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Historical origins of persistent inequality in Nigeria

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Abstract: Horizontal inequality by ethnic group has remained remarkably persistent for wealth, education, and access to certain services in Nigeria. While significant gains in the reduction of inequality and improvement in access have been made for more locally administered services, outcomes are stickier and largely divergent for wealth, education, and historically federally administered services like grid-based power access. Notable is the increasing or stagnant inequality of access to these measures in the northwest and northeast ethnic/geopolitical zones and a remarkable divergence for wealth outcomes for these two zones versus the rest of the country over the 1990–2013. This paper explores different explanations for the patterns observed and puts forth the thesis that persistent inequality in access to education and federally administered services is in large part driven by historical heterogeneous federal government policy towards different groups in Nigeria.

Keywords: development, ethnicity, geopolitical zone, horizontal inequality, Nigeria
JEL classification: O10, O43, O55, N27

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1 Introduction

Persistent inequality between groups or horizontal inequality has well documented negative consequences for development outcomes. Recent studies have documented negative relationships between ethnic inequality, income and public good provision (Alesina et al., 2016; Easterly and Levine, 1997) and, more generally, horizontal inequality and conflict (Stewart, 2009; Langer and Stewart, 2013). While there is a growing literature on the effects of these inequalities, their patterns, origins, and the mechanisms through which they persist remain understudied in the economic literature. Focusing on Africa, a continent where significant development challenges remain, a more recent body of literature has highlighted the role of historical institutions and environments in shaping current development outcomes (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013; Osafo-Kwaako and Robinson, 2013; Alsan, 2015; Fenske, 2014; Archibong, 2016). Particularly given the adverse development and social ramifications of group inequality, an analysis of the patterns, origins and drivers of group inequalities within African countries is essential for framing appropriate public policy.

In this article, I use survey data between 1990 and 2013 from Nigeria, the most populous country in Africa and one of the most ethnically diverse countries in the world,[1] to test hypotheses concerning the existence and origins of persistent inequality in access to public services by ethnic group identity. Nigeria's ethnic distribution is proxied by six geopolitical zones, delineating ethnic homelands of populations as shown in Figure 1 and Figure 2. Three ethnic groups– the Hausa, Yoruba and Igbo dominate three zones– the Northwest, Southwest and Southeast respectively. The Kanuri dominate the Northeast, the Ijaw/Edo/Bini/Ibibio weakly dominate the Southsouth zone, and the Northcentral is home to the Tiv, Nupe and other smaller ethnic populations.[2] Results show significant inertia in access to certain federally administered services like access to grid-based electricity. In contrast, access to locally administered services like sanitation from improved pit latrine access, and potable water access from piped water and tubewells/borewells have seen remarkable gains across all groups in the country, with convergence and, in some cases, outperformance by

[1] And home to some 374 ethnic groups (Mustapha, 2006).

[2] Figure 5 provides a snapshot of the distribution of individuals into ethnic groups by zone.

formerly lagging Northeast and Northwest zones.[3] Note, the division of services into federally and locally administered 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.[4] Results also show that initial gains to education have stalled for groups in the Northeast and Northwest zones since 2000. Mean wealth presents a remarkable case of divergence between groups, where some groups (the same groups in the Northeast and Northwest zones with sticky education and federal service access outcomes) appear to have experienced negative growth in wealth relative to their Northcentral and Southern counterparts since 1990.

Different hypotheses for these patterns in persistence and mobility in access to public services are examined in this research. This paper presents evidence supporting the thesis[5] that a mechanism through which inequalities in access to public services between groups might persist is through differential group investment in services by historic federal regimes. Under a simple conceptual framework of bilateral bargaining between local ethnic group leaders and federal autocratic regimes, local leaders from certain groups that were compliant with federal regimes were able to bargain successfully for access to federally administered infrastructure services whose allocation the federal regime could directly control. When local leaders from those groups were non-compliant or rebelled against the federal regime, they were punished by underinvestment in access to these services. A framework of increasing returns to investment coupled with high costs of initial investment and geographic economies of scale might explain nonconvexities in access to these federally administered infrastructure services, where historically underinvested-in areas experience low, sticky outcomes for access today. Education presents an interesting counterpoint to federally

[3]So significant are the gains in improved pit latrine and water access in the two aforementioned Northeast and Northwest zones that by 2013 we see either convergence or access in these two zones exceeding access in other zones, as shown in Figure 13.

[4]For infrastructure, grid-based electricity and flush toilets are considered "federally administered" in the Nigerian context. Access to improved pit latrines and water access are considered "locally administered". The categories are based on historical and present policy choices by the federal government on administration not infrastructure capability. Historically, flush toilet access was a result of grant-based military government investment in the 1970s (see Uduku, 1994), and grid-based electricity came under the national electric power company previously/currently known as ECN/NEPA/PHCN. Local sanitation and water through pit latrines, and piped and tubewell water has always been under the purview of the Local Government Areas (LGAs) which are the smallest administrative unit in the country. See Appendix for further details.

[5]Presented in Archibong (2016).

administered infrastructure services in Nigeria, where differential investments in education between groups in the country are a result of past bargains between federal regimes and local leaders in these areas but not "punishment".[6] The framework of increasing returns and geographic economies of scale might explain why, despite improvements in educational attainment nationwide, notable inequalities by ethnic group/zone persist. Given the links between education and wealth established in the theoretical and empirical literature (Glewwe and Kremer, 2006; Dev et al., 2016), this might also explain the diverging trend in wealth by ethnic group/zone mentioned earlier as well. In contrast, for locally administered services, where costs of initial investment are low and geographic economies of scale are marginal or negligible, local government quality is a strong predictor of access and marginal improvements in local government quality can result in significant gains in access to these services.

A significant contribution of this paper is to test for the existence of persistent ethnic group-based inequality of access to public services using evidence from Nigeria. Results show evidence of persistence of inequality in access to education, wealth and federally administered public services by group identity. In particular, the Northwest and Northeast zones consistently report access below the national mean, with very little variance in intergroup inequality, as shown in Figure 3. In contrast, there have been remarkable gains in reduction of intergroup inequality in access to locally administered services like water and improved pit latrine access in the country, with standard deviations in the group Gini (GGini) inequality index as high as .12 and .1 for improved pit latrine and tubewell access versus .034 and .037 for power and flush access respectively between 2000 and 2013.

Another major contribution of this paper is to present a general framework to explore the mechanisms through which horizontal inequalities might persist and empirically test some hypotheses on the role of historical institutions in determining current unequal distribution of access to services. Here, I test various historical, institutional and geographical explanations for patterns of access to public services over time. To explore the hypothesis of historic compliance/reward

[6]There is an extensive literature on the history of colonial provision of education services in Nigeria. See Ukiwo (2007) and text for details.

and non-compliance/punishment bargaining relationships between federal regimes and local ethnic group leaders that might set the stage for nonconvexities in current access to federally administered public infrastructure services in particular, following work in Archibong (2016), I examine, the impact of precolonial centralization or having an identifiable sovereign in 1850 on access to these services. There is a growing literature documenting a positive relationship between precolonial centralization and current development outcomes (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013; Osafo-Kwaako and Robinson, 2013; Alsan, 2015; Fenske, 2014; Archibong, 2016). Given that many areas in present-day Northeast and Northwest Nigeria, including the current states of Bauchi, Borno, Gombe, Kebbi and Kaduna, to name a few (shown in Figure 2), were part of centralized ethnic states[7] in the precolonial era and have some of the poorest development outcomes in the country today, what could explain this divergence or "reversal of fortunes"? One hypothesis is that being centralized in 1850 might have placed you in a better position to bargain with federal regimes[8] for access to public services whose allocation they could directly control through the indirect rule system. This bargain was only successful, however, if you were a compliant centralized ethnic state. Depending on compliant/non-rebellious[9] behavior towards the federal regime,[10] being a centralized ethnic state/group is associated with a 14% increase in access to grid-based electricity for compliant groups versus a 6% decrease in access to electricity for non-compliant groups on average between 1990 and 2013. Similar patterns are found with access to flush toilets, another historically federally administered[11] service. In contrast, precolonial centralization and the bargaining mechanism are not significant for access to locally administered infrastructure services, including access to improved pit latrines and water, whose allocation federal regimes were/are unable to directly control. For these locally administered services, local government quality[12] seems to more strongly predict access to these services, though it does not predict

[7] Including the Hausa and Bolewa precolonial ethnic states in present-day Bauchi, the Kanuri in present-day Borno, the Bolewa in present-day Gombe, the Hausa and Reshe in present-day Kebbi and the Hausa in present-day Kaduna.

[8] In Nigeria, first under the British from 1885 to 1960 and then under the military from 1966 to1999.

[9] See text for details. An indicator for the proportion of the administrative state being $> 70\%$ Muslim as of 1952, called supermajority Muslim, is used as a proxy for the expectation of rebellion post an exogenous change in military policy in 1976.

[10] Under the guise of the British colonial autocrats from 1885 to1960 and the military postcolonial autocrats from 1966 to1999. See text for details.

[11] Again, by policy not infrastructure capability. See text for details.

[12] As measured through the 2012 Afrobarometer surveys.

access to the aforementioned federally administered services.

The organization of the paper is as follows: Section 2 includes a brief background on ethnic group and other categories discussed in this paper. Section 3 describes the data, methods and empirical specifications used in this study and tests for the existence of persistence ethnic group-based inequality using well-known measures across the four aforementioned categories under study– zone, proxied ethnicity, language and gender, with a focus on analysis of results from primarily the geopolitical zone and secondarily the proxied ethnicity groups. Section 4 examines the varying patterns in horizontal inequality in further detail and presents some preliminary support for the historical mechanism described in the Introduction as the main channel for persistent inequality of access to the variables described here. Section 5 discusses and tests various mechanisms along with the thesis of precolonial centralization, compliance and punishment as a factor in determining persistent horizontal inequalities as discussed in the introduction. Section 6 concludes with a brief discussion on directions for future research and potential policy implications of this research.

2 Geopolitical Zones, Ethnicity, Language and Government Structure in Nigeria

Horizontal inequality by ethnic group is examined in this paper and explored across four categories: geopolitical zone, ethnicity, language and gender. Results from the analysis based on geopolitical zone/ethnicity will be mainly discussed here. Nigeria has a three-tier administrative system with the federal government at the most macro level and a Federal Capital Territory at Abuja. The next administrative level is 36 state governments which are further subdivided into 774 local government areas (LGAs), the smallest administrative unit in the country.[13] The states and accompanying LGAs can be classified further into six geopolitical zones as shown in Figure 1 and Figure 2a. The six geopolitical zone categorizations are not trivial,[14] with ethnic affiliations aligning, by design, along these six zones. Using Demographic and Health Survey (DHS) data from 1990 to 2013, I

[13]Its equivalent is outlined in grey in Figure 2(a) and it was created by federal military mandate in 1976 to replace the ethnic state leaders as the official arm of local governance in the country.

[14]Officially recognized during President Ibrahim Babangida's regime from 1985 to1993 and currently used by government agencies for reports on socioeconomic development in Nigeria.

cross-reference location of household members with their locations on the 1960s Geo-Referencing of Ethnic Groups (GREG) dataset (Weidmann et al., 2010) from the Soviet Atlas Narodov Mira map in Figure 4 to identify ethnic group location, which is not reported in the DHS household member survey for Nigeria. Cross-referencing the information on the spatial distribution of ethnicities from GREG with the 2012 and 2008 Afrobarometer[15] surveys reveals a significant .7 correlation between locations of ethnic groups identified on GREG in the 1960s and Afrobarometer. Generally, the Northwest and Northcentral zones are dominated by Hausa-Fulani populations, the Northeast by the Kanuri, the Southwest by Yoruba, the Southeast by Igbo and the Southsouth by Edo, Ijaw, Ibibio and other designated "minority" ethnic groups.[16] DHS GPS data matched to GREG locations confirms the stability of these categories, with 80–90% of respondents in the Northwest, Southwest, and Southeast zones identified as Hausa, Yoruba and Igbo, respectively, and native speakers of the similarly named languages as reported by the respondents and shown in Figure 5. Fractionalization by ethnicity and zone are similarly stable and high in Nigeria with values between 0.8 and 0.9 between 1990 and 2013 as shown in Figure 8.

To further confirm that geopolitical zone is a proxy for ethnicity in Nigeria, I use Selway's (2011) measures of cross-cuttingness and cross-fractionalization, where cross-cuttingness is based on a normalized chi-square statistic and measures "the degree groups on a first cleavage are identically distributed amongst groups on a second cleavage" (Selway, 2011). The cross-cuttingness statistic is calculated as below:

$$CC = 1 - \sqrt{\sum \frac{(O-E)^2}{E} / nm} \tag{1}$$

"where O is the observed frequency in the subgroup cell, E is the expected frequency, n is the sample size and m is the smaller of either the number of columns minus 1 or the number of rows minus 1. With higher values implying higher cross-cuttingness" (Gisselquist, 2015). Cross-fractionalization is a version of the Herfindahl index and measures "the extent to which individuals who are in the same group on one cleavage are in different groups on the other cleavage" (Selway, 2011). The

[15]The Afrobarometer is "an African-led series of national public attitude surveys on democracy and governance in Africa" (www.afrobarometer.org).

[16]See Figure 2.

cross-fractionalization statistic is calculated as below:

$$CF = \sum_{x=1}^{n} p_x^2 + \sum_{y=1}^{n} p_y^2 - 2\sum_{x,y}^{n} p_{xy}^2 \tag{2}$$

"where p_x is the proportion of population at cleavage x, p_{xy} is the proportion of population at both x and y" (Gisselquist, 2015). Values of cross-cuttingness for ethnicity and geopolitical zone are low and stable at about 0.16 between 1990 and 2013 as shown in Figure 9. Values of cross-fractionalization for ethnicity and geopolitical zone are low, stable and near 0 at about .04 between 1990 and 2013 as shown in Figure 9. Ethnicity and geopolitical zones are almost perfect proxies for one another in Nigeria and there is very little geopolitical zone–ethnicity cross-cuttingness in the country. Ethnicity–language cross-cuttingness and zone–language cross-cuttingness are similar, relatively low and stable between 2003 and 2013 at around 0.4, with low, near identical figures for ethnicity–language and zone–language cross-fractionalization at about 0.1 over the same time period. The results point to the fact that the GREG ethnicity, geopolitical zone and language from DHS are tightly linked metrics and close proxies for ethnic group identity in Nigeria, though there is a stronger link between GREG ethnicity and geopolitical zone than with language.

3 Data Construction and Empirical Framework

3.1 Data, Descriptive Statistics and Initial Visualization on Five Socioeconomic Variables from 1990 to 2013

The data on the socioeconomic variables used here come from the Demographic and Health Surveys (DHS) which provide "nationally representative household surveys"[17] collecting information on household members (individuals within households) across Nigeria for five year rounds: 1990, 2003, 2008, 2010 and 2013. The surveys also have the benefit of being geocoded, including GPS information called DHS "clusters" providing the location of surveyed households and household members within 2 to 10 km of the geocoded DHS cluster.[18] Cases examined are limited to respon-

[17] For more information on DHS data see: http://dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm

[18] Note, census data for Nigeria is not readily publicly available and has a patchy history. Four of the five censuses collected in Nigeria since 1962, have been withdrawn, discredited, or heavily questioned. The most recent available

dents 18 years of age and older. Summary statistics on number of individuals surveyed in each study year and by zone are provided in Figure 7 and Table 16.[19]

Trends in five broad socioeconomic variables are examined in this paper: wealth, years of education, power access, potable water access and improved sanitation access.[20] The wealth index is a constructed index by the DHS using a weighted measure of reported ownership of assets by households.[21] The final wealth index varies from 1 to 5 where 1 = "*poorest*", and below wealth median households, 2 = "*poorer*", 3 = "*middle*" or median wealth households, 4 = "*richer*" and 5 = "*richest*" or the top percentile by wealth in the country. The years of education variable denotes how many years of education completed.[22] Next, for the infrastructure variables, the power access variable is a binary for individual respondents who report that they or their household has access to electricity.[23] The improved sanitation access binary variable, is coded 1 for individuals reporting access to flush toilets or improved pit latrines.[24] The potable water access binary variable is similarly coded 1 for individuals reporting access to piped water or water from a borehole, tubewell or protected well and 0 otherwise[25]. Finally an aggregated measure for these variables was created at different spatial scales. To analyze general spatial inequality in access to these measures, variables were aggregated first at the level of the geocoded DHS cluster such that, for each cluster, the average proportion of individuals reporting wealth, years of education and infrastructure access was calculated. Similar mean statistics were calculated at the level of the geopolitical zone as well. Table 1 and Figures 10, 11, 12 and 13 provide variable means across the country for all years in

census seen as somewhat reliable was the 2006 census, with the last known census before then in 1991 (see Yin, 2007, for details). DHS data is used as the most complete georeferenced representative micro dataset available for the country. This study uses the "PR" dataset type from DHS which "records one record for every household member" (DHS website), with the unit of analysis being the individual household member.

[19]Note, only four of six zones were surveyed in 1990 (Northcentral and Southsouth had no surveyed respondents in 1990), but respondents from all six zones were surveyed from 2003 to 2013.

