic federal military government. High federal state control public services were provided when cooperation between precolonial centralized ethnic states and the autocratic federal regime was in effect, and under-provided for non-cooperating centralized ethnic states in the cooperative federalist system that existed between autocratic federal states and centralized ethnic states in Nigeria and much of colonized Africa. Another contribution to the literature is to present centralization as a dynamic process and underline the role of colonial policy in the pre-independence "hyper-centralization" of certain precolonial centralized ethnic states, under British colonial policy, with implications for the failure of cooperation with the subsequent military regime. A further contribution of this paper is to attempt to present a structured approach to the understanding of the mechanisms underlying the effects of precolonial centralization on current development outcomes.

Though ecological diversity is used as an instrument for centralization here, potential weakness of the ecological diversity index, in one specification of the interacted model, and failure of the TSI to predict centralization in the within Nigeria case, motivates further research on the within-state drivers of the precolonial centralization variable used. One study has suggested examining the role of interstate warfare (following Tilly's "war makes states, states make war" hypothesis (Tilly,1985)) in state centralization by examining the the use of plants for poisons and medicines in so-called 'biological warfare' (Akiwunmi and Filaba, 2005) to strengthen state sovereignty; there is potential for using ethnobotanic records and environmental historical modeling of plant distribution to gain more insight into the role of environmentally backed interstate warfare in precolonial state centralization.

On the policy implications, this study also addresses the important roles of current non-state actors like traditional leaders in facilitating public service expansion in the country by capitalizing on historic social capital in formerly centralized ethnic states reflected in attitudes as the ones presented in the 2008 Afrobarometer Nigeria survey where almost 60% of respondents felt that traditional leader influence in local government should increase. Finally, particularly given the recent outbreaks of violence and social upheaval in those areas, there might be some role for an affirmative action policy aimed at improving development outcomes for areas that suffered from underinvestment under the military punishment regime. Though further work is needed to understand the full extent of this throughout the country, along with a more structured theoretical framework of the mechanism of cooperation and punishment, particularly regarding the role of taxation, that operated between precolonial ethnic states and federal autocratic regimes.

Table 1: Outcomes(Infrastructure and Health Access, Light and Trust) Summary Statistics (Observations are LGA-Ethnic states)

Statistic	N	Mean	St. Dev.	Min	Max
Power	945	0.19	0.20	0.00	1.00
Grid	945	0.13	0.16	0.00	1.00
Offgrid	945	0.10	0.14	0.00	1.00
Sanitation	945	0.41	0.24	0.00	1.00
Flush	945	0.12	0.16	0.00	1.00
Latrine	945	0.27	0.20	0.00	1.00
Water	945	0.29	0.20	0.00	1.00
Piped Water	945	0.04	0.09	0.00	1.00
Tubewell	945	0.22	0.18	0.00	1.00
Yellow Fever Immunization	900	0.56	0.24	0.00	1.00
Meningitis Immunization	900	0.18	0.19	0.00	1.00
Health Professionals Density	900	1.99	2.54	0.00	44.79
Log Night Light Density	943	1.76	0.63	1.13	4.14
Police Over Traditional Trust	224	0.34	0.37	-0.88	1.00
Police Trust	224	0.50	0.24	0.00	1.00
Traditional Leader Trust	224	0.16	0.19	0.00	0.88

Notes: See text for more details. Power, Sanitation and Water were constructed from responses to 'or' questions, e.g. for Power access, 'do you have power from the grid or an offgrid source?' at schools. So Power is in effect a union of Grid and Offgrid access but note since the overall Power access numeral takes only unique responses, the estimate for Power is lower than the actual sum of Grid and Offgrid for Power displayed in the above table. Calculations were executed in ArcGIS so Sanitation and Water access estimates are slightly inflated since points falling on the borders of LGA-Ethnic polygons were counted twice, the measured error is minute and inconsequential when adjusted for in later analysis.

Table 2: Controls Summary Statistics (Observations are LGA-Ethnic states)

Statistic	N	Mean	St. Dev.	Min	Max
Centralization (bin)	945	0.89	0.32	0	1
Centralization (full)	945	1.51	0.88	0	3
Supermajority Muslim	945	0.25	0.43	0	1
No Military President	945	0.82	0.38	0	1
Population Density	945	690.19	2,352.28	6.90	41,012.70
Mean Elevation	859	286.96	251.69	-0.25	1,829.00
Distance to Capital	945	410.61	169.29	13.29	825.47
Petrol	945	0.25	0.43	0	1
Mean Agricultural Suitability	925	4.73	0.79	0.00	6.00
Slavery	921	0.99	0.07	0	1
Malaria	945	0.99	0.03	0.72	1.00
Ruggedness	945	0.28	0.25	0.03	2.28
Ecological Diversity*	945	0.26	0.24	0.00	0.66

Notes: See text for details. *Ecological diversity is used in the IV specification only. Models are tested with the binary and full Centralization index. Results from the binary Centralization variable are reported in this paper.

Table 3: Night Light Density and Infrastructure Access Correlation Matrix (Night light density has highest correlation with Power (.6) over Sanitation (.4) and Water (.4))

Correlations	Night Lights	Power	Grid	Offgrid	Sanitation	Flush	Latrine	Water	Piped	Tubewell
Night Lights	1	0.594	0.616	0.424	0.431	0.689	-0.055	0.397	0.329	0.393
Power	0.594	1	0.873	0.807	0.544	0.674	0.108	0.535	0.404	0.468
Grid	0.616	0.873	1	0.489	0.483	0.644	0.059	0.479	0.468	0.432
Offgrid	0.424	0.807	0.489	1	0.469	0.594	0.120	0.469	0.236	0.431
Sanitation	0.431	0.544	0.483	0.469	1	0.538	0.729	0.445	0.258	0.421
Flush	0.689	0.674	0.644	0.594	0.538	1	-0.120	0.522	0.285	0.523
Latrine	-0.055	0.108	0.059	0.120	0.729	-0.120	1	0.131	0.106	0.089
Water	0.397	0.535	0.479	0.469	0.445	0.522	0.131	1	0.403	0.735
Piped	0.329	0.404	0.468	0.236	0.258	0.285	0.106	0.403	1	0.160
Tubewell	0.393	0.468	0.432	0.431	0.421	0.523	0.089	0.735	0.160	1

Notes: Night light density in 2012 from the NOAA DMSP database. Observations calculated at the LGA-Ethnic level. Highest correlation between night lights density and functional grid based power (.62) and also between night lights density and working flush toilets (.69). Overall for the aggregate infrastructure indicators, night light density has highest correlation with functional Power ($\approx .6$) over Sanitation ($\approx .4$) and Water($\approx .4$) in the country suggesting that the Power and Grid variables from school level surveys accurately proxy mean distribution of available functional electricity for the country.