[20]By access, the variable refers to availability reported by the respondent here. See main text. Wealth, power access, potable water access and sanitation access are reported by individuals at the household level.

[21]The construction of the index is done using principal components analysis (PCA) and reported asset ownership in the DHS surveys: see DHS website for details.

[22]The Nigerian system has six years of primary school followed by six years of secondary school and typically two or more years of tertiary education depending on the individual.

[23]Where electricity is primarily grid-based as reported by Afrobarometer respondents.

[24]Pit latrines with slabs or ventilated improved pit latrines.

[25]Data for the infrastructure access variables is only available for individual household members from 2003 to 2013 and not available in the 1990 DHS data.

the study, along with means disaggregated by zone.

There has been a generally positive trend nationally across most sanitation and water access variables since 2003, as shown in Figure 10. Disaggregating infrastructure variables in Figure 10 shows that improvements in sanitation access have been almost entirely driven by improvements in access to improved pit latrines since 2003.[26] Power access has seen only slight changes since 2003, with most of the gains accruing to the Southwest zone, as shown in Figure 13. Mean years of education has risen significantly from about three years in 1990 to over six years[27] in 2013. Most of the improvement in years of education is driven by improvements in the Southern and Northcentral zones with the trend remaining relatively flat for years of education since 2000 for the Northeast and Northwest zones as shown in Figure 10. Additionally, while there have been marked improvements in access to education for both males and females[28] as shown in Figure 11, gains are uneven across geopolitical zones as shown in Figure 12. The widest gender gap in education persists in the Northwest zone and there have been remarkable gains towards closing the gender gap in educational attainment in the Southeast zone as shown in Figure 12.

In contrast, wealth has remained somewhat flat from 1990 to 2013, with slight dips between 2003 and 2008 and again between 2010 and 2013, remaining around a score of '3' or 'middle wealth' nationally. Mean wealth disaggregated by zone, shows a divergent trend between the Northeast and Northwest zones versus the rest of the country, with the former two zones experiencing a downward trend in wealth since 1990 as shown in Figure 13.

Pairwise correlations between variables are shown in Figure 14.[29] An interesting result here is that while the correlation between wealth and the infrastructure variables has been decreasing over time, the relationship between education and wealth has increased since 1990 in a notable divergence from the overall trend. Power access and years of education have maintained the highest significant correlations with wealth in the five-year period, registering correlations of .676 and .617 respectively

[26] Note, interpret improved sanitation access for 1990 with caution. The 'pit latrine with slab' option was not available as a response in 1990 whereas it was in 2003 to 2013 so the sharp gains in improved sanitation between 1990 and 2003 might be an artifact of the method in which the category is constructed.

[27] Primary school completion.

[28] As measured by years of education completed.

[29] All correlations were significant at $p < .001$.

with wealth as of 2013.

3.2 Assessing Patterns of Spatial Inequality

To test for the existence of persistent ethnic group-based inequality of access to public services, first I assess and test for the existence of local patterns of spatial inequality. Following Archibong et al. (2015), a Global Moran's I can be constructed to assess overall pattens of spatial association in the aggregated socioeconomic metrics by DHS cluster. The Getis-Ord Gi*(d) statistic for local spatial autocorrelation is useful in identifying less 'parametric' patterns of spatial inequality in the country. The equation for the Global Moran's I statistic is as follows:

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2} \tag{3}$$

with: x_i = socioeconomic access rates at location i, $\bar{x}$ = global mean for variable x in the sample, w_{ij} = binary contiguity weight matrix which equals 1 if locations i and j are neighbors and 0 otherwise and n = number of observations, DHS clusters for each study year–see Table 1 for number of DHS clusters in each year.

The results are presented in Table 2 and Figure 15. The $k = 8$ nearest neighbors weight matrix used for the rest of the study is based on our knowledge of the study area and allows every entity to have an adjacent neighbor. To assess the significance of the observed I statistic, the I statistic is compared to the expected value of I in the absence of spatial autocorrelation, $E(I) = -1/(n-1)$ which tends to 0 as n gets larger; a larger I (i.e. $I > E(I)$) reflects positive spatial autocorrelation (spatial cluster) and a smaller I ($I < E(I)$) reflects negative spatial autocorrelation (spatial dissimilarity) (Yu and Wei, 2008). Significance of the global Moran's I statistic is assessed by a test of a null hypothesis of spatial randomness, whose rejection indicates a spatial pattern to the data. Significance is then tested by comparison to a reference distribution.[30]

Local spatial association is analyzed using the Getis-Ord Gi*(d) statistic which is a distance-

[30]See Archibong et al. (2015); Anselin (1995); Yu and Wei (2008) for further discussion. The Global Moran's I is akin to a spatial Pearson's r with values varying from -1 to 1 and values closer to 1 reflecting more positive spatial autocorrelation.

based metric that measures the proportion of a variable located within a specific radius of a point, respective to the total sum of the variable in the study region (Archibong et al., 2015; Páez and Scott, 2005). In other words, it measures "the overall concentration of all pairs x_i, x_j such that i and j are within d of each other" (Getis and Ord, 1992) as depicted in Equation 4 below (all variables defined as in Equation 3):

$$G_i^*(d) = \frac{\sum_{j=1}^{n} w_{ij}(d)x_j}{\sum_{j=1}^{n} x_j} \tag{4}$$

Gi*(d) values are expressed as standard normal variates Z[Gi*(d)]).[31] Significance is determined by an examination of these z scores, with large positive z scores and a $p < .05$ indicating clustering of high values and large negative z scores with a $p < .05$ indicating clustering of low values within distance d. Clustering of high (positive) values are regarded as High clusters or "hotspots" and clusters of extreme values above the global mean and clustering of low (negative) values are viewed as Low clusters or "coldspots" and specify clusters of extreme values below the global mean.[32] Results from the spatial patterns analysis over 1990 to 2013 are discussed in Section 4.1.

3.3 Statistical Measures of Horizontal and Vertical Inequality

Five measures of horizontal inequality are examined here to quantify the extent of persistent ethnic group-based inequality of access to public services. The three main measures of horizontal inequality used in this paper are adapted from Stewart et al. (2005) and are defined as follows:

- Group-weighted coefficient of variation (GCov): based on the well-known coefficient of variation which gives a distribution's standard deviation divided by its mean, weighted by the

[31] Under the null hypothesis of spatial randomness, Z[Gi*(d)] are asymptotically normally distributed, $N(0,1)$ as $n->\infty$. (Getis and Ord, 1992).

[32] Note there are two uses of the term "clusters" here. The first refers to the DHS GPS clusters of households or points on the map mentioned earlier. The second refers to the close in proximity and significantly above the global and their neighborhood mean status of these DHS GPS points or 'clusters'. P values from the Gi*(d) statistic are also adjusted for multiple testing using the Benjamini-Hochberg (BH) procedure: see Archibong et al. (2015) for further discussion.

population size of each group

$$GCov = \frac{1}{\bar{y}}(\sum_{r}^{R} p_r((\bar{y_r} - \bar{y})^2)^{\frac{1}{2}} \tag{5}$$

- Group-weighted Gini coefficient (GGini): based on the Gini coefficient and provides the sums of the pairwise differences in the socioeconomic variables between groups

$$GGini = \frac{1}{2\bar{y}} \sum_{r}^{R} \sum_{s}^{S} p_r p_s |\bar{y_r} - \bar{y_s}| \tag{6}$$

- Group-weighted Theil (GTheil): which compares each group with the mean for the socioeconomic variable in question

$$GTheil = \sum_{r}^{R} p_r \frac{\bar{y_r}}{\bar{y}} log \frac{\bar{y_r}}{\bar{y}} \tag{7}$$

where $\bar{y_r}$ is group r's mean value; R is group r's population size and p_r is group r's population share.

Horizontal inequality indices are calculated by various group types including by geopolitical zone, GREG ethnicity, language and gender, and results are presented in Section 4. To contrast these group-level indices with individual measures of inequality or vertical inequality, the Gini coefficient and Theil are also calculated for all five years across the five broad socioeconomic variables mentioned in Section 3.1 with results presented in Section 4.

4 Results

4.1 Patterns in Spatial Inequality (Global and Local Spatial Association) of Socioeconomic Variables

Global Moran's I results in Table 2 and Figure 15 reveal positive spatial association across all socioeconomic variables and all years in the study. Similar households with similar values on wealth, years of education and infrastructure access cluster together spatially. The main result here for global spatial association, is the presence of a high degree of clustering of similar households,

particularly for variables like wealth and education where the Global Moran's I statistic averaged around .5 and .6 respectively, marking significant positive spatial autocorrelation over the 1990 to 2013 period. Global Moran's I values for the infrastructure variables are positive but comparatively lower over the same period. An implication of this result is that while similarly performing groups on all indicators tend to live in the same neighborhoods, a fact which is unsurprising, for wealth and education in particular there are significant spatial disparities, with most populations living in pockets of high or low wealth and education regions in the country. This implication is confirmed with an examination of the local spatial association statistic, the Getis Gi* statistic, with maps in Figures 16, 17, 18, 19, 20 and 21 showing significant spatial clustering along all five measures and all five survey round years. The general trend appears to be largely low (significant below the global mean and surrounded by neighbors who are similarly below the global mean) clusters in the Northern zones and high (significant above the global mean and surrounded by neighbors who are similarly above the global mean) clusters in the Southern zones for education and wealth and power access (Figures 17, 18, 19) over the 1990 to 2013 period with the exceptions of a consistent high cluster (in red) in Kano state in the Northwest zone for wealth and a growing cluster of red in Abuja, the Federal Capital Territory located in the Northcentral zone for education in 2008 and 2013.

The picture is not quite so Low-North, High-South for the sanitation and water access variables. For sanitation, there is a more heterogeneous spattering of Low and High clusters in the Northwest zone in particular for almost all years of available data for improved sanitation access from 2008 to 2013. And in 2013, there appears to be something of a reversal for the Northeast zone for sanitation access, with significant clustering of high values for sanitation access in the Northeast zone particularly in Yobe and Gombe states. The picture is similar though not as dramatic for potable water access, with states in the Northwest zone[33] revealing high clusters of water access for 2008 and 2013 (Figure 21). On the high cluster side, the Southern zones perform remarkably well on most indicators, with the Southwest zone dominating its peers for the highest proportion of its zone in high clusters for wealth, education (though it is matched and sometimes overtaken in

[33]States beyond just Kano.

this regard by the Southsouth zone with the Southeast zone coming a not so distant second) and power access. In contrast, the Northeast zone almost consistently lags behind as the zone with the highest proportion of its zone dominated by low clusters on every socioeconomic variable except, very interestingly, education where the Northwest zone dominates the low cluster at the bottom of the pack, mirroring the results in mean years of education over 1990 to 2013.

4.2 Trends in Group-based Horizontal Inequality Indices and Vertical Inequality Indices

The results from the calculation of the indices measuring horizontal inequality show quite similar trends across zone, the GREG based ethnicities, and language in Nigeria. For horizontal inequality, given the similarity in the overall patterns of the group-based indices, GCov, GGini and GTheil, the results from mainly the GGini and alternatively the GCov will be interpreted here. For wealth, the Gini index shows a flat trend hovering around .25 nationally between 1990 and 2013 as shown in Figure 8. Disaggregating the Gini index by zone in Figure 8 shows that while there have been notable decreases in wealth inequality in the Southern and Northcentral zones between 1990 and 2013[34] so that average Gini hovered around .15 in 2013 in these areas (down from over .25 in the Southeast as of 1990), the trend has remained largely stagnant with relatively higher wealth inequality in the Northeast and Northwest zones. The group GGini for wealth has remained largely flat since 1990 at around .13, following a slight dip between 1990 and 2003 . Trends in the GCov show a dip in group wealth inequality from 1990 to 2003, followed by an increase between 2003 and 2008 and subsequent flattening out post-2008. Measuring trends in ethnic group inequality by the GREG Ethnicity in Figure 8 leaves overall patterns unchanged with the GGini largely flat, since 2008 and hovering between .13 and .14. Results are similar when horizontal inequality is measured using language reported by survey participants as shown in Figure 8, with the GGini still low and around .1 on average, but increasing slightly between 2003 and 2013. Wealth, it seems, is a sticky category at best in Nigeria, with very little inter-ethnic group variation in mean wealth over the 1990 to 2013 period of study.

[34]Barring a sharp increase in the Southwest zone between 1990 and 2003.

For infrastructure, there are three broad categories as discussed in Section 3.1: access to electricity, access to improved sanitation[35] and access to potable water.[36] Federally administered infrastructure services include access to electricity from the grid[37] and flush toilets access. Locally administered services include access to improved pit latrines and water access. As mentioned in the Introduction, these federal-local classifications of resources are as a result of policy choices by past and present federal governments not infrastructure capability. As mentioned in Section 3 and shown in Figure 23, changes in the sanitation category have been largely driven by changes in access to improved pit latrines in the country. Trends in vertical inequality or the Gini index across all zones show notable decreases in inequality in access to sanitation and water between 2003 to 2013 years of available data as shown in Figure 24 and Figure 25. Examining the horizontal inequality indices by geopolitical zone in Figure 24 and Figure 25 shows a downward trend in the sanitation and water indices for the GCov and GGini between 2003 and 2013. The GGini by zone for sanitation decreased from about .3 in 1990 to .08 in 2013. For water access, inequality across zones as measured by the GGini fell from .16 in 1990 to about .05 in 2013. Similar declines in inequality by GREG ethnicity and DHS language for sanitation and water are shown in Figure 24 and Figure 25. In contrast, the GGini by zone for power access has remained largely flat at around .2, following a slight increase from 2003 to 2008 as shown in Figure 26. Similar trends are found for GGini by GREG ethnicity for power access as shown in Figure 26, with inequality in access to power by language group type registering a slight increase between 2003 and 2013. While ethnic group-based inequality in access to locally administered services like water and certain sanitation (almost entirely improved pit latrine access) has seen notable declines since 1990, group-based inequality in access to federally administered services like grid-based electricity has been sticky, with little reduction in intergroup inequality of access.

Finally, for access to education, as measured by years of education completed, some interesting patterns emerge by ethnic group/zone and by gender overall, and within each ethnic group/zone

[35] Which is a combination of access to flush toilets and access to improved pit latrines.

[36] Which is a combination of access to piped water and access to tubewell or protected borewell water.

[37] We assume that much of the reported availability is access to grid-based electricity given government reports on access (http://thenationonlineng.net/97m-nigerians-dont-access-grid-electricity/) and reports on grid availability from Afrobarometer residents since DHS does not disaggregate electricity access into grid vs off grid sources.

as well. Overall national inequality in access to education has declined slightly since 1990 from a Gini index of .64 in 1990 to a Gini index of .49 in 2013 as shown in Figure 27. Disaggregated by zone, vertical inequality in access to education by zone shows high (between .7 and .8) and largely flat[38] inequality in the Northeast and Northwest zones between 1990 and 2013 as shown in Figure 27. Inequality in access to education is lower and decreasing in the Southern zones with the Southsouth zone registering the lowest levels of education inequality with a Gini index of about .3 in 2013. The trend for horizontal inequality in access to education by zone looks largely flat[39] with a GGini index hovering around .2 over the 1990 to 2013 period of study. An examination of the gender gap in education nationally shows a notable decrease (about 38%) in the GGini by gender for education between 1990 and 2013 from .13 in 1990 to about .08 in 2013 as shown in Figure 28. The gender gap in each zone looks notably different with largely flat GGini and GCov indices (hovering around .2 and .6 respectively) by gender in the Northwest zones, following first a decrease then an increase in the GGini by gender between 1990-2008 as shown in Figure 29. In contrast, there have been decreases in the gender gap in all other zones as measured by the GGini and GCov with the most notable declines in the Northeast zone where the GGini index by gender declined from almost .3 in 1990 to around .13 in 2013 (a decrease of about 57%). Access to education has been improving nationally, but gains are uneven by ethnic group/zone and by gender within each ethnic group/zone. Overall inequality has remained high and flat in the Northeast and Northwest zones, while inequality in access to education has been declining in other areas in the country. The gender gap has decreased notably nationally, but most of the decrease is driven by declines in zones other than the Northwest where the gap remains comparatively high and sticky over the 1990 to 2013 period of study. Intergroup inequality in access to education has also remained relatively static and sticky over the period of study. In the next section, I explore various mechanisms to explain these trends and present the conceptual framework concerning the historical origins of the persistent inequality mentioned in the Introduction.

[38] Following a decrease between 1990 and 2003.

[39] Following a slight decrease between 1990 and 2003.

5 Discussion and Evaluation of Alternative Hypotheses

5.1 Origins of Persistent Horizontal Inequality

The literature on the origins of persistent ethnic group-based inequality provides two broad mechanisms to explain the patterns of persistence shown in the data. First, there is the differential geographical endowments argument, which argues that differences in geographical endowments and environmental conditions can cause ethnic inequalities to form and persist over time (Alesina et al., 2016; Michalopoulos, 2012; Sachs and Malaney, 2002). The second argument is the historical institutions thesis, that differences in historical legal traditions (Porta et al., 2007), conditions that European settlers faced at time of colonization as measured by settler mortality (Acemoglu, 2001) or precolonial political centralization (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013; Osafo-Kwaako and Robinson, 2013; Archibong, 2016) could have led to differential outcomes among groups today. I test these mechanisms here. Following results from Archibong (2016), I find that historical institutions, as measured by precolonial centralization, best predicts access to federally administered services over the 1990 to 2013 period of available data. In contrast, local government quality appears to be strongly associated with better access to and improvements in locally administered services. A brief conceptual framework and historical background is presented in Sections 5.2 and 5.3 respectively, with data and results discussed in Section 5.4 and Section 5.5.

5.2 Testing Mechanisms: Precolonial Ethnic Centralization and the Role of Federal Regimes in Persistent Inequality of Federally Administered Infrastructure Services

Recent studies on the origins of African economic development have documented a positive relationship between historical institutions, particularly political centralization in the precolonial era and modern development outcomes (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013; Nunn and Wantchekon, 2011; Bandyopadhyay and Green, 2016; Alsan, 2015; Archibong, 2016). Precolonial centralization is defined here as a measure of ethnic state sovereignty, where a simple measure is an indicator for the presence of a state sovereign around 1850. The original

measure is from anthropologist George Murdock's *Ethnographic Atlas* and is a measure of "Jurisdictional Hierarchy Beyond the Local Community Level" with details presented in Section 5.4 below. Though there is some debate about the dates the variable was collected, with much of the sample collected in the 20th century, Murdock explicitly used methods to attempt to capture political complexity before European colonialism, which is specified as c. 1850 here (Michalopoulos and Papaioannou, 2013). For Nigeria, this means having an ethnic state centralization score greater than 0[40] as identified in the Murdock *Ethnographic Atlas* in Figure 2c. There is a correlation of about .7 between ethnicities identified on the Murdock map and locations of ethnicities as identified through the 2008 and 2012 Afrobarometer surveys. The literature so far has shown a positive relationship between precolonial centralization and development outcomes. However, given that many areas in present-day Northeast and Northwest Nigeria, including the current states of Bauchi, Borno, Gombe, Kebbi and Kaduna, to name a few, shown in Figure 2, were part of centralized ethnic states in the precolonial era and have some of the poorest development outcomes today, as discussed in the preceding sections, what could explain this divergence or "reversal of fortunes"? One answer comes from understanding the mechanism through which precolonial centralization affects development outcomes of ethnic states today. In Archibong (2016), results reveal a heterogeneous effect of this precolonial ethnic state centralization showing a nonlinear relationship between precolonial state centralization and current public service provision using evidence from Nigeria. That paper and this paper both provide evidence, supported by the historical literature, that the relationships of compliance/reward and non-compliance/punishment between federal autocratic regimes (in the guise of first the colonial regime and next the military regime), and centralized ethnic state leaders drove public service provision outcomes documented in that paper and previous research. Where compliance was the equilibrium outcome in the bilateral bargaining "game" between centralized precolonial ethnic state leaders and autocratic federal leaders, then public services were provided. When compliance failed between parties, then ethnic state leaders were punished through underinvestment in goods and services whose allocation autocratic federal governments could control. Where this argument relates to the results presented in this paper, is

[40] Denoting non-"stateless" societies.

that it lends support to the thesis that persistent inequalities in access to these federally administered services are a result of federal policy of underinvestment in these services. Hence you see a kind of "reversal of fortunes" for certain areas like the Northeast zone,[41] which boasted highly centralized ethnic states in 1850, but today has low, sticky outcomes for access to the aforementioned federally administered variables. In contrast, these areas register huge gains for the reduction in inequality of access and improvement in overall mean access to more locally administered services like sanitation and water.

A framework of increasing returns to investment coupled with high costs of initial investment and geographic economies of scale might explain nonconvexities in access to these federally administered infrastructure services where historically underinvested-in areas experience low, sticky outcomes for access today. In contrast, for locally administered services where costs of initial investment are low and geographic economies of scale are marginal or negligible, local government quality is a strong predictor of access, and marginal improvements in local government quality can result in significant gains in access to these services. Section 5.3 below presents a brief historical background on the meaning and identification of compliance/non-compliance for centralized ethnic states.[42]

5.3 Brief Historical Background: Precolonial Ethnic Centralization, Compliance and Non-compliance

Being a centralized ethnic state in 1850 is likely linked to development outcomes inasmuch as it allowed centralized ethnic states to "bargain" with federal regimes for access to federally controlled services through the system of indirect rule. In Nigeria, these federal regimes took on the identity of the British colonial autocrats from 1885 to 1960 in the first period and military postcolonial autocrats[43] from 1966 to 1999 in the second period. If the ethnic state was centralized in the precolonial era, there was at least one identifiable state sovereign as shown in Figure 2c (Falola and Ogundiran, 2005; Murdock, 1967). The British colonial autocrat was then able to bargain with the sovereign,

[41] Which was home to the Bornu empire.
[42] First presented in Archibong (2016).
[43] After the independence of Nigeria in 1960.

with the ethnic state leader becoming an official representative of "local government" known as a "Native Authority" under indirect rule (Mamdani, 1996). Note, though the term "bargaining" is used here, the power relationship between the British and local leaders was particularly asymmetrical during this period as several authors have noted (Mamdani, 1996). Costs of expropriation through direct force were high enough that bargaining with local leaders through the indirect rule system was often a dominant strategy for British colonial autocrats (Falola and Ogundiran, 2005). Note, the "bargaining" was also often accompanied by the threat of violence to non-compliant local leaders so that while there were many who resisted colonial occupation, the costs of rebellion were often exile and death for rebellious leaders. So, this is a sort of forced compliance or compliance achieved largely through coercion, particularly in the early part of the colonial period (Mamdani, 1996). In this bargaining game, the British colonial autocrat would move first by setting a fiscal policy instrument which was a fiscal transfer or a "rate of extraction" that defined the proportion of the initial wealth of the ethnic state (measured in amounts of agricultural commodities produced–most notably cash crops like cocoa, groundnuts and palm kernel) that was expropriated by the British colonial regime (Nunn, 2007; Gardner, 2012; Salami, 2011; Frankema, 2011).[44] The centralized ethnic state leader could then "choose"[45] to comply and allow the fiscal transfer, or not comply with the British colonial autocrat. When the centralized ethnic state leaders were compliant with British colonial autocrats, they were rewarded with some proportion of federal benefits (e.g. in terms of public service provision like railroad construction)[46] (Gardner, 2012; Ayoola, 2006) and increased political autonomy in their region (Ogbomo, 2005; Otoide, 2005). When the centralized ethnic state leaders were not compliant with the British colonial autocrats, they were punished by a withdrawal of these benefits (e.g. forfeited autonomy through bloody depositions and exile (Ogbomo, 2005; Otoide, 2005)). Over the long run, compliance with the British colonial regime was the equilibrium outcome, on average, since costs of non-compliance often outweighed

[44]Note, while the main source of revenue for the British empire in West Africa was through custom duties, direct taxes played an important role in replenishing the Native Treasury which was managed by the Native Authorities. The role of direct taxes in revenue was even more significant in Northern Nigeria which had less access to the coast for trade than Southern Nigeria, though it featured prominently in both under the direction of the colonial official Sir Frederick Lugard (Bush and Maltby, 2004). See Appendix for details.

[45]Again under the threat of force, particularly in the early days of the colonial period.

[46]The Bornu extension of the railway, first planned in the 1950s, despite its non-viability and lack of finance, is a prime example of the politics involved in colonial public works projects (see Ayoola, 2006 for details).

any expected benefits of non-compliance as noted previously (Ogbomo, 2005; Otoide, 2005; Falola and Ogundiran, 2005).

The second period in the historiography, marks the beginning of the game between military postcolonial autocrats and ethnic state leaders spanning years 1966 to 1999.[47] Differential British policy between the centralized areas of the Muslim North versus the South of Nigeria led to strengthening of hegemony among centralized ethnic state leaders in the Muslim North of the country, a process termed hegemonization here (Berger, 2009; Mustapha, 2006; Tonwe and Osemwota, 2013). An existing sophisticated local tax bureaucracy in the largely Muslim North under the Islamic empire known as the Sokoto Caliphate made it an attractive prospect for the imposition of direct taxation using the existing local elites as Native Authorities under colonial official Sir Frederick Lugard's indirect rule system. Eager to consolidate support of the ruling elite 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'" (Mustapha, 2006; Dudley, 2013). This doctrine was crystallized in the Native Authority Proclamation of 1907 whereby the Emir became the sole Native Authority within their jurisdictions in a hyper-concentration of political authority in the hands of these figures.[48] What this meant practically was that support for and, in many cases, entry of missionaries and accompanying missionary education was highly restricted in the very Muslim North of Nigeria. This was not the case in Southern Nigeria, where a diverse array of ethnoreligious groups and a looser tax structure,[49] made the area more fertile ground for missionary education. The rise of a new educated elite in the South, demanding accompanying political rights along with their new, often-times elevated status,[50] more quickly led to the erosion of the political authority of local

[47] There is a very brief democratic period between 1960 and 1966, followed by a civil war and another very brief period of elections between 1979 and 1983, but the subsequent 30 years of post-colonial rule were characterized by autocratic military rule

[48] 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 checks on the power of the Emir (Mustapha, 2006; Dudley, 2013)

[49] Taxes were often in the form of tributes between local elites rather than direct taxes on subjects as in the North (Bush and Maltby, 2004).

[50] The new educated elites and the old traditional leaders/elites were often disjoint sets since distrust of British education meant that the traditional elites would often, initially, refuse to send their own children to the schools lest they be "corrupted" by the British colonials and would send their servants instead (Ayandele, 1966).

traditional leaders or Native Authorities in the South, with Native Authorities replaced by democratically elected local officials as authorities of local government. This marked a significant break in the political systems of particularly the highly Muslim parts of the North and the South during the colonial era, with the centralized areas of the highly Muslim North becoming hegemonized and Native Authorities playing even more prominent roles in local government. By contrast, the centralized states of the South became increasingly non-hegemonized with Native Authorities there replaced by democratically elected local officials by the end of the colonial period.

The eviction of the British in 1960, after the discovery of oil in 1956, preceded a brief democratic period between 1960 and 1966, followed by military rule for almost all of the next three decades and a civil war from 1967 to 1970, partly over the control of oil resources in the country that highlighted tensions between federal and subnational governing authorities.[51] Following an oil boom and huge windfalls for the military regime in the 1970s that shifted the composition of federal revenue to over 80% from oil, the military regime sought to resolve this tension in their favor by setting out a legal policy instrument, in the form of the 1976 Local Government Reform Law, that authorized the legal transfer of political autonomy from ethnic state leaders to the federal military government. The 1976 law removed ethnic state leaders from their posts as official representatives of local government, and banned them from participation in democratically elected local governments propped up by the military party system. It relegated them to advisory roles only. It also allowed for an official grant for the new local government leaders as a proportion of mostly oil-fueled federal revenue (Blench et al., 2006; Hickey, 1984; Mustapha, 2006; Tonwe and Osemwota, 2013). The 1970s also marked a period of substantial investment in infrastructure, with notable investments in grid expansion and sanitation like access to flush toilets by the military government (Uduku, 1994).

Under the legal policy regime, the hegemonized ethnic state leader (who was also centralized in the precolonial era, by definition), could choose to "comply" and step down from their official post without inciting rebellion among their constituents or "not comply" and refuse to step down, typified

[51] The case of a mostly Igbo-led secession in the state of Biafra is well studied in the historical literature and beyond the scope of this paper.

by refusal to abstain from local governance politics, withholding tax revenue and, notably from the historiography, inciting rebellion among their constituents. The slew of uprisings afterwards, peaking in the 1980s with the Maitatsine riots, were a prime example of these rebellions stemming from federal–local tensions in many areas, including the present-day states of Kano, Borno and Kaduna[52] (Hickey, 1984; Tonwe and Osemwota, 2013). If the hegemonized ethnic state leader chose to comply, their expected payoff was the public service provision issued from the military autocrat minus the political autonomy given up, along with the proportion of initial wealth and government revenue given up by the ethnic state leader with the relinquishing of their position as an official local government representative. If the hegemonized leader chose non-compliance, then they received an expected payoff equivalent to the withheld political transfer and initial wealth minus the withheld public services (or plus the punishment) from the federal military regime. As shown in the historiography and revealed in the results, non-compliance with the military postcolonial autocrats was the equilibrium outcome and the dominant strategy of hegemonized ethnic state leaders and punishment in the form of underinvestment in public services was particularly pronounced in areas with little cleavage (by ethnic/state origin) to the military president (Blench et al., 2006; Hickey, 1984; Mustapha, 2006; Osaghae, 2006; Tonwe and Osemwota, 2013).

In summary, leaders of non-hegemonized ethnic states that were centralized in the precolonial period chose compliance with federal autocratic regimes in both periods, explaining the positive relationship with federally administered public services that precolonial centralization has in some regions today. In contrast, leaders of hegemonized ethnic states that were centralized in the precolonial period chose first compliance, then non-compliance with the federal autocratic regime, incurring a punishment in the second period, which explains the negative relationship with the federally administered services viewed in the empirical results. This mechanism might partly explain the heterogeneity in the effects of precolonial centralization shown in the empirical results and illustrates a way in which historical institutions might affect unequal access to current public services within countries. A simple model is presented in the Appendix.

[52]See Appendix for details.

5.4 Testing Mechanisms: Data from Precolonial Ethnic Centralization and DHS

Data on precolonial ethnic state centralization comes from 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. There is a significant correlation (about .7) between location of Nigerian respondents to the Afrobarometer in 2012 and 2008 and ethnic group location as identified in the Murdock map in Figure 2c.[53] One thousand four hundred and fifteen new LGA-ethnic state partitions are created by intersecting the location of Nigeria's 774 LGAs with Murdock's ethnic state partitions. Precolonial centralization data and dependent variable access data from DHS is available for 61 of the 117 ethnic states within Nigeria or 685 LGA-ethnic states. The main measure of precolonial centralization used here is an indicator that assigns a score of 0 to "0" coded societies (specified as non-centralized) in the Murdock map and 1 (specified as centralized) to any ethnic states with scores above 0 and captures any degree of centralization in the sample.[54] For the measure of pre-independence centralization and hence non-compliance with the 1976 military policy as outlined in Section 5.3, following the historiography, the percentage of the Muslim population in each administrative state as of 1952 (Ostien, 2012) is used to create a supermajority Muslim indicator where states are assigned a score of 1 (so that a state is hegemonized if it is both centralized and supermajority Muslim) if they have a population of greater than 70% in the upper quartile of the percentage Muslim distribution and 0 otherwise as shown in Figure 6.[55]

Dependent variables include disaggregated infrastructure, wealth and education access variables averaged over 1990-2013, to capture investments made over the postcolonial period. Averages

[53]Nunn and Wantchekon (2011) confirm a significant correlation (about .55) between location of respondents to the Afrobarometer in 2005 and ethnic group location as identified in the Murdock map in the Africa-wide sample.

[54]Some results are robust to alternate specifications of the centralization index, including using the full index. This specification of the indicator is in contrast with the one used in some of the previous literature as it seems to more appropriately capture the importance of having any identifiable sovereign for the purpose of the indirect rule compliance/non-compliance relationships described in Section 5.3.

[55]The choice of a 70% cutoff is not arbitrary. First, in the multilevel model shown in the robustness checks, when the coefficient on centralization is allowed to vary by administrative state, a notable portion of states where the coefficient turns negative are states resting in the greater than 70% Muslim cutoff, though the results from the model are interpreted with caution due to low power. Second, centralized states in the upper quartile of the percentage Muslim distribution are most likely to fit the description of the hegemonized states through the process described in Section 5.3 and this is confirmed in the historiographic literature (see Appendix for more details).

of DHS clusters in each LGA-ethnic polygon are used to provide unique values for each LGA-ethnic area. To test for the effects of punishment, following the literature on political repression and trust (Booth and Richard, 2000), a "Trust in Police over Traditional Leaders" variable (historic ethnic state leaders are called traditional leaders today) is created. The measure is based on the 2012 Afrobarometer survey[56] 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?"[57] The measure is the 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 in the survey. Also, directly reported trust in local governing councils and trust in police and army variables are constructed, with the hypothesis that residents from punished areas should have less trust in federal institutions (police/army) over their traditional ethnic state leaders.

To test hypotheses concerning the role of differential geographical endowments, extensive geographical[58] and disease controls[59] are included in the OLS specification. To test hypotheses concerning the role of other institutions like slavery, transatlantic slave exports between 1400 and 1900 are included as a control on the model. To test hypotheses concerning the role of the Nigerian civil war, the Southeast region, where most of the casualties were concentrated, is dropped in alternate specifications with results unchanged. To test hypotheses concerning the role of federal ethnic favoritism, military president state of origin (as shown in Figure 6) is included as an interaction in alternative specifications of the model.[60] To test hypotheses concerning the role of local government quality in predicting access to locally administered services but not federally administered services, various local government quality metrics, including trust in local governing councils from the 2012 Afrobarometer, and respondents' reports on how well their local government does in maintaining

[56] Round 5 of the survey.

[57] Q12.