Table 4: Night Light Density and Health Access Correlation Matrix (Night light density positively associated with health professional density (.55))

Correlations	Night Lights	Health Prof. Dens.	Yellow Fever Imm.	Meningitis Imm.
Night Lights	1	0.551	-0.160	-0.177
Health Professional Density	0.551	1	-0.192	-0.171
Yellow Fever Immunization	-0.160	-0.192	1	0.385
Meningitis Immunization	-0.177	-0.171	0.385	1

Notes: See text for details.

Table 5: Hypothesis C: Positive impacts, on average, of precolonial ethnic state centralization on access to federally administrated goods for which cooperative centralized ethnic state leaders were better positioned then and today to bargain for access with federal authorities

	Grid (1)	Night Lights (2)	Flush (3)	Health Prof. (4)	Yellow Fever Imm. (5)	Meningitis Imm. (6)
Centralization	0.041** (0.018)	0.092* (0.052)	0.019 (0.013)	0.517*** (0.186)	0.070** (0.034)	0.047** (0.023)
Slavery	0.048 (0.066)	0.030 (0.166)	-0.032 (0.050)	-1.101* (0.667)	-0.084 (0.091)	0.104** (0.044)
Petrol	0.078*** (0.024)	0.535*** (0.096)	0.119*** (0.032)	1.380*** (0.298)	0.001 (0.027)	-0.026 (0.016)
Constant	-0.455 (0.355)	2.039** (1.011)	0.152 (0.227)	16.560* (8.871)	0.053 (0.805)	-0.297 (0.423)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
N	821	821	821	799	799	799
R ²	0.148	0.417	0.307	0.178	0.027	0.085
Adjusted R ²	0.139	0.411	0.299	0.168	0.016	0.075

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Flush toilet access just barely misses significance cut off at .15, which is mostly a power issue, I estimate. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital except in the interaction case where the distance variable was dropped due to collinearity with the muslim indicator. Results remain significant in most specifications when the full Centralization index is used. Interaction is not significant in all models except (6), where the effect is positive, but main effects are not significant and effect on Centralization is insignificantly different from 0. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 6: Hypothesis C: Precolonial ethnic state centralization has no effect for LGA administrated low federal state control goods: Offgrid, Pit Latrines, Water Access

	Offgrid (1)	Sanitation (2)	Latrine (3)	Water (4)	Piped (5)	Tubewell (6)
Centralization	0.017 (0.011)	0.042 (0.040)	0.020 (0.034)	0.019 (0.019)	0.006 (0.008)	0.021 (0.026)
Slavery	0.054 (0.040)	-0.145 (0.092)	-0.071 (0.078)	0.163** (0.066)	0.046 (0.032)	0.138** (0.064)
Petrol	0.044*** (0.016)	0.140*** (0.050)	0.019 (0.061)	0.030 (0.028)	0.021* (0.011)	0.071*** (0.025)
Constant	-0.450* (0.251)	0.353 (0.668)	0.133 (0.614)	-1.072*** (0.371)	-0.242 (0.151)	-0.431 (0.420)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
N	821	821	821	821	821	821
R ²	0.106	0.143	0.029	0.126	0.055	0.085
Adjusted R ²	0.096	0.134	0.018	0.116	0.045	0.075

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital. Results remain insignificant when the full Centralization index is used. Results remain insignificant when the supermajority muslim interaction is included. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 7: Hypothesis 1: Negative impacts of precolonial centralization on access to high federal state control infrastructure for non-cooperative ethnic states and More Negative impacts under punishment regimes where $f_2 = 0$

	Grid			Flush		
	(1)	(2)	(3)	(4)	(5)	(6)
Centralization	0.041** (0.018)	0.070*** (0.025)	0.138*** (0.036)	0.019 (0.013)	0.031* (0.017)	0.076*** (0.025)
Supermajority Muslim		0.020 (0.028)	0.026 (0.028)		-0.027 (0.025)	-0.018 (0.022)
No Military President			0.028 (0.025)			0.050*** (0.017)
CentXMus		-0.079** (0.035)	-0.106*** (0.036)		-0.051** (0.025)	-0.059** (0.024)
CentXNo Military			-0.073** (0.033)			-0.048** (0.023)
Slavery	0.048 (0.066)	0.001 (0.057)	-0.001 (0.053)	-0.032 (0.050)	-0.054 (0.050)	-0.053 (0.050)
Petrol	0.078*** (0.024)	0.061** (0.026)	0.067*** (0.025)	0.119*** (0.032)	0.105*** (0.030)	0.105*** (0.030)
Constant	-0.455 (0.355)	-0.335 (0.306)	-0.273 (0.277)	0.152 (0.227)	0.252 (0.194)	0.187 (0.206)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
N	821	821	821	821	821	821
R ²	0.148	0.166	0.175	0.307	0.339	0.340
Adjusted R ²	0.139	0.156	0.163	0.299	0.331	0.331

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Dependent variable measures Grid access in (1)-(3) and Flush toilet access in (4)-(6). Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital except in the interaction case where the distance variable was dropped due to collinearity with the muslim indicator. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 8: First stage results: Ecological Diversity predicts precolonial state centralization

	Precolonial State Centralization				
	(1)	(2)	(3)	(4)	(5)
Ecological Diversity	0.188*** (0.045)	0.193*** (0.045)	0.137*** (0.046)	0.158*** (0.046)	0.156*** (0.046)
Constant	-2.490*** (0.784)	-2.490*** (0.782)	-2.203*** (0.784)	-2.777*** (0.780)	-2.777*** (0.780)
Population Density	Yes	No	Yes	No	Yes
Disease control	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes*	Yes*
Other controls	Yes	Yes	Yes	Yes	Yes
Supermajority Interaction	No	No	Yes	Yes	Yes
N	821	821	821	821	821
Adjusted R ²	0.108	0.108	0.534	0.531	0.530
F Statistic	16.98	17.88	8.52	11.62	11.20