[58] Including population density in 2006 and 1990, land suitability for agriculture, mean elevation, ruggedness of terrain, distance to rivers and seacoast, availability of petrol, distance to the capital and a Lagos dummy/Lagos dropped in alternate specifications with results unchanged.

[59] Malaria and tsetse fly suitability.

[60] Results seem to point to the fact that not having a military president come from your area while being a centralized, hegemonized (and non-compliant) ethnic state means worse punishment/underinvestment in your area relative to your military president having counterparts. Though results are unstable here.

local services like road quality, health codes, local marketplaces and keeping communities clean are analyzed as well. Summary statistics are shown in Table 3, Table 4 and Table 5.

5.5 Testing Mechanisms: Results from Precolonial Centralization, Trust and Local Government Quality

Results from Table 6 show that being a centralized ethnic state is strongly associated with a 9% average increase in access to mostly grid-based electricity between 1990 and 2013. Being a centralized, non-hegemonized or compliant with the military (non-supermajority Muslim) ethnic state is associated with a 14% increase in access to mostly grid-based electricity, while being a centralized, hegemonized or non-compliant with the military (supermajority Muslim) ethnic state is associated with a 6% decrease in access to mostly grid-based electricity as seen in column (2). A similar picture emerges for flush toilets access, where being a centralized, non-hegemonized, compliant with the military (non-supermajority Muslim) ethnic state is associated with about a 6% increase in flush toilets access, while being a centralized, hegemonized, non-compliant with the military (supermajority Muslim) ethnic state washes out the positive effect of precolonial centralization as shown in column (4) of Table 6. The coefficient on "supermajority Muslim" is insignificant, lending support to the fact that the effect of precolonial centralization is independent of being a Muslim state. To further test that this precolonial centralization effect is not driven by being a Muslim state, I test the non-Muslim split sample and find the effect of precolonial centralization is significant in the split sample.[61]

Precolonial centralization has no effect on locally administered services, improved pit latrines and water access, as shown in Table 7, in line with the hypothesis that precolonial centralization only matters inasmuch as it allows local ethnic leaders to bargain for access to federally administered and controlled services. There is also no relationship between precolonial centralization and wealth and education access, as shown in Table 8. Years of education appear to have a negative association with the Muslim indicator, in line with the historical literature on differential investments in education in the very Muslim North versus the rest of the country as a result of historic agreements between

[61] Tables available upon request.

British colonial autocrats and local ethnic leaders in very Muslim areas to restrict the spread of Christian missionary headed schools in the heavily Muslim north.[62]

As possible evidence of the effects of long-term punishment by the federal regime, residents from "punished" areas seem to report less trust in police over their own traditional leaders as shown in Table 9, though instability of the coefficient means results should be interpreted with caution.[63] Additionally, residents from "punished" areas report more trust in local governing councils, with no effects for trust in police and army as shown in Table 10.[64]

Examining results from the 2013 DHS survey and 2012 Afrobarometer surveys alone, shows that trust in local governing councils is significantly negatively associated with a decrease in access to federally administered services (power [grid] and flush toilet access) and positively associated with locally administered services (improved pit latrine access) as shown in Table 11. One possible interpretation of this result is that local government is substituting for federal government in areas with less historic federal investment. Similar negative associations between trust in local governing councils and wealth and education are also shown in Table 11. Measures of local governance quality also appear positively associated with locally administered services and negatively associated with federally administered services, education and wealth, as shown in Tables 12, 13 and 14.

These results, while correlations, are largely robust to extensive controls and might explain the persistent ethnic inequality in access to public services observed in Nigeria. Differential initial investments in federally administered services by historic federal regimes in ethnic states that were centralized in the precolonial era and compliant with the military government versus those that were centralized in the precolonial era and not compliant with the military might explain low, sticky outcomes for access to these services concentrated in the Northwest and Northeast zones/ethnic groups over the 1990 to 2013 period of study. In contrast, mobility in inter-ethnic inequality and improvement in access to locally administered services whose allocation federal regimes could not directly control, might be explained in the context of improved local government

[62] See Falola and Ogundiran (2005); Tonwe and Osemwota (2013); Ukiwo (2007) for details.

[63] Sample sizes are not enough for comparison in the full sample, so split sample observations $Cent = 1$ alone are evaluated here.

[64] Results should be interpreted with caution, since split sample observations alone are evaluated here.

quality, where the absence of federal investment in these areas is associated with greater dependence on and improvement in local government quality. A framework of increasing returns to investment coupled with high costs of initial investment and geographic economies of scale might explain nonconvexities in access to these federally administered infrastructure services where areas that were historically underinvested in experience low, sticky outcomes for access today. In contrast, for locally administered services, where costs of initial investment are low and geographic economies of scale are marginal or negligible, local government quality is a strong predictor of access and marginal improvements in local government quality can result in significant gains in access to these services.

6 Conclusion

Horizontal inequality by ethnic group in Nigeria has remained remarkably persistent for wealth, education and access to certain services in Nigeria. While significant gains in the reduction of inequality and improvement in access have been made for more locally administered services like certain sanitation and water access, outcomes are stickier and largely divergent for wealth, education and historically federally administered services like grid-based power access in the country. Notable is the increasing or stagnant inequality of access to these latter three measures in the Northwest and Northeast ethnic/geopolitical zones and a remarkable divergence for wealth outcomes for these two zones versus the rest of the country over the 1990 to 2013 period of study. While gains have been made in narrowing the gender gap in education nationwide, the distribution of gains has been uneven by ethnic group, with a widening of the gender gap in the Northwest zone between 2000 and 2013.

This paper explores different explanations for the patterns observed and puts forth the thesis that persistent inequality in access to education and federally administered services is in large part driven by historical heterogeneous federal government policy towards different groups in Nigeria. A framework of increasing returns to investment coupled with high costs of initial investment and geographic economies of scale might explain persistent inequalities in access to these services today. Better local government quality is positively associated with improved access to locally

administered services but not federally administered services. Further work on identifying the non-compliance mechanism should be done, including the creation of a dataset of the timing of riots in Nigeria to more precisely identify rebellion of local ethnic leaders. More work should also be done on understanding the drivers of improvement in local government quality and the links between perceived improvements in local government quality and access to locally administered services. The persistence of the gender gap in education in Northwest zone is also of interest and should be investigated in further research as well. Particularly given the documented links between ethnic inequality, economic development, stability of legal and political institutions and conflict, further work should be done on understanding the origins of these inequalities to understand how to frame and target appropriate policy to reduce these inequalities as well.

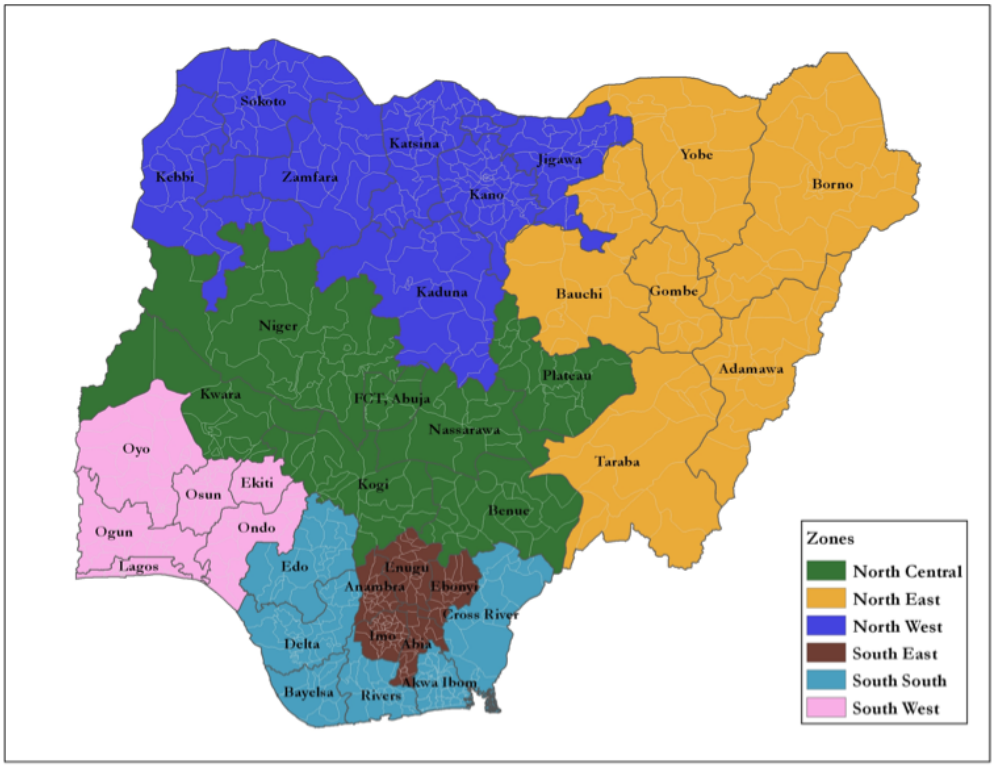

Figure 1: 6 Geopolitical zones in Nigeria with 36 states and Federal Capital Territory (FCT) labeled and 774 LGAs in faint outline. Source: Author's illustration based on DHS data.

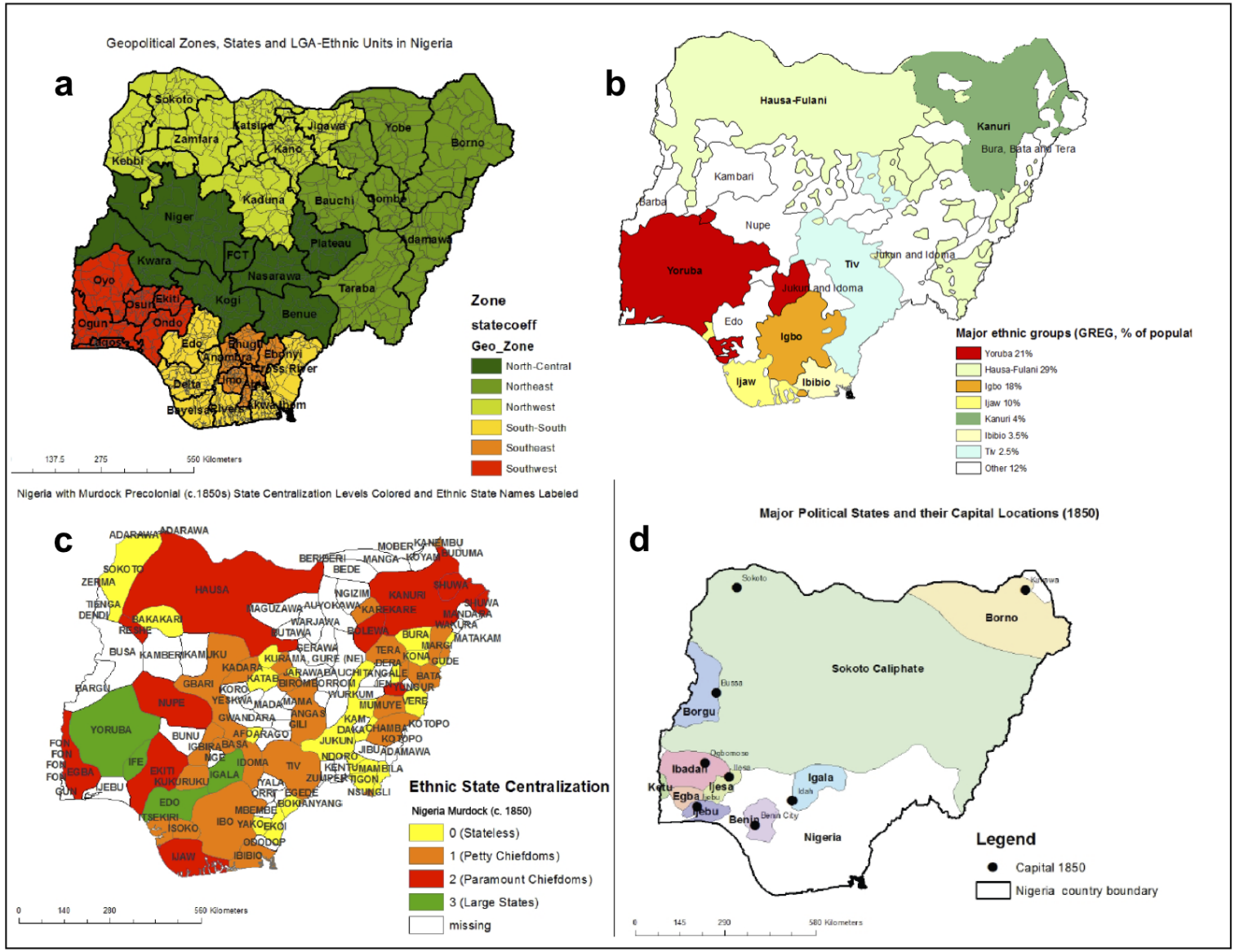

Figure 2: Nigeria: the actors 1850 to present. Source: Author's illustration based on DHS and Murdock (1967) data.

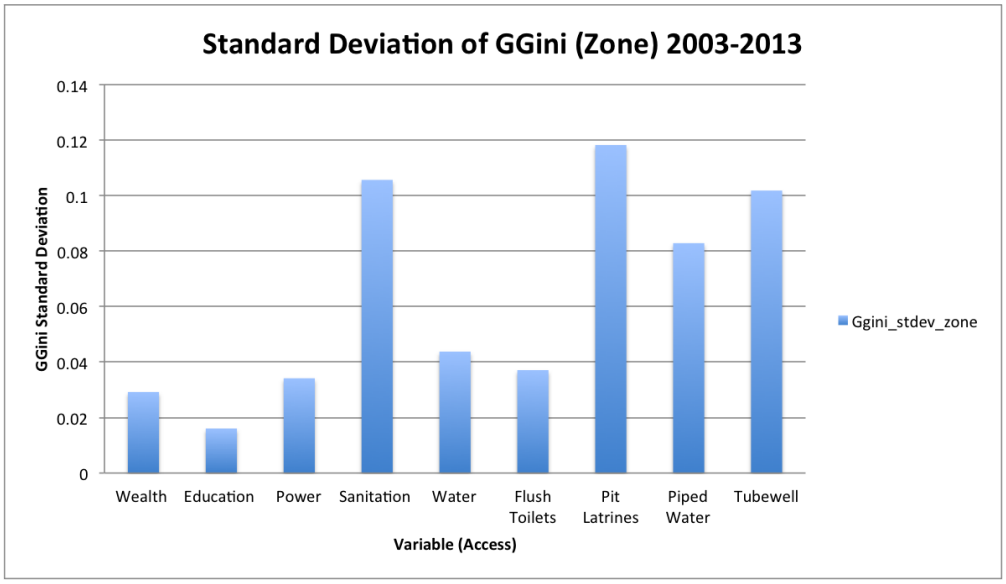

Figure 3: Standard deviation of GGini by zone 2003 to 2013. Source: Author's illustration based on DHS data.

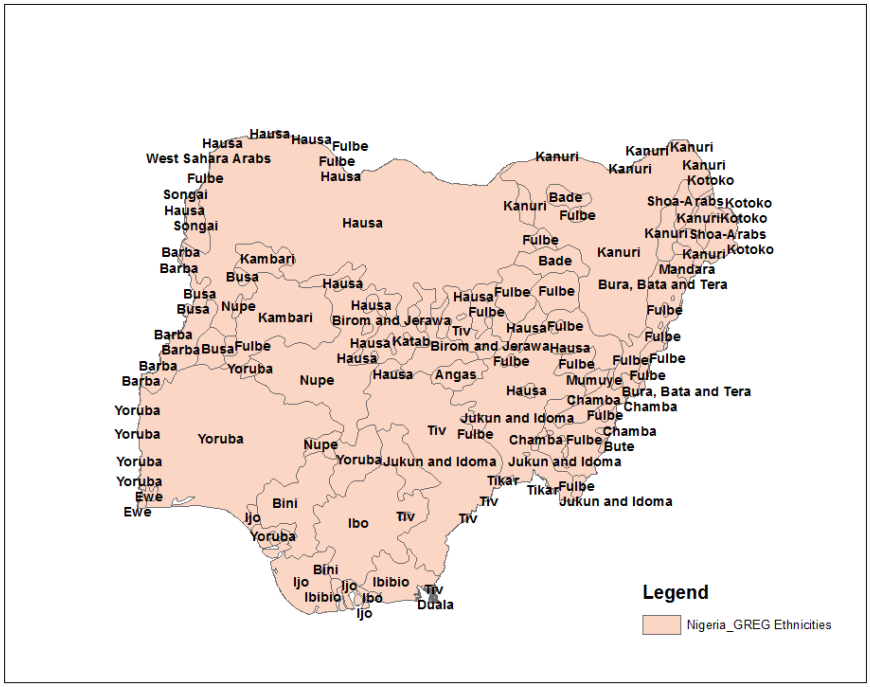

Figure 4: Nigeria 30 ethnicities from GREG. Source: Author's illustration based on GREG data.

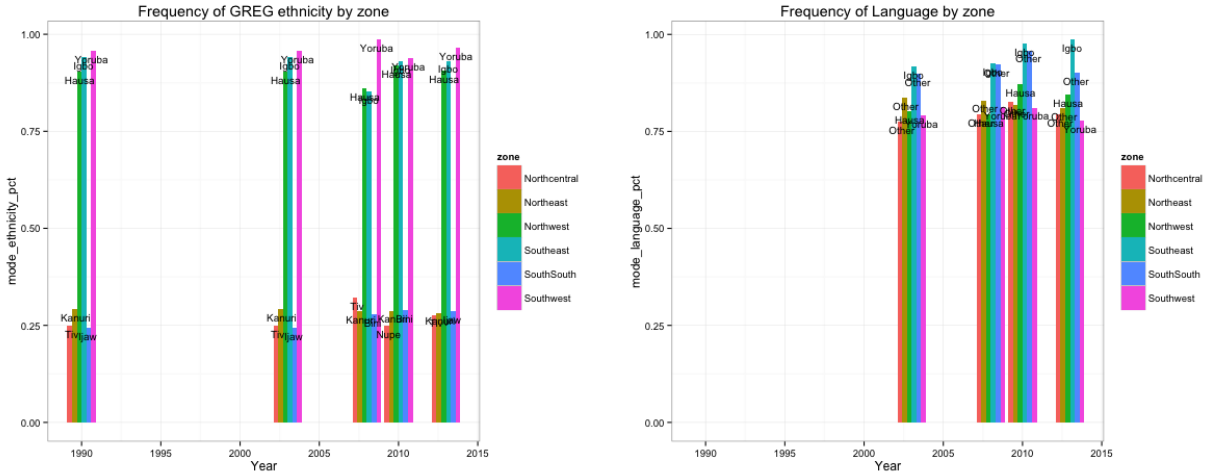

Figure 5: Frequency of GREG ethnicity and language from DHS by zone 1990 to 2013. Source: Author's illustration based on DHS and GREG data.

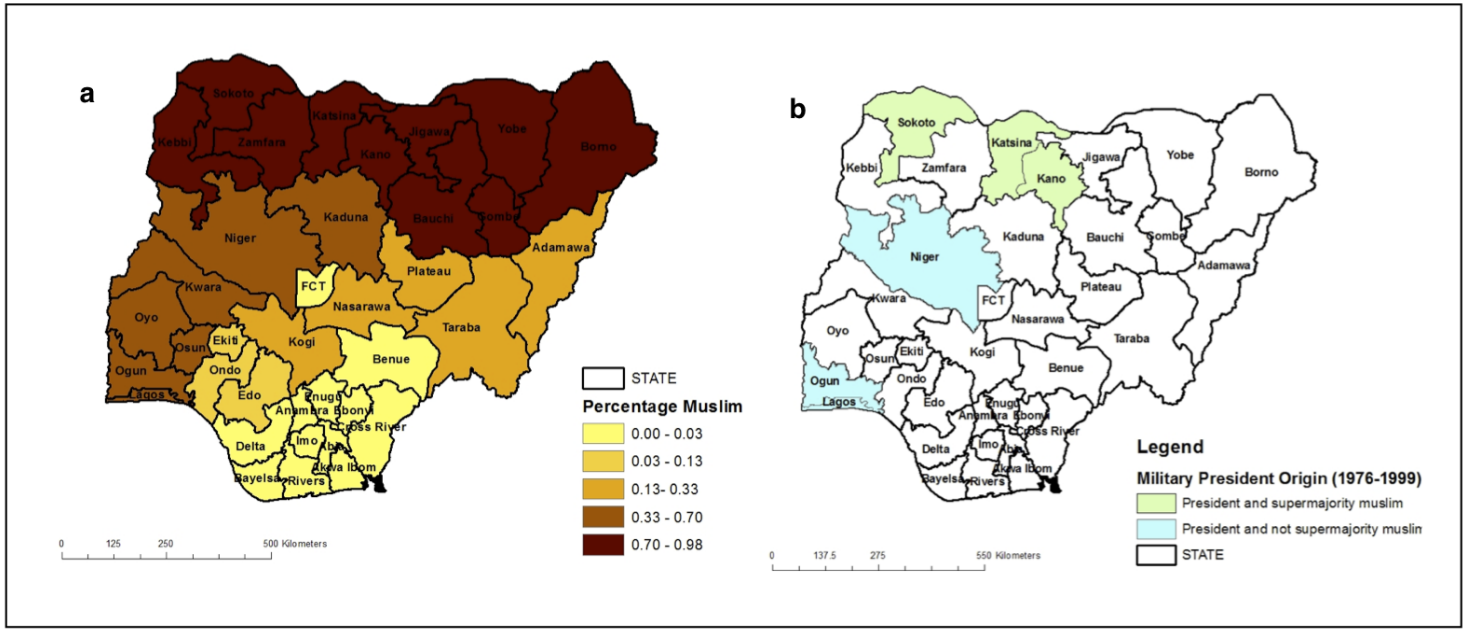

Figure 6: Percentage Muslim by state in 1952 (a) and states of military[65]president origin from 1976 to 1999 labeled in (b). Source: Author's illustration based on Ostien (2012) data.

[65]Note, including President Ernest Shonekan from Lagos state, who was technically not a military official himself though he was chosen by the previous military president as an interim head of state in light of contentious 1993 elections. Lagos is included in the sample for completeness though the results remain unchanged when Lagos is excluded from the military president origin variable. See Appendix for tables.

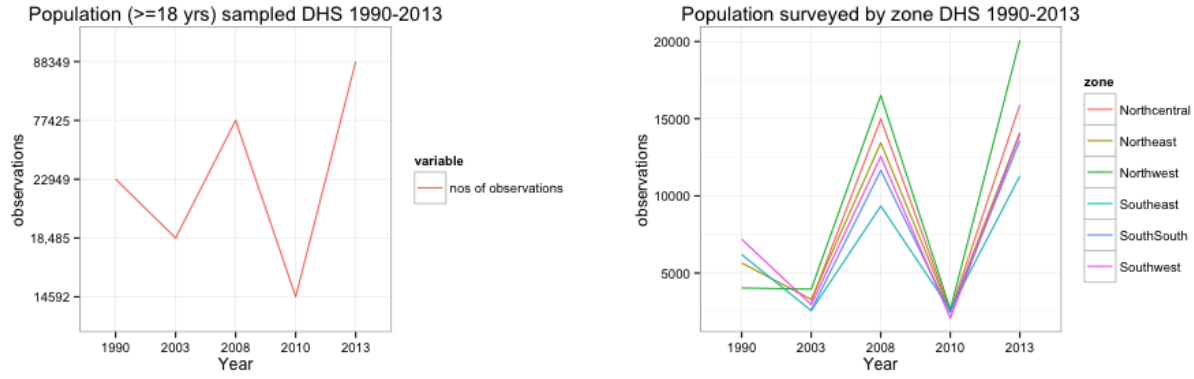

Figure 7: Nigeria number of individuals (household members) ≥ 18 years surveyed 1990 to 2013. Source: Author's illustration based on DHS data.

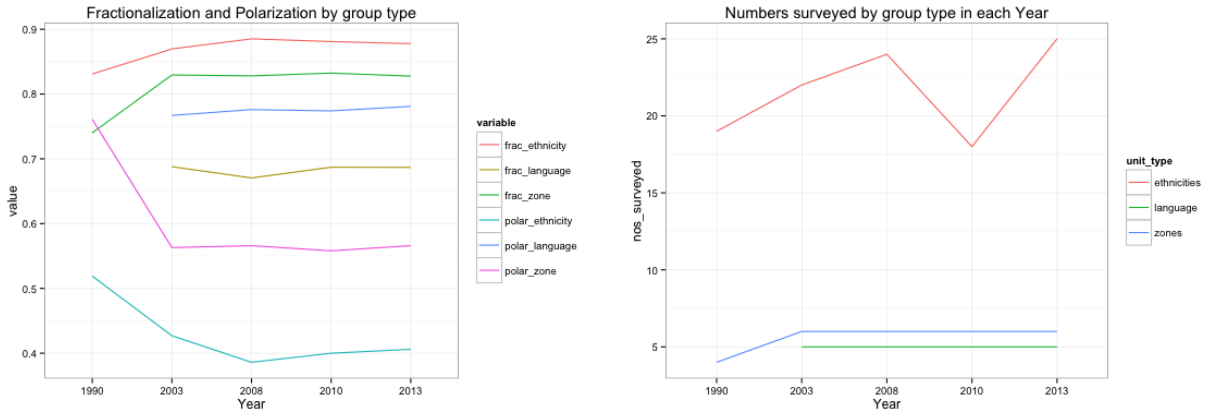

Figure 8: Fractionalization and polarization by group type 1990 to 2013. Source: Author's illustration based on DHS data.

Table 1: Means for socioeconomic variables 1990 to 2013 (weighted). Source: Author's calculations based on DHS data.

Year	Observations	Number of DHS clusters	Wealth	Years of education	Power	Water	Sanitation
1990	22949	298	3.010	3.261			
2003	18485	362	3.073	5.325	0.527	0.400	0.174
2008	77425	886	3.116	6.229	0.505	0.509	0.544
2010	14592	239	3.114	5.688	0.485	0.491	0.437
2013	88349	896	3.142	6.329	0.555	0.586	0.507

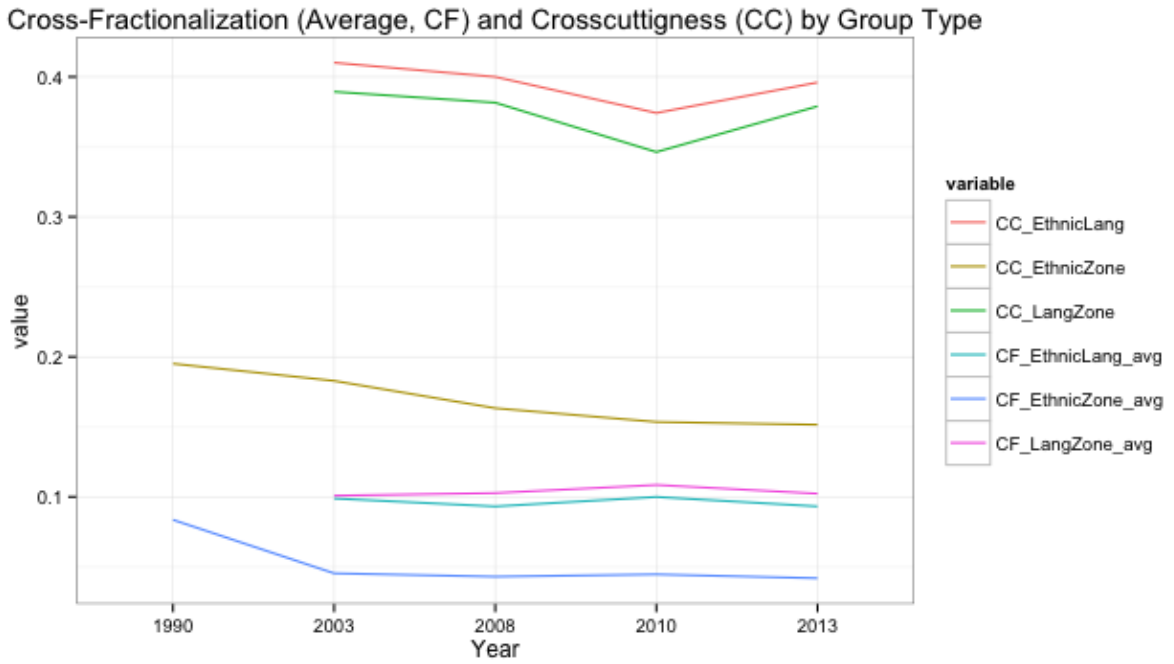

Figure 9: Cross-fractionalization and cross-cuttingness by group type 1990 to 2013. Source: Author's illustration based on DHS data.

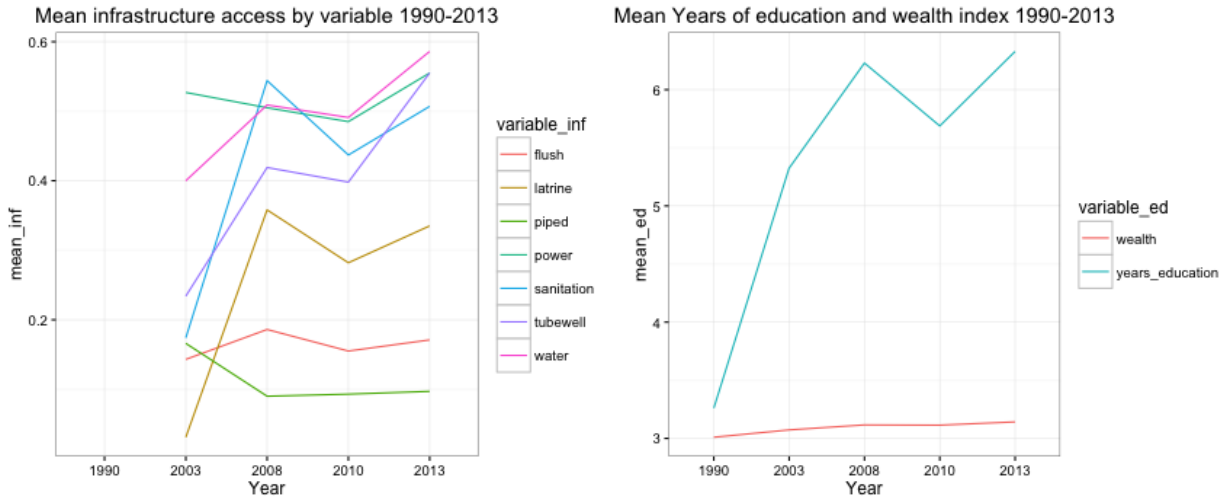

Figure 10: Nigeria nationwide mean socio-economic variables statistics 1990 to 2013 (weighted). Source: Author's illustration based on DHS data.

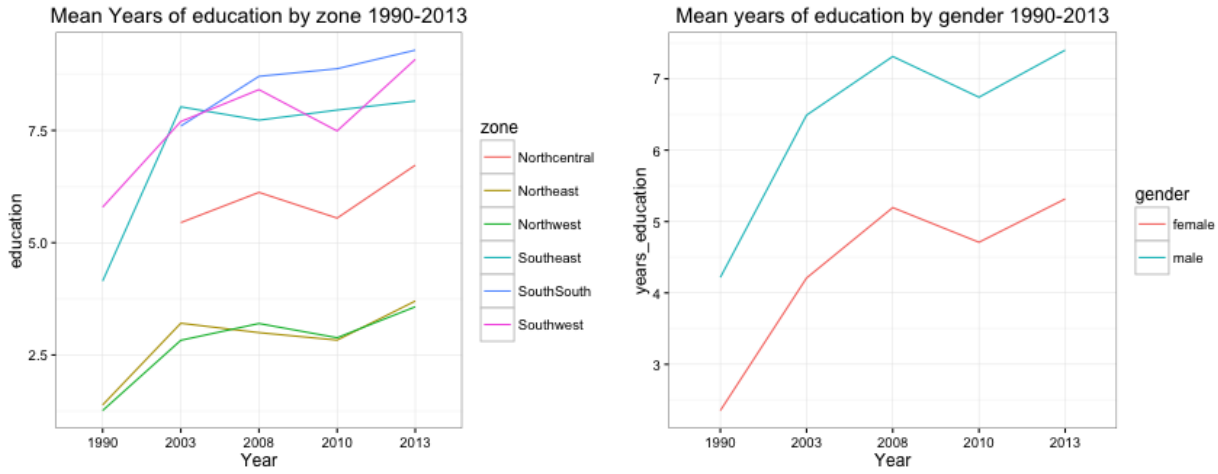

Figure 11: Nigeria mean years of education by zone and gender 1990 to 2013 (weighted). Source: Author's illustration based on DHS data.

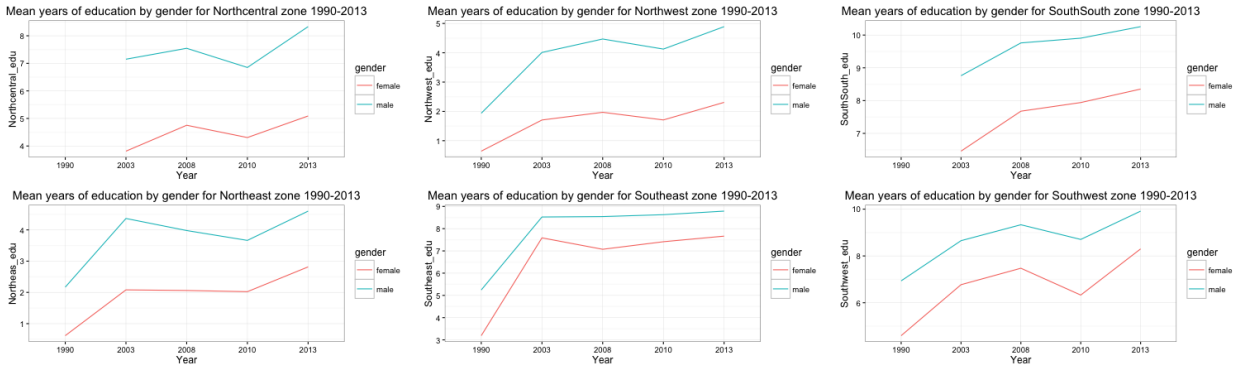

Figure 12: Nigeria mean years of education by gender for each zone 1990 to 2013 (weighted). Source: Author's illustration based on DHS data.