Notes: IV 2SLS regression first stage OLS estimates. Robust standard errors in parentheses. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital in (1) and (2), distance to capital excluded in (3), (4) and (5) due to collinearity. Ruggedness excluded from geographic controls in (4) and (5). Other controls include slavery and petrol. Results remain significant when the full Centralization index is used. Results remain significant when the supermajority muslim interaction is included. Interpretation of results in (3), (4) and (5) interaction case should be interpreted with caution due to collinearity between the muslim indicator and supermajority muslim interaction on the RHS and , in the case of (3), an F-statistic ; 10. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 9: OLS and IV results: Effect of Centralization with punishment regime on access to high state control goods: Grid based Power and flush toilets

	Grid (OLS)		Grid (IV)		Flush (OLS)		Flush (IV)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Centralization	0.041** (0.018)	0.070*** (0.025)	0.490** (0.204)	0.457* (0.292)	0.019 (0.013)	0.031* (0.017)	0.575*** (0.176)	0.478* (0.306)
Supermajority Muslim		0.020 (0.028)		0.373 (0.261)		-0.027 (0.025)		0.381 (0.281)
CentXMus		-0.079** (0.035)		-0.471* (0.297)		-0.051** (0.025)		-0.503* (0.310)
Constant	-0.455 (0.355)	-0.335 (0.306)	0.595 (0.574)	0.457 (0.706)	0.152 (0.227)	0.252 (0.194)	1.452*** (0.349)	1.165** (0.538)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	821	821	821	821	821	821	821	821
R ²	0.148	0.166	0.160	0.162	0.307	0.339	0.331	0.344
Adjusted R ²	0.139	0.156	0.151	0.152	0.299	0.331	0.324	0.336

Notes: Robust standard errors in parentheses clustered by state. Dependent variable measures Grid access in (1)-(4), Flush toilet access in (5 -(8). Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital except in the interaction case where the distance variable not included. Other controls include slavery and petrol. Results remain significant in most specifications when the full Centralization index is used. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 10: IV second stage results: The effects of centralization on Federally administrated goods and the punishment regime for high state control goods (Grid based power and Flush toilets access) persist in the IV specification

	Power		Grid		Night Lights		Health Prof. Dens.	Flush
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Centralization	0.862*** (0.236)	0.807** (0.350)	0.490** (0.204)	0.457* (0.292)	1.252** (0.594)	0.924 (1.095)	8.657*** (1.931)	0.4776* (0.306)
Supermajority Muslim		0.647** (0.316)		0.373 (0.261)		0.651 (1.004)		0.3806 (0.281)
CentXMus		-0.820** (0.356)		-0.471* (0.297)		-0.894 (1.107)		-0.5030* (0.310)
Slavery	-0.460*** (0.151)	-0.450* (0.230)	-0.263* (0.143)	-0.263 (0.202)	-0.773** (0.336)	-0.617 (0.656)	-6.715*** (1.336)	-0.359** (0.178)
Petrol	0.020 (0.043)	0.032 (0.041)	0.035 (0.036)	0.040 (0.036)	0.423*** (0.131)	0.440*** (0.134)	0.605* (0.329)	0.081** (0.041)
Constant	0.969 (0.590)	0.726 (0.798)	0.595 (0.574)	0.457 (0.706)	4.753*** (1.371)	3.953* (2.041)	35.444*** (8.104)	1.166** (0.538)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	821	821	821	821	821	821	799	821
R ²	0.188	0.197	0.160	0.162	0.424	0.427	0.195	0.344
Adjusted R ²	0.179	0.187	0.151	0.152	0.417	0.420	0.186	0.336

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Notes: IV 2SLS estimates reported. Robust standard errors in parentheses clustered by state. Dependent variable measures Power access in (1) and (2), Grid access in (3) and (4), Night lights density in (5) and (6), Health professional density in (7) and Flush toilet access in (8). Effect on flush toilets is weak, due to its tenuous nature as a 'high state control good' after the 1977 instance mentioned in the text. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital except in the interaction case where the distance variable was dropped due to collinearity with the muslim indicator. Estimates from (2), (4), (6) and (8) with the interaction term should be interpreted with caution due to collinearity in the first stage. Results remain significant when the full Centralization index is used. Population density is included in all specifications in the full model.

***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 11: IV second stage results: Precolonial ethnic state centralization has no effect for LGA administrated low federal state control goods

	Sanitation (1)	Latrine (2)	Water (3)	Piped (4)	Tubewell (5)
Centralization	0.350 (0.366)	-0.217 (0.345)	0.368 (0.265)	-0.007 (0.084)	0.359 (0.285)
Slavery	-0.358 (0.264)	0.093 (0.243)	-0.079 (0.174)	0.055 (0.065)	-0.096 (0.201)
Petrol	0.110* (0.060)	0.041 (0.068)	-0.004 (0.041)	0.022 (0.013)	0.038 (0.038)
Constant	1.072 (1.280)	-0.420 (1.212)	-0.255 (0.700)	-0.270 (0.259)	0.360 (0.787)
Population Density	Yes	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes
N	821	821	821	821	821
R ²	0.144	0.030	0.132	0.055	0.093
Adjusted R ²	0.135	0.019	0.122	0.045	0.083

Notes: Robust standard errors in parentheses clustered by state. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital. Results remain significant when the full Centralization index is used. Population density is included in all specifications in the full model. Note 'Offgrid access' not included here due to possible failure of the exclusion restriction with offgrid or access to solar based electricity and ecological diversity (see Pausas and Austin, 2001) ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 12: Respondents from punished (S.Mus) areas in centralized states seem to report lower trust in federal institutions (police) over traditional leaders