Table 2: Global Moran's I (w=knn(8) from 1990 to 2013 for Nigeria DHS clusters ($p < .001$). Source: Author's calculations based on DHS data.

Year (Global Moran's I)	Avg. Wealth	Avg. Education	Power Access	Water Access	Sanitation Access
1990	0.508	0.654			
2003	0.335	0.421	0.248	0.242	0.261
2008	0.509	0.581	0.269	0.301	0.345
2010	0.467	0.530	0.193	0.146	0.275
2013	0.611	0.607	0.346	0.265	0.403

Notes: Global Moran's I calculated using spatial weight= 8 nearest neighbors (w= knn(8)).All I statistics in the table are significant at $p < .001$. Results remain largely unchanged with specification of alternate spatial weights, including a fixed distance weight and nearest neighbors= 4 or more as well. The Global Moran's I is similar to a spatial Pearson's r and values of $I > E(I)$ where $E(I)$ tends to 0 so values of $I > 0$ indicate

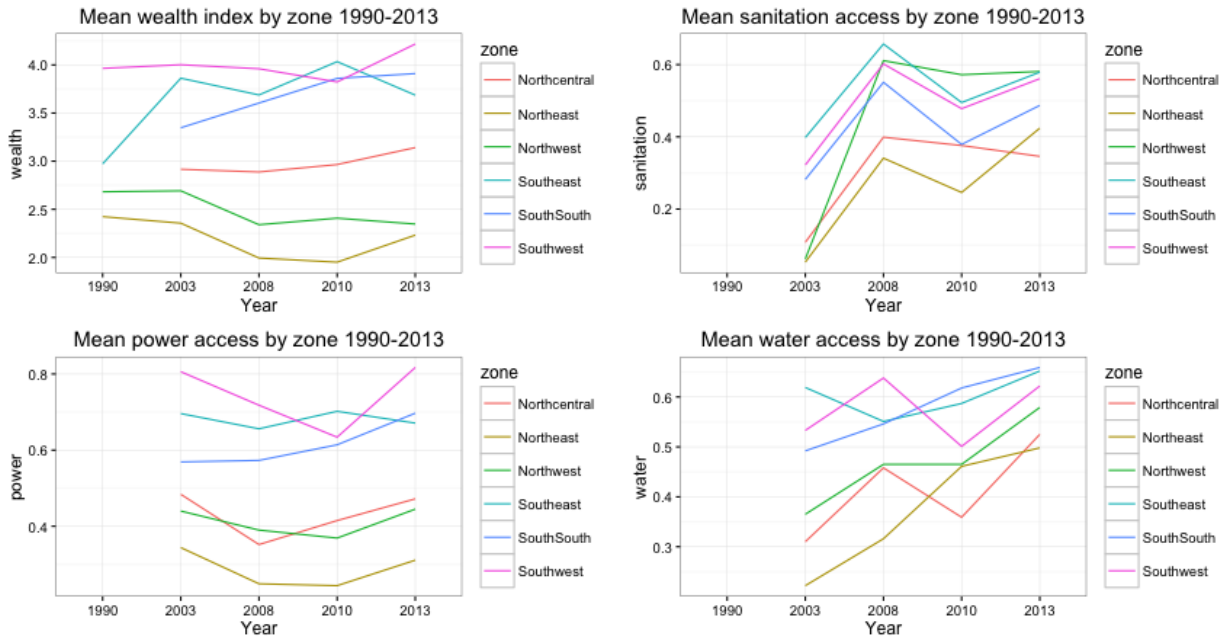

Figure 13: Nigeria mean years of wealth and infrastructure access by zone 1990 to 2013 (weighted). Source: Author's illustration based on DHS data.

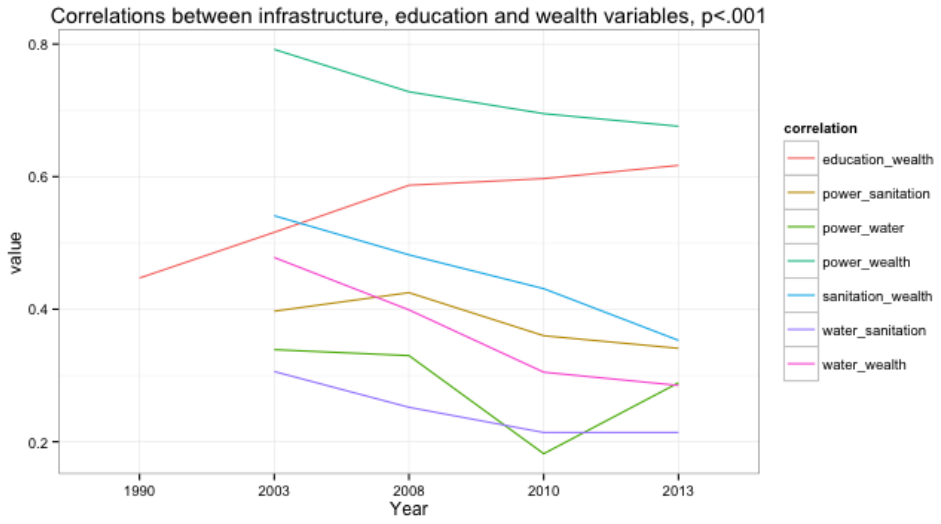

Figure 14: Correlations between infrastructure, education and wealth variables ($p < .001$) 1990 to 2013. Source: Author's illustration based on DHS data.

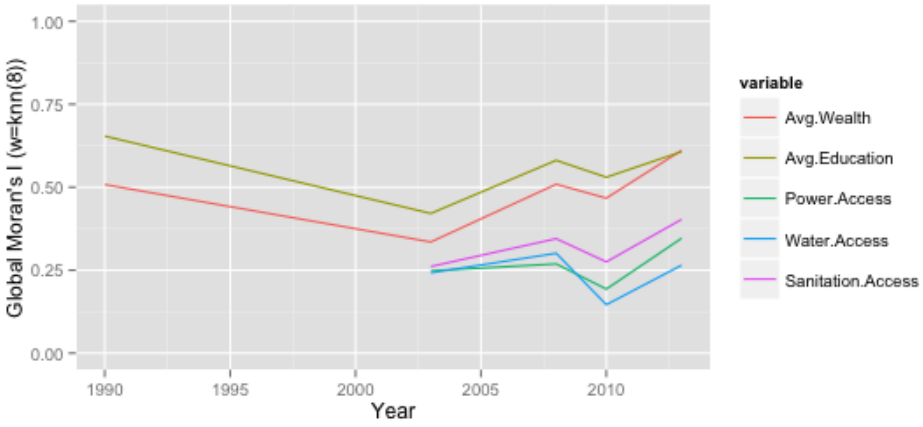

Figure 15: Global Moran's I (w=knn(8) from 1990 to 2013 for Nigeria DHS clusters for all socioeconomic measures. Source: Author's illustration based on DHS data.

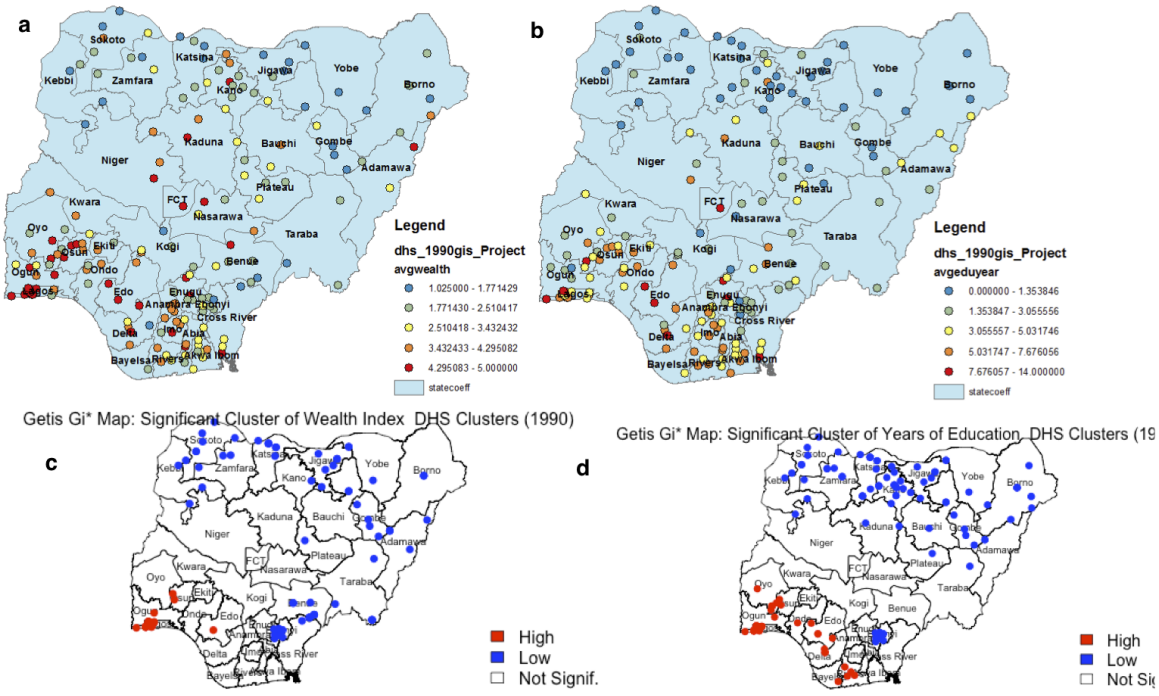

Figure 16: Average wealth and years of education by DHS cluster and Getis Gi* significant clusters of wealth and education 1990. Source: Author's illustration based on DHS data.

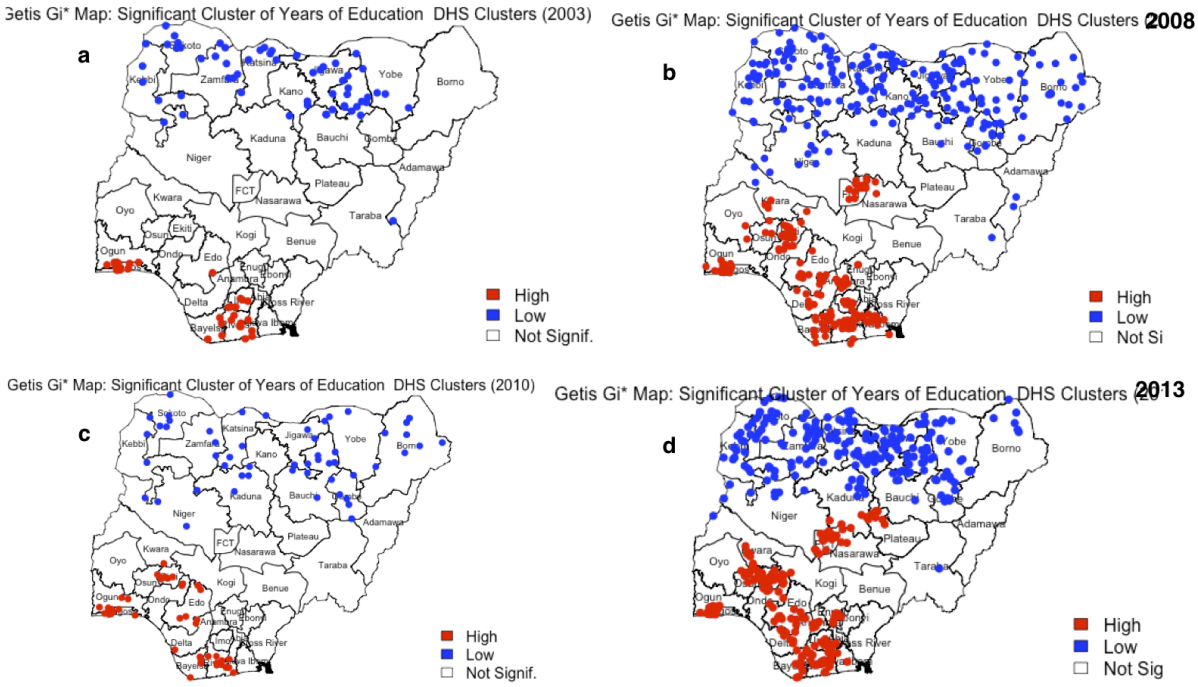

Figure 17: Getis Gi* Maps: significant clusters of average years of education by DHS clusters 2003 to 2013. Source: Author's illustration based on DHS data.

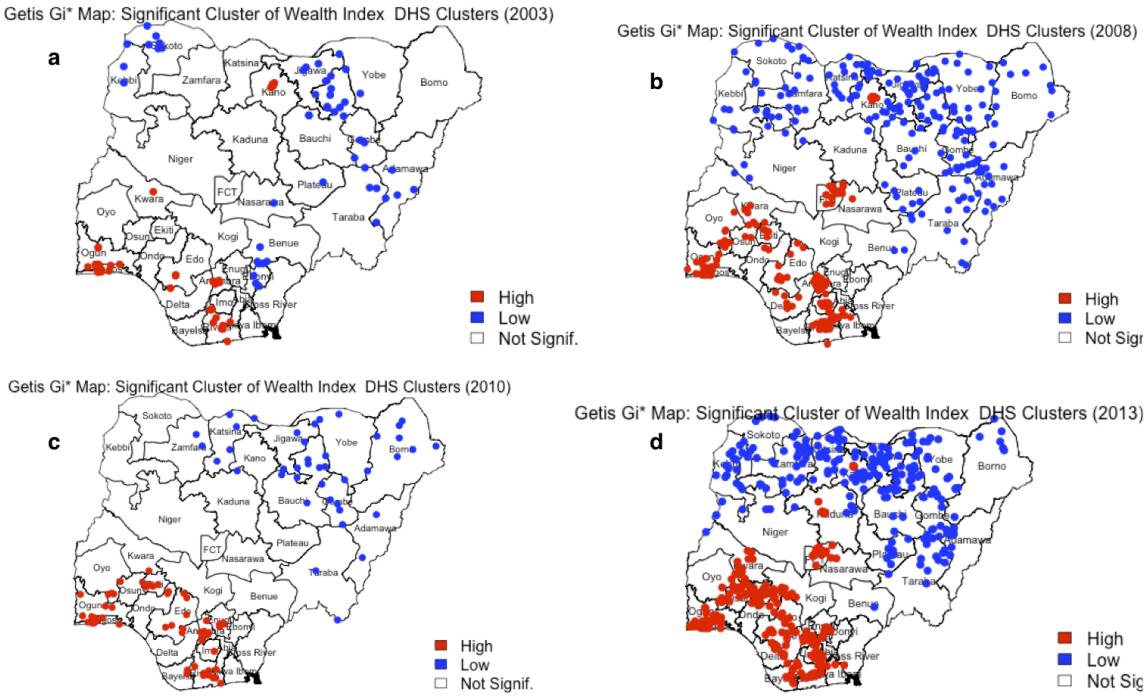

Figure 18: Getis Gi* Maps: significant clusters of average wealth index by DHS cluster 2003 to 2013. Source: Author's illustration based on DHS data.

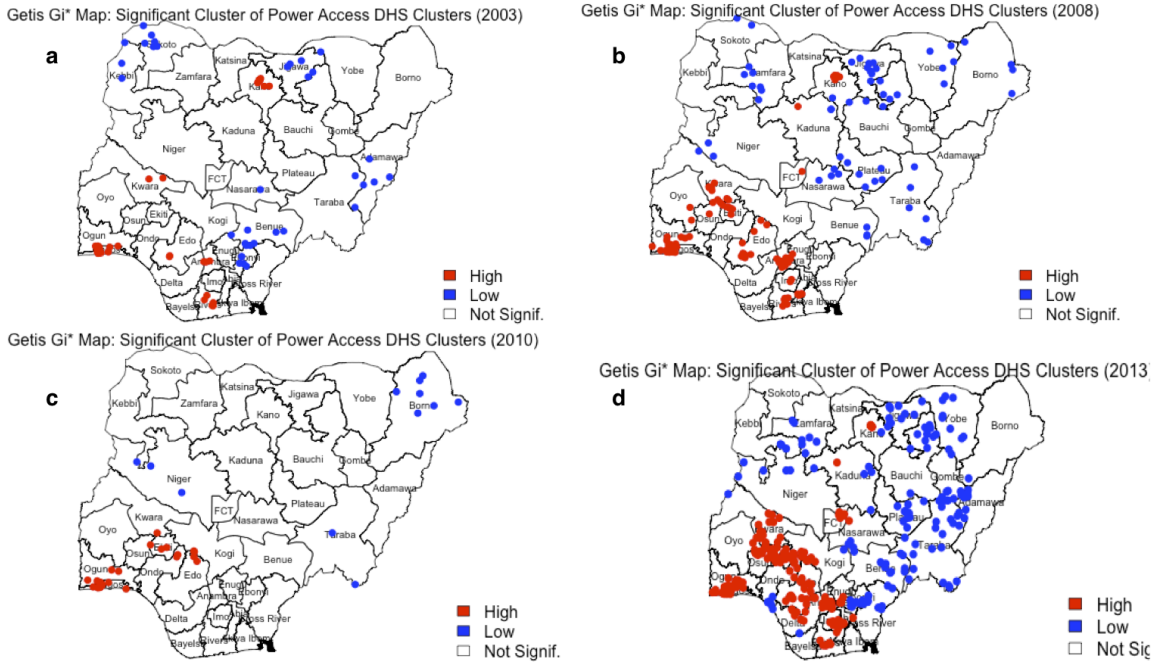

Figure 19: Getis Gi* Maps: significant clusters of average power access by DHS cluster 2003 to 2013. Source: Author's illustration based on DHS data.

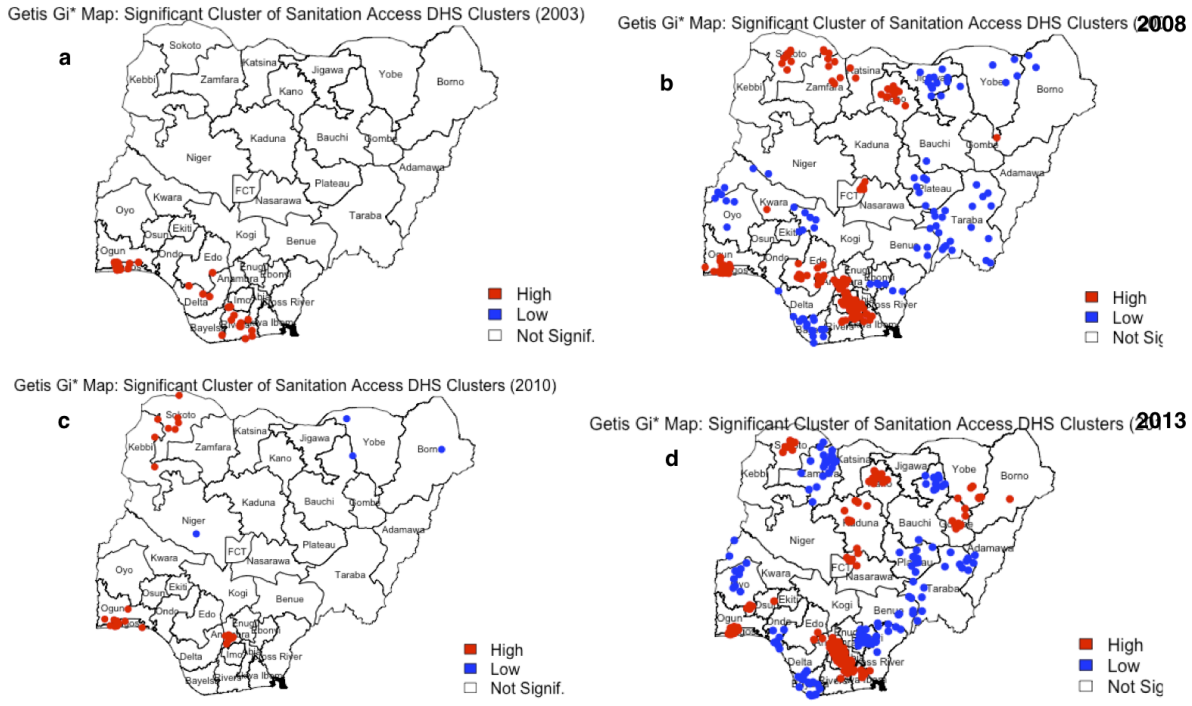

Figure 20: Getis Gi* Maps: significant clusters of average sanitation access by DHS cluster 2003 to 2013. Source: Author's illustration based on DHS data.

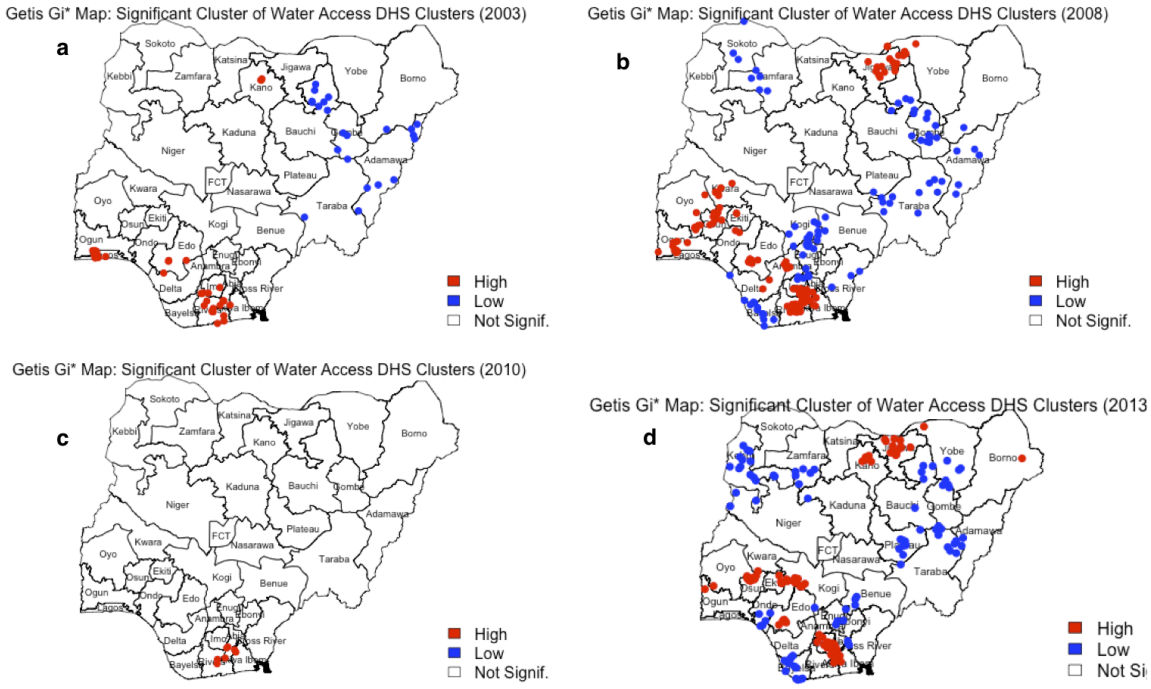

Figure 21: Getis Gi* Maps: significant clusters of average water access by DHS cluster 2003 to 2013. Source: Author's illustration based on DHS data.

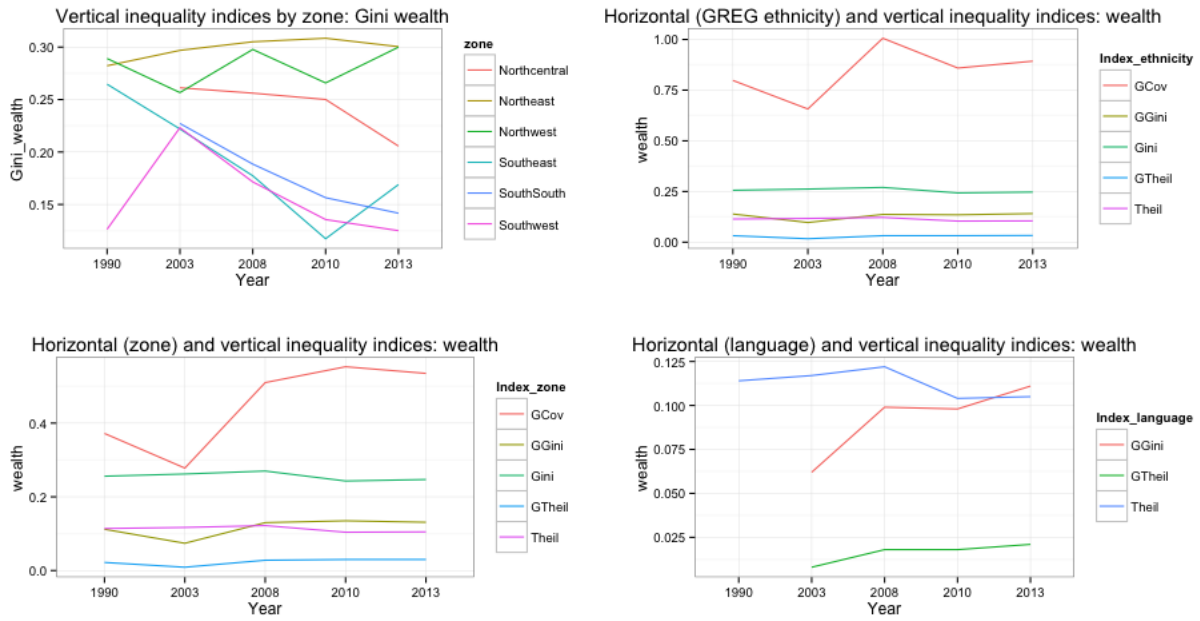

Figure 22: Horizontal and vertical indices for wealth 1990 to 2013. Source: Author's illustration based on DHS data.

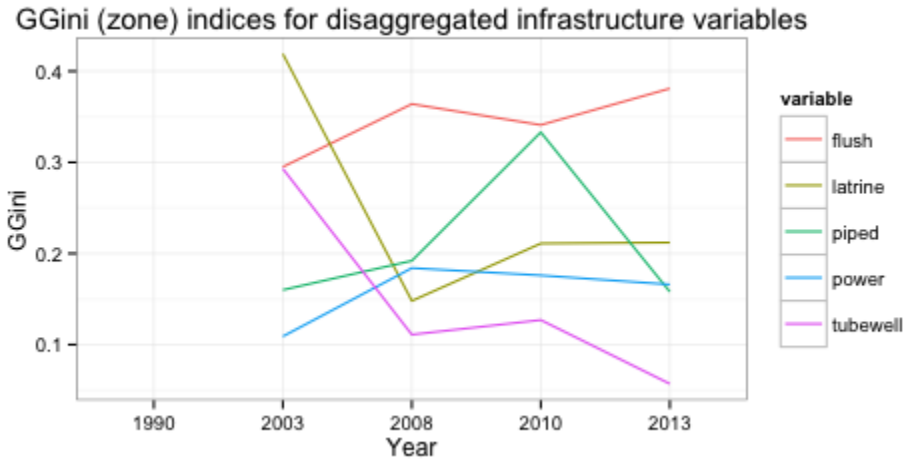

Figure 23: Horizontal (zone) GGini indices for infrastructure (disaggregated) access variables 1990 to 2013. Source: Author's illustration based on DHS data.

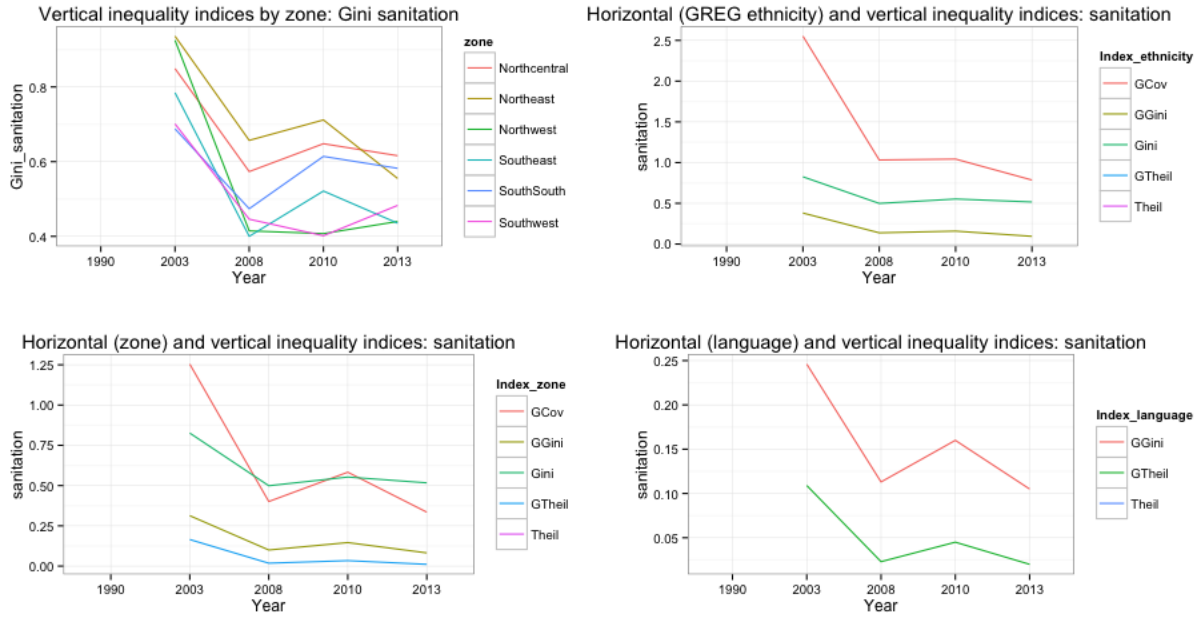

Figure 24: Horizontal and vertical indices for improved sanitation access 1990 to 2013. Source: Author's illustration based on DHS data.

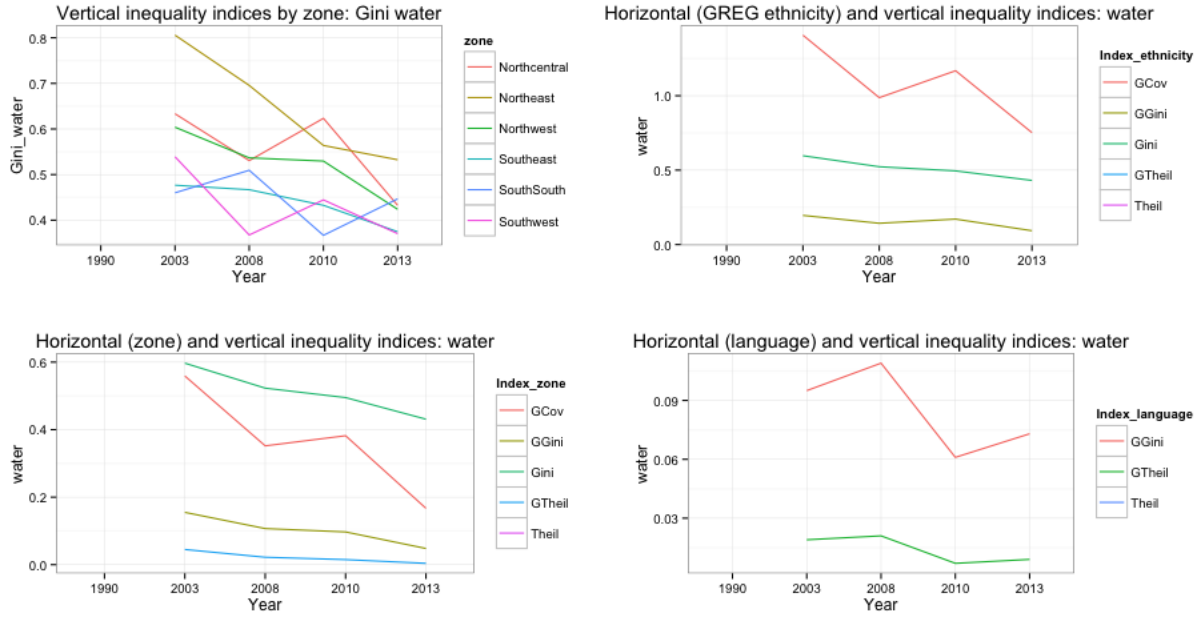

Figure 25: Horizontal and vertical indices for potable water access 1990 to 2013. Source: Author's illustration based on DHS data.

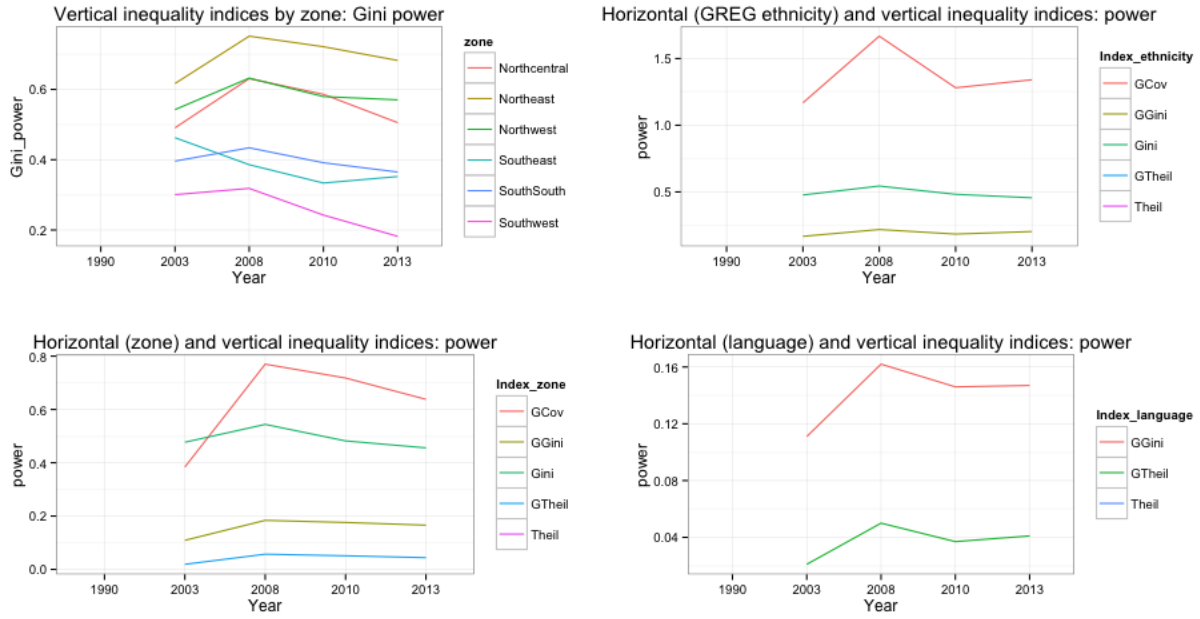

Figure 26: Horizontal and vertical indices for power access 1990 to 2013. Source: Author's illustration based on DHS data.