	'Trust' in Police Over Traditional Leaders (Cent=1)				
	(1)	(2)	(3)	(4)	(5)
S.Muslim	-0.165 (0.115)	-0.165 (0.112)	-0.216* (0.117)	-0.211* (0.130)	-0.238* (0.138)
Slavery				0.063 (0.050)	0.022 (0.051)
Petrol	-0.123 (0.115)	-0.110 (0.114)	-0.081 (0.102)	-0.143 (0.109)	-0.086 (0.109)
Constant	0.396*** (0.049)	3.347*** (1.269)	3.458*** (1.219)	0.262** (0.105)	0.380 (0.351)
Population Density	Yes	Yes	Yes	Yes	Yes
Disease control	No	Yes	Yes	No	No
Geographic control	No	No	Yes	No	Yes
N	210	210	174	209	173
R ²	0.071	0.086	0.098	0.083	0.082
Adjusted R ²	0.058	0.068	0.060	0.065	0.043

Notes: Regressions estimated by OLS. Standard errors in parentheses clustered by state. Dependent variable measures choice of police over traditional leaders as first resort for help when the respondent has been victim of a violent crime. Disease control includes malaria. Geographic controls include ruggedness, mean elevation and agricultural land suitability. Full index of slavery based on V70 from the Ethnographic atlas and Fenske (2014)'s specification is used here to avoid singularities. Slavery is coded into 4 levels, where 0 is 'absence or near absence' and 3 is 'hereditary and socially significant'. Results remain significant when the full Centralization index is used. Population density is included in all specifications but (1). ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

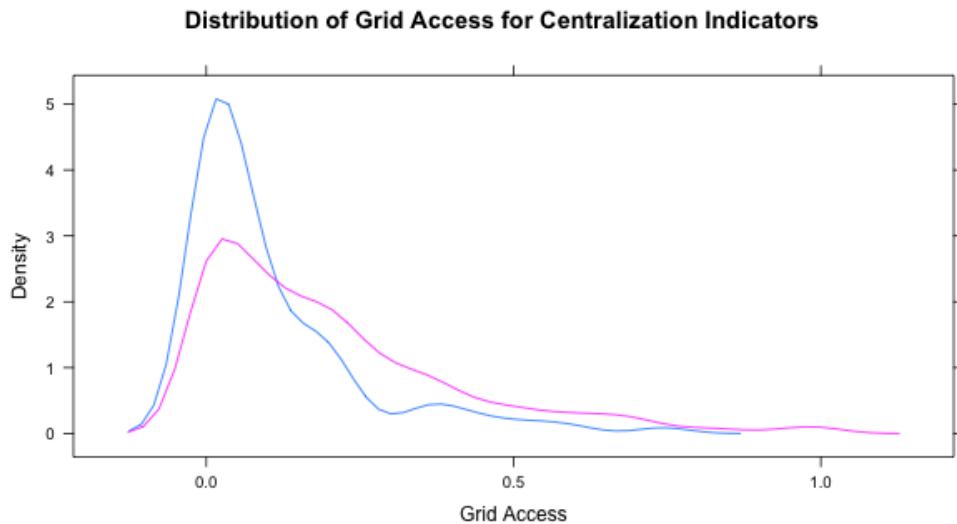


Figure 8: Precolonial centralization has a positive effect on grid access in cooperative ethnic states: First order stochastic dominance of distribution of grid access in centralized (purple) vs. non-centralized (blue) states

Distribution of Flush Toilet Access by Centralization Indicators

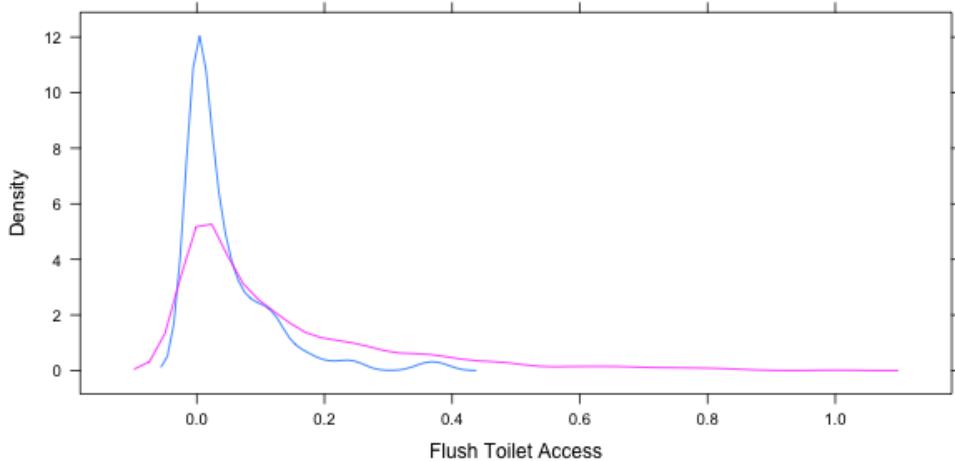


Figure 9: Precolonial centralization has a positive effect on flush access in cooperative ethnic states: First order stochastic dominance of distribution of flush access in centralized (purple) vs. non-centralized states

Afrobarometer Distribution of 'Trust' in Leaders by Centralization and Supermajority Muslim Indicator

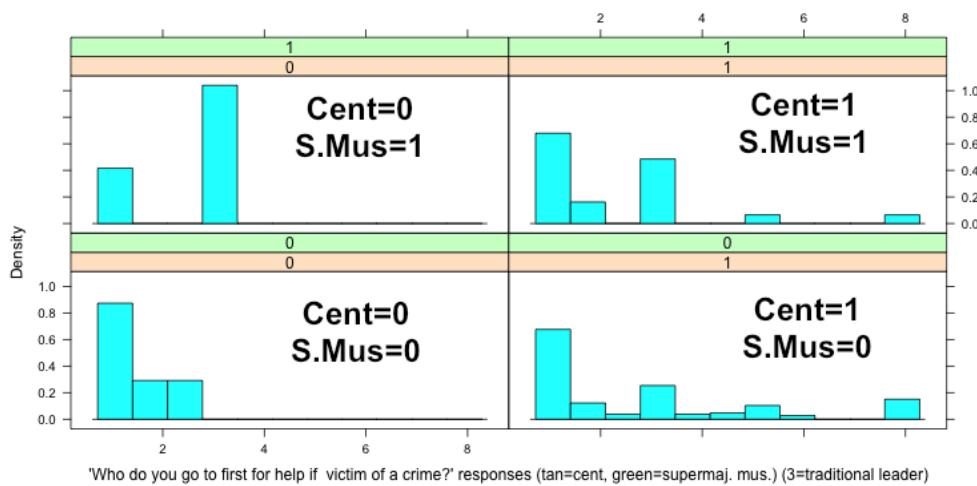


Figure 10: Respondents from Precolonial Centralized areas subjected to punishment regime (proxied by supermajority muslim indicator) report less 'trust in police over traditional leaders' than their centralized counterparts in non-punishment regime states: 1= police, 3=traditional leaders

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8 Appendix

8.1 Simple Theoretical Model: Sketch

In the model⁴ there are two types of agents, the ethnic state leader denoted by s and the autocratic federal government, c . There is some policy instrument τ such that: $\tau = (0, 1]$ which can be taxes collected by the federal autocratic regime, levies, or any transfers to the federal regime from the ethnic state leader.

The payoff for the ethnic state leader is as follows: They can choose to cooperate with some probability $p = f(\lambda)$ where λ is the share of ethnic state leadership that are pro the federal government and:

$$p = \begin{cases} \min(1, \frac{\lambda}{1-\lambda}) \end{cases}$$

With payoff equal to:

$$\begin{cases} (1 - \tau)A + \theta\tau \end{cases}$$

Where A is some initial wealth condition and θ is the proportion of rewards or patronage (eg in terms of public service provision) going to the cooperative ethnic state. They can choose to not cooperate with probability $1 - p$ and payoff equal to:

$$\begin{cases} A - \theta\frac{1}{\tau} \end{cases}$$

So the Expected payoff to the ethnic state leader is:

$$\begin{cases} E[\pi] = \min(1, \frac{\lambda}{1-\lambda})(1 - \tau)A + \theta\tau + (1 - \min(1, \frac{\lambda}{1-\lambda}))A - \theta\frac{1}{\tau} \end{cases}$$

⁴This section is co-written with Francis Annan and is part of a further working paper on a detailed theory and evidence on the cooperation/patronage, non-cooperation/punishment mechanism mentioned in this paper

And the ethnic state leader chooses to cooperate with the federal regime if $E[\pi] \geq 0$. Sample optimal solutions can be shown graphically and we can find that the optimal λ and hence p will depend on the level of τ in particular.

8.2 Evidence from Nigerian Historiography: Cooperation, Punishment and Access to Public Infrastructure Services under Cooperative Federalist, Dual Authority Regimes in Precolonial Nigeria to Present

8.3 Precolonial Nigeria: c. 1850s

By the 1850s, in the territory that became known as Nigeria, some central plotlines are identified by historians of this period. First is the presence of more or less centralized ethnic states, with broadly, monarchial Yorubaland (headed by the Alafin and attendant council) to the Southwest, The Edo and monarchial Benin Kingdom (headed by the Oba and attendant council) to the South South, monarchial Hausaland (headed by the Hausa kings) to the Northwest, the Bornu kingdom (headed by the Mai) to the Northeast and The less centralized but still with organized chieftaincy and governance structures and impressive trading capacities among their subgroup, the Aro, Ibos/Igbos to the Southeast (Falola, 2005; Ogundiran, 2005). Then there were the so-called "stateless" or non-centralized societies like the Ekoi to the South, the Bakakari to the North sprinkled in between throughout the region as depicted in (c) of figure x.

Another major thread is the nearing of the close of the Atlantic slave trade, the collapse of the Old Oyo Empire in Yoruba land unleashing unprecedented levels of warfare in the region and contributing to the expansion of sovereignty crystallized in Murdock's 1967 Atlas (Dudley, 1968; Ogbomo, 2005). Most important for this paper's thesis during this period, however is the expansion of the infamous Sokoto caliphate political state spearheaded by Usman Dan Fodio at the beginning of the 19th century and transforming most of Northern Nigeria through a series of jihads into Islamic political states by the mid 19th century headed by religious/political Fulani rulers titled 'Emirs' as depicted in (d) in Figure/refnigeria. This expansion would have important consequences for the doctrine of indirect rule that followed and the differential application of this

doctrine in the converted muslim North, particularly the supermajority muslim North versus the area delineated South (and consisting of areas not part of the Sokoto caliphate) during the period of British colonial rule (Dudley, 1968).

8.4 British Colonial Nigeria: 1885-1960

The colonial period in Nigeria dates as far back as 1800, with events like the annexation of Lagos as a crown colony in 1861, heralding the eventual British occupation of the area that would come to be known as Nigeria in 1885. Until 1900, cooperation between ethnic state kings and the British colonial regime, headed by Sir Frederick Lugard in Nigeria was sometimes with ethnic state kings rebelling against British encroachments on their sovereignty with 2 notable examples being the opposition by King Jaja of Opobo and Oba Ovonranmwen of Benin in 1897 (Ogbomo, 2005). Punishment however was swift and brutal in the case of the latter, with both monarchs deposed and exiled and a bloody, destructive 'punitive expedition' in 1897 throughout the Benin empire (Ogbomo, 2005; Otoide, 2005). The lessons for centralized ethnic state leaders, who might have had incentive to vie with the British colonials over sovereignty in their area was clear, these new entrants to the political field had no sympathy ($f_j = 0$) for detractors and retaliation, punishment for non-cooperating entities would be brutal and swift; on the other hand, for co-operators with the regime, the rewards could be plentiful in the form of increased autonomy in one's jurisdictions and the benefits thereof under indirect rule as discussed below. By 1900, all of Nigeria, including the previously antagonistic Sokoto caliphate, had been brought under British rule. However, once centralized ethnic state leaders surrendered, a 'pacifist' approach under the system of indirect rule became the rule of the day.

Under Lugard's doctrine of indirect rule, centralized ethnic state leaders were given autonomy over their regions crystallized in a series of legislations starting with the Native Courts proclamation in 1900 and followed by the Native Revenue Proclamation in 1904. Authority over tax collection and administration of justice within their areas was afforded to centralized ethnic state kings. As of this time Nigeria was administered as 2 separate provinces, a Northern Province headed by Lugard and aligned with the boundaries of the Sokoto caliphate and a Southern

province. Impressed with the extent of the Sokoto caliphate, its high tax bureaucratic capacity and highly hierarchical nature of the 'Muslim North', and eager to consolidate support of the ruling elite in the area as a strategy for solidifying British rule in the area, Lugard pursued a policy of complete non-intervention in Northern Nigeria where he promised the Sultan of Sokoto in 1903 to have "non-intervention in matters of religion or 'tradition'" This doctrine was crystallized in the Native Authority Proclamation of 1907 where the Emir became the sole Native Authority within their jurisdictions in a hyper-centralization of power in the hands of these figures. Note this was a significant break with the practice in the 1850 period, as while the Emirate system was highly hierarchical, there had existed "various middlemen" in the 'traditional' precolonial system who acted as a manner of checks for the power of the Emir (Dudley, 1968; Mustapha, 2006). With the hypercentralization of power in the hands of the Emir, these middlemen had their posts 'abolished', leading to unprecedented near despotic levels of power afforded to Emirs in the Muslim North of the country and prompting FW de St Croix to comment that "Not only was authority of the Emir unchecked by his Council...the Emir quickly became an absolute ruler" (Dudley, 1968). Added to Lugard's ideological vision of fashioning the Muslim North as a "modern, aristocratic Anglo-Muslim" region (Mustapha, 2006) that would be free of the 'challenging, revolutionary' influences of Christian missionary led 'Western education' on the local populace that was proliferating in the South (and that led Graham to make the observation 'It was Lugard's view that in Southern Nigeria, "education had produced men discontented, impatient of any control and obsessed with their own importance" '(Mustapha, 2006; Graham 1966:136; Dudley, 1968)) and of course, completely under British control, and the divide in administration between the Northern and Southern protectorates became so wide that even after the amalgamation of the 2 protectorates into a single Nigeria in 1914, so disparate were the political systems in both that years later in 1939, on visiting the Southern Lagos for the first time, the Northern Premier Sir Ahmadu Bello "viewed with a lack of comprehension, with suspicion and dissatisfaction Southern politics and politicians" (Dudley, 1968).

And so it continued, that while political power of centralized ethnic state leaders in the South became more and more decentralized, with emergent Western educated elites increasingly ex-

pressing their disdain for 'backward political systems' and their desire for more power in the colonial political structure culminating in the replacement of the Native Authority system with elected local councils under the Local Government Ordinance of 1950 which relegated Southern ethnic state or traditional leaders to merely ceremonial roles, in the North, power became increasingly centralized in the hands of Emirs, particularly in states with high majority muslim populations after first, the Native Authority Ordinance of 1933 reclassified Native Authorities, modifying the policy with regards to 'Non-Muslim areas of the North' and the Native Authority Law of 1954 which further consolidated power in the hands of high majority muslim emirs with allowances afforded for the introduction of justice systems based on Sharia law in these areas (Dudley, 1968; Tonwe and Osemwota, 2013).

So it was that by the end of the colonial era and independence in 1960, there were 2 very different systems of local governance in Nigeria, one in the North, particularly the high majority muslim North, where Emirs were afforded near absolute power over their jurisdictions under the Native Authority system and one in the South and non-high majority muslim North where more decentralized, democratic systems of local governance had cropped up to erode the authority of centralized ethnic state leaders in the area. At this time, investment in infrastructure by the British was minimal and largely catered to the needs of British residents with two small generating sets built to serve British colonials in Lagos in 1886 (Sambo, 2012). It was not till towards the close of the colonial period in 1951 that the federally controlled Electricity Corporation of Nigeria (ECN) was established in the country with the next significant investment/innovation in the country's power infrastructure not occurring till 1972 when the National Electric Power Authority (NEPA) was formed under military rule (Sambo, 2012).

8.5 Military Nigeria: 1966-1999

Fast forwarding past the brief detour into democracy between 1960-1966 and apart from a short period of pseudo-'democracy' between 1979-1983, the subsequent next 30 or so years of Nigerian history were characterized by autocratic military rule replacing the previous autocratic British colonial regime. Most significantly for the story of cooperation between the centralized ethnic

state leaders under the Native Administration system that still existed in formidable form in the high majority or supermajority Muslim North, was the slow erosion of Native Authority and the Emir's powers by military officials who wanted to consolidate power and feared the influence of these Emirs (Mustapha, 2006; Tonwe and Osemwota, 2013). In light of the efforts by the military regime to undermine the authorities of the Northern, Muslim Emirate/Native Authority local governance system, the military period has been described as "traumatic for muslim establishment of Northern Nigeria" (Hickey, 1984). At no time was this trauma more evident than in the complete demolition of the Native Authority system with the establishment of the 1976 Local Government Reform law that removed traditional leaders from politics, virtually banned them from participation in democratically elected local governments with the establishment of the Local Government Area as the smallest constitutionally acknowledged unit of local administration in the country and shafted ethnic state/traditional rulers to mere advisory roles, if even that in some cases. The break was traumatic for the rule of the Emirs particularly under the high Muslim majority states where they had enjoyed near absolute levels of autonomy over their territories for almost a century under British colonial policy. And understandably, the move spurred enormous opposition from traditional leaders in these areas. In the South, however where previously mentioned laws had already greatly subdued the powers of traditional rulers, there was little or no opposition to the 1976 law. (Tonwe and Osomwota, 2013; Hickey, 1984; Mustapha, 2006; Blench et al., 2006).

It should also be noted that part of the reason the military regime felt comfortable completely dismantling the Native Authority regime in 1976, traditionally in charge of tax collection in their locales, was that around the same time in 1973, an oil boom, meant Nigeria was now flush with revenue from petrol and for perhaps the first time in the country's history, its federal government no longer depended on tax revenue for its income (Tonwe and Osemwota, 2013). With the new petrorevenue, came investment in a series of public works projects in the 1970s-1980s and most notably a cash grant given out as incentive to areas which installed septic tanks and flush toilets after the abolishment of the bucket latrine system by federal decree in 1977 (Uduku, 1994). With the high federal state control of the electricity infrastructure through NEPA, the high fed-

eral state control of flush toilet access at primary public schools through the cash grant scheme (which the government had taken over in 1974-1976), the new petrol fueled independence of the military government from the local traditional rulers and subsequent abolishment of the Native Authority system, what this meant for non-cooperating Northern traditional rulers refusing to relinquish political power under the 1976 law from these high majority muslim areas who had experienced the most 'trauma' over loss of political power post the 1976 law was that punishment from the regime was able to take on a different form than punishment for non-cooperation had been under the British colonial era. Namely, the military strategy transformed from one of swift punishment of rebellious traditional rulers in the form of exile and occasionally execution (a la the British), to one of not-so benign neglect of jurisdictions ruled by non-cooperating Emirs, with underinvestment in these high state control goods becoming the dominant strategy by military elites during this period (Tonwe and Osemwota, 2013; Mustapha, 2006; Olasupo, 2001; Blench et al., 2006). This punishment of underinvestment was particularly pronounced in areas with no cleavage to the military government (Mustapha, 2006; Blench et. al, 2006; Osaghae, 2006) particularly where the military presidents themselves did not originate. And the tension and discontent spawned by this non-cooperation was evident throughout the supermajority Muslim states with a series of riots, so called 'muslim uprisings' breaking out in Northern supermajority muslim cities in the 1980s with a particularly bloody, infamous one being the 1982 Maitatsine uprisings in Maiduguri (capital of Borno state, former homeland of the precolonial Bornu kingdom) in Nigeria (Hickey, 1984).

8.6 And Today: Traditional Leaders and Local Government Areas and Public Service Provision

The relationship between the current democratic regime and traditional rulers, particularly with historically precolonial era centralized ethnic state leaders has somewhat changed from the military era. The current strategy by the federal government has been to gain legitimacy in formerly centralized areas by lobbying the support of traditional leaders from these areas calling on their social capital with their citizenry to resolve internal conflicts in their regions and promote federal

policies like the 2012 national immunization efforts (Blench et. al, 2006; Tonwe and Osemwota, 2006; Johns Hopkins, 2012). Here as in the past, cooperative traditional leaders from formerly centralized ethnic states, that are often the target of the federal government relationship building for all the reasons mentioned previously, are able to benefit from the bargaining with federal authorities for greater access to currently federally controlled resources for their areas, among which were the health/immunization efforts of 2012. Today, constitutional local governance is at the level of the LGA and not the Native Administration system in Nigeria. From the original just over 300 created in 1976, there are currently 774 Local Government Areas (LGAs) in Nigeria today. Broadly, the governance of the LGAs has 2 main parts, a Policy making body and an Executive body. Council members are elected in a democratic process and the Policy making department is headed by 4 main executives- the executive chairman, the vice chairman, the supervisory councilor and the councilor, complemented by 3 groups of personnel in the Executive body- the secretary, head of departments and subordinate staff. The departments are further divided into 7 parts, the General and Administrative Department, the treasury, the Works department, the Health Department, the Maternity Division of the medical department, the Dispensary Division of the Medical Department and the Farm Division. Some of the duties of the LGA include responsibility for sanitation access- including pit latrine maintenance, most immunization programs (with the exception of the 2012 date of the survey, where as will be discussed in the Data section, the national government intervened to ramp up child immunization efforts hosting its first ever national vaccine summit in the capital Abuja in 2012, and spurring the classification in this paper of immunization in 2012 as a federally administrated, but medium federal state control good (Johns Hopkins, 2012)) , the health centers, maternity center administration, water supply- including its rural and urban extension, construction and maintenance of primary schools, town planning and care of markets and motor-parks. Under the current system, LGAs are allocated funds from the federal government (up to 20% of federal revenue as of 2004 (Khemani, 2004)) which they can use to attend to the aforementioned responsibilities. Of the problems cited by observers of the system are the presence of too many actors, with difficulty reaching consensus on projects to pursue with subsequent high incentives for corrupt activities in

the absence of accountability mechanisms from the federal government and where staff are often underpaid or not paid at all; lack of accountability is also partly driven by the lack of continuity of LGA governments and executives within LGA governments (Olanipekun, 1988; Khemani, 2004; Olowu and Erero, 1995). In this multilateral bargaining framework, there is no role for the ethnic state/traditional leaders in the bargaining/decision making process and hence no effect of ethnic state centralization on locally administrated, low federal state control goods.

8.7 Robustness checks

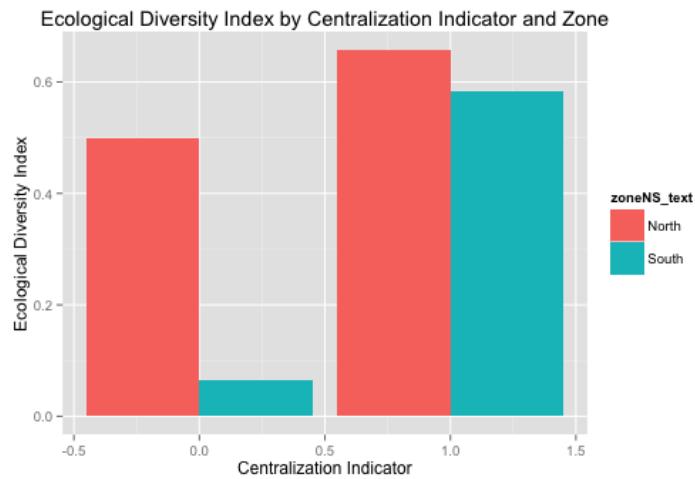


Figure 11: Ecological Diversity Index by Centralization Indicator and Geopolitical Zone

Table 13: First stage results: Ecological Diversity predicts precolonial state centralization

	Precolonial State Centralization			
	(1)	(2)	(3)	(4)
Ecological Diversity	0.367*** (0.094)	0.372*** (0.094)	0.137*** (0.046)	0.139*** (0.046)
Zone	0.059 (0.055)	0.058 (0.055)		
Ecological Diversity x Zone	-0.369*** (0.116)	-0.374*** (0.045)		
Constant	-2.577*** (0.812)	-2.578*** (0.811)	-2.203*** (0.784)	-2.203*** (0.784)
Population Density	Yes	No	Yes	No
Disease control	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Supermajority Interaction	No	No	Yes	Yes
N	821	821	821	821
R ²	0.118	0.116	0.540	0.539
Adjusted R ²	0.108	0.108	0.534	0.534
F Statistic	19.11 (df = 9; 809)	19.40 (df = 8; 810)	8.52 (df = 10; 810)	8.83 (df = 9; 811)

Notes: IV 2SLS regression first stage OLS estimates. Robust standard errors in parentheses. Zone is an indicator for geopolitical zone equal to 1 if North, 0 if South. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital in (1) and (2), distance to capital excluded in (3) and (4) due to collinearity. Other controls include slavery and petrol. Results remain significant when the full Centralization index is used. Results remain significant when the supermajority muslim interaction is included. Interpretation of results in (3) and (4) interaction case should be interpreted with caution due to collinearity between the muslim indicator and supermajority muslim interaction on the RHS and an F-statistic ≥ 10 . Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

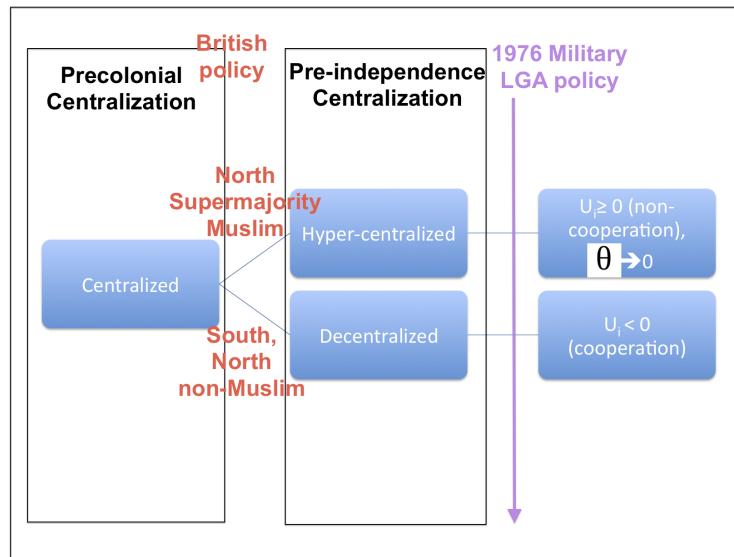


Figure 12: Calculus of non-cooperation by centralized ethnic state leaders

Table 14: Robustness check: split sample for S.Mus=0 and 1; effects retain sign at 90% and 95% Confidence level

	Grid, S.Mus=1	Grid, S.Mus=0	Flush, S.Mus=1	Flush, S.Mus=0
	(1)	(2)	(3)	(4)
Centralization	-0.055** (0.028)	0.071** (0.029)	-0.028: (0.021)	0.032* (0.017)
Petrol		0.058** (0.027)		0.106*** (0.031)
Slavery	0.040** (0.016)	-0.007 (0.015)	0.008 (0.011)	0.020 (0.036)
Constant	-0.214 (0.212)	-0.235 (0.293)	0.553*** (0.105)	-0.085 (0.161)
Population Density	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	No
N	215	601	215	606
R ²	0.244	0.125	0.341	0.253
Adjusted R ²	0.219	0.114	0.318	0.244

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Dependent variable measures Grid access in the S.Mus=1 and S.Mus=0 split samples in (1) and (2) respectively, Flush access in the S.Mus=1 and S.Mus=0 split samples in (3) and (4). Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability. Results remain significant when the full Centralization index is used. Petrol omitted for S.Mus=1 case where no petrol deposits. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 15: Robustness check: split sample for S.Mus=1 and Nomil=1 (punished and nonfavored); effects retain sign at 90% Confidence level

	Grid, S.Mus=1	Grid, S.Mus=1 and NoMil=1	Flush, S.Mus=1	Flush, S.Mus=1 and NoMil=1
	(1)	(2)	(3)	(4)
Centralization	-0.055** (0.028)	-0.064* (0.038)	-0.028: (0.021)	-0.036* (0.021)
Slavery	0.040** (0.016)	0.030 (0.026)	0.008 (0.011)	0.007 (0.014)
Constant	-0.214 (0.212)	-0.161 (0.329)	0.553*** (0.105)	0.557*** (0.110)
Population Density	Yes	Yes	Yes	Yes
Disease control	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
N	215	109	215	109
R ²	0.244	0.294	0.341	0.304
Adjusted R ²	0.219	0.245	0.318	0.255

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Dependent variable measures Grid access in the S.Mus=1 split samples in (1) and (2) respectively, Flush access in the S.Mus=1 split samples in (3) and (4). Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability. Results remain significant when the full Centralization index is used. Petrol omitted for S.Mus=1 case where no petrol deposits. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

A second means of correcting for spatial autocorrelation is with the spatial error model which has the form:

$$Y = X\beta + \epsilon \quad (7)$$

$$\epsilon = \lambda W\epsilon + \xi \quad (8)$$

with: ξ assumed normal, mean 0 and homoskedastic (classical assumptions) and ϵ as a vector of error terms, weighted using the pre-specified spatial weights matrix W , λ as the scalar parameter of the spatial error term. Note, rewriting Y with the solved error term, reveals non-linearity in the model, and the coefficients are estimated by maximum likelihood. A number of spatial weights were tested here, and sample results for grid access and meningitis immunization availability for $W = KNN(4)$ - the symmetric 4 nearest neighbors spatial weight matrix are presented below. Dependence on the specification of the spatial weight matrix for estimation of the coefficients is an issue here, with coefficient estimates on Centralization differing slightly from the OLS with clustered errors model here.

Table 16: Spatial Error Model Results W=KNN(4), for Grid Access and Meningitis Immunization Availability on Precolonial Centralization

	Grid	Meningitis Imm.
	(1)	(2)
Centralization	0.032* (0.019)	0.041* (0.021)
Slavery	0.025 (0.036)	-0.032 (0.043)
Petrol	0.069*** (0.019)	-0.034* (0.019)
Constant	0.136 (0.256)	-0.421 (0.286)
Population Density	Yes	Yes
Disease control	Yes	Yes
Geographic controls	Yes	Yes
N	945	945
Log Likelihood	548.504	304.093

Notes: Regressions estimated by ML. Dependent variable measures Grid access and Meningitis Immunization availability. Disease control includes malaria. Geographic controls include ruggedness, mean elevation, agricultural land suitability. Population density is included in all specifications in the full model. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.