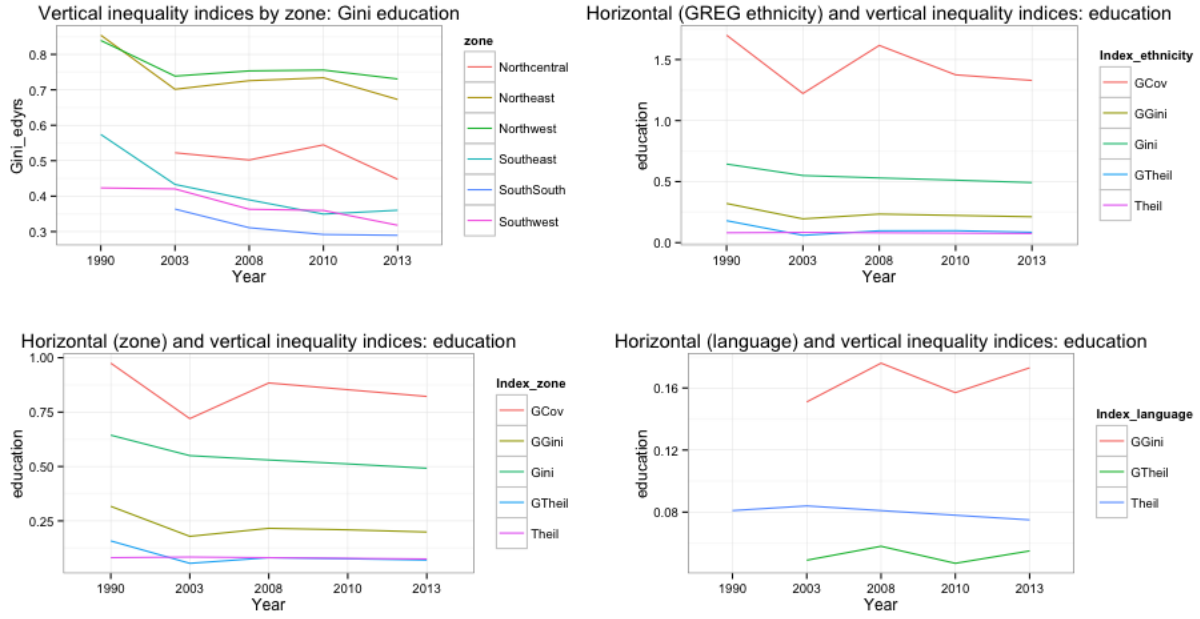

Figure 27: Horizontal and vertical indices for years of education 1990 to 2013. Source: Author's illustration based on DHS data.

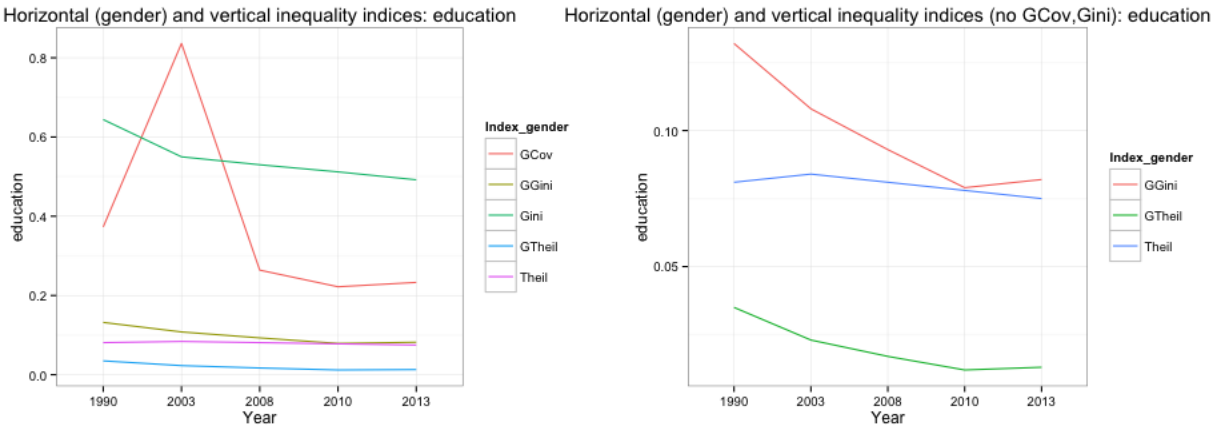

Figure 28: Horizontal (by gender) and vertical inequality indices for years of education 1990 to 2013. Source: Author's illustration based on DHS data.

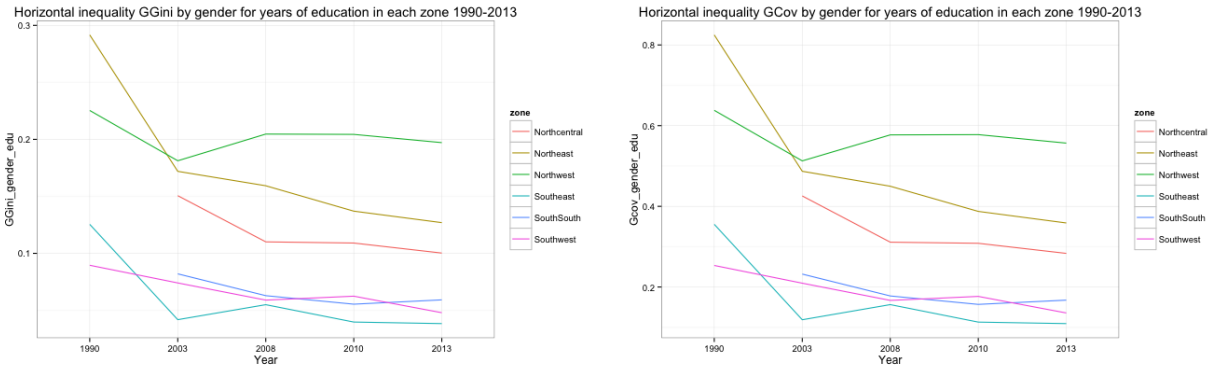

Figure 29: Horizontal (by gender) inequality indices for years of education in each zone 1990 to 2013. Source: Author's illustration based on DHS data.

Table 3: Infrastructure, education and wealth summary statistics (averages over 1990 to 2013 from DHS data, observations are LGA-ethnic states)

Statistic	N	Mean	St. Dev.	Min	Max
Power(Grid)	678	0.49	0.38	0.00	1.00
Flush Toilets	678	0.13	0.20	0.00	1.00
Improved Pit Latrines	678	0.28	0.24	0.00	1.00
Sanitation	678	0.41	0.29	0.00	1.00
Piped Water	678	0.10	0.17	0.00	0.98
Tubewell	678	0.41	0.29	0.00	1.00
Water	678	0.49	0.31	0.00	1.00
Average Wealth	436	3.25	1.11	1.00	5.00
Years of Education	685	5.77	3.14	0.00	13.79

Table 4: Full model controls summary statistics (observations are LGA-ethnic states)

Statistic	N	Mean	St. Dev.	Min	Max
Centralization (dum)	685	0.90	0.30	0	1
Centralization (full)	685	1.54	0.88	0	3
Supermajority Muslim	685	0.25	0.43	0	1
No Military President	685	0.81	0.39	0	1
Pop.Density	685	857.96	2,727.82	6.90	41,012.70
Mean Elevation	652	268.84	240.43	−0.25	1,379.27
Ruggedness	685	0.26	0.23	0.03	2.28
Distance to Capital	685	373.82	131.57	23.62	835.27
Petrol	685	0.28	0.45	0	1
Mean Agricultural Suitability	669	4.71	0.76	1.80	6.00
Slavery(Prevalence)	674	0.99	0.07	0	1
Slavery(Exports)	685	149,169.20	214,072.30	0	665,966
Malaria	685	1.00	0.02	0.72	1.00
Distance to Rivers	685	65.26	47.42	0.18	236.24
Sea Coast	685	0.19	0.40	0	1
Tse Tse Suitability	556	0.831	0.501	-0.778	1.449

Notes: See text for details. Models are tested with the binary and full Centralization index. Results from the binary Centralization variable are reported in this paper. Distance in km. Slave exports from 1400 to 1900 as a measure of intensity of slave trade are used in main results. Based on data from various sources, see Archibong (2016) for details.

Table 5: Trust and local government quality summary statistics (observations are LGAs*)

Statistic	N	Mean	St. Dev.	Min	Max
No Police	171	0.05	0.10	0.00	0.50
Police over Traditional Leaders	171	0.34	0.37	−0.88	1.00
Police Trust	171	0.48	0.24	0.00	1.00
Traditional Leader Trust	171	0.14	0.18	0.00	0.88
Trust in Local Government Councils	152	0.98	0.35	0.00	1.75
Local Govt. Maintenance of Roads	160	1.95	0.45	1.00	3.50
Local Govt. Maintenance of Marketplaces	154	2.10	0.46	1.25	3.31
Local Govt. Maintenance of Health Standards	135	2.13	0.47	1.12	3.25
Local Government Community Clean	155	2.21	0.52	1.00	3.62

Notes: See text for details. Observations calculated at the LGA level from the 2012 Afrobarometer survey except for police and traditional leader trust variables which are calculated at the LGA-ethnic state unit.

Table 6: Reduced form estimates showing heterogenous effects of precolonial centralization on access to federally administered infrastructure services

	Power(Grid)		Flush	
	(1)	(2)	(3)	(4)
Centralization	0.095*	0.140*	0.039**	0.059**
	(0.053)	(0.081)	(0.019)	(0.026)
Supermajority Muslim		−0.002		−0.042
		(0.083)		(0.030)
CentXMus		−0.200**		−0.055*
		(0.086)		(0.029)
Petrol	0.087	0.035	0.098***	0.078***
	(0.067)	(0.050)	(0.022)	(0.019)
Constant	−1.155	−1.658**	0.674**	0.354
	(0.859)	(0.772)	(0.333)	(0.254)
Population density	Yes	Yes	Yes	Yes
Disease controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
N	631	631	631	631
R^2	0.126	0.177	0.191	0.213
Adjusted R^2	0.112	0.160	0.178	0.196

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by ethnicity. Errors clustered by state in alternate specifications with results unchanged. Dependent variables are averages over 1990-2013 DHS records. Disease controls includes malaria and tse tse fly suitability in alternate specifications. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital and rivers and sea coast. Population density and controls for slavery are included in all specifications in the full model. Slavery not included in (1) only, (effect size is 0 for slavery), results for (1) remain significant in alternate specifications when slavery added as a control. Lagos dummies are included and Lagos excluded in alternate specifications with results unchanged. The Southeast zone is excluded in alternate specifications with results largely unchanged (see Appendix for details/tables available on request). Results remain significant in most specifications when the full Centralization index is used (see Appendix for details/tables available on request). Model tested in the split sample in non supermajority muslim states and effects for centralization remain significant (see Appendix). ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 7: Reduced form estimates of the relationship between precolonial centralization and access to locally administrated infrastructure services

	Latrine		Piped		Tubewell	
	(1)	(2)	(3)	(4)	(5)	(6)
Centralization	0.015	0.008	0.030	0.014	0.029	0.079
	(0.049)	(0.045)	(0.022)	(0.037)	(0.041)	(0.060)
Supermajority Muslim		0.181***		−0.020		0.057
		(0.065)		(0.036)		(0.067)
CentXMus		0.007		0.033		−0.104
		(0.064)		(0.038)		(0.066)
Petrol	0.038	0.071**	0.012	0.013	0.006	0.001
	(0.036)	(0.036)	(0.021)	(0.018)	(0.038)	(0.039)
Constant	−1.426**	−0.805*	−0.216	−0.165	0.069	−0.107
	(0.589)	(0.426)	(0.209)	(0.236)	(0.454)	(0.457)
Population density	Yes	Yes	Yes	Yes	Yes	Yes
Disease controls	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
N	631	631	631	631	631	631
R^2	0.066	0.114	0.033	0.034	0.082	0.085
Adjusted R^2	0.050	0.097	0.015	0.013	0.065	0.066

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by ethnicity. Errors clustered by state in alternate specifications with results unchanged. Dependent variables are averages over 1990-2013 DHS records. Disease controls includes malaria and tse tse fly suitability in alternate specifications. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital and rivers and sea coast. Population density and controls for slavery are included in all specifications in the full model. Lagos dummies are included and Lagos excluded in alternate specifications with results unchanged. The Southeast zone is excluded in alternate specifications with results unchanged (see Appendix for details/tables available on request). ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 8: Precolonial centralization has no effect for wealth and education, but strong negative association with supermajority Muslim

	Wealth		Years of Education	
	(1)	(2)	(3)	(4)
Centralization	0.136	0.348	−0.154	0.364
	(0.276)	(0.308)	(0.782)	(0.671)
Supermajority Muslim		−0.635*		−3.667***
		(0.344)		(0.923)
CentXMus		−0.876**		−0.594
		(0.388)		(0.882)
Petrol	0.508**	0.141	1.740***	1.119***
	(0.237)	(0.153)	(0.388)	(0.278)
Constant	7.352*	3.509	17.901*	3.195
	(3.894)	(2.539)	(10.628)	(5.952)
Population density	Yes	Yes	Yes	Yes
Disease controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
N	405	405	638	638
R^2	0.292	0.510	0.395	0.526
Adjusted R^2	0.274	0.494	0.384	0.516

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by ethnicity. Errors clustered by state in alternate specifications with results unchanged. Dependent variables are averages over 1990-2013 DHS records. Disease controls includes malaria and tse tse fly suitability in alternate specifications. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital and rivers and sea coast. Population density and controls for slavery are included in all specifications in the full model. Lagos dummies are included and Lagos excluded in alternate specifications with results unchanged. The Southeast zone is excluded in alternate specifications with results unchanged (see Appendix for details/tables available on request). ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 9: Residents from 'punished' (Cent=1 and S.Mus=1) areas report less trust in police over traditional leaders (split sample observations: Cent=1)

	Trust in Police over Trad. Leader			
	(1)	(2)	(3)	(4)
Supermajority Muslim	−0.129	−0.284*	−0.271*	−0.324**
	(0.141)	(0.149)	(0.141)	(0.141)
No Police	−0.497	−0.450	−0.409	−0.457
	(0.343)	(0.378)	(0.379)	(0.369)
Petrol				−0.232**
				(0.090)
Constant	0.357***	0.456***	2.730	3.418**
	(0.061)	(0.093)	(1.768)	(1.709)
Population density	Yes	Yes	Yes	Yes
Geographic controls	No	Yes	Yes	Yes
Disease control	No	No	Yes	Yes
N	162	147	147	147
R^2	0.085	0.131	0.141	0.195
Adjusted R^2	0.068	0.094	0.098	0.148

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Tests with split sample where Cent0=1 only since not enough observations in the non-centralized sample. Results interpreted with caution since sample potentially underpowered. Dependent variable is constructed from responses to Q12 in 2012 Afrobarometer and represents 'trust in police over traditional leaders'. Constructed from the answer to question: 'if you were the victim of a crime in this country, who would you go to first for help?'. Disease controls includes malaria and tse tse fly suitability in alternate specifications. Geographic controls include ruggedness and mean elevation. Population density and controls for slavery are 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: Residents from 'punished' (Cent=1 and S.Mus=1) areas report more trust in local governing councils. No effect for trust in police and army (split sample observations: Cent=1)

	Local Governing Council		Police		Army	
	(1)	(2)	(3)	(4)	(5)	(6)
Supermajority Muslim	0.356***	0.439***	0.144	0.039	0.038	−0.013
	(0.068)	(0.077)	(0.094)	(0.107)	(0.133)	(0.140)
No Police		0.986***	0.639*	0.617	0.559	0.410
		(0.327)	(0.363)	(0.383)	(0.384)	(0.369)
Petrol		−0.138		−0.055		−0.074
		(0.094)		(0.092)		(0.108)
Constant	0.887***	2.416***	0.589***	1.323	1.381***	−1.137
	(0.050)	(0.630)	(0.046)	(0.983)	(0.068)	(1.284)
Population density	Yes	Yes	Yes	Yes	Yes	Yes
Disease controls	No	Yes	No	Yes	No	Yes
Geographic controls	No	Yes	No	Yes	No	Yes
N	143	127	159	138	149	128
R^2	0.199	0.440	0.065	0.171	0.042	0.100
Adjusted R^2	0.188	0.381	0.047	0.091	0.022	0.006

Notes: Regressions estimated by OLS. Robust standard errors in parentheses clustered by state. Dependent variables are from the 2012 Afrobarometer survey. Disease controls includes malaria and tse tse fly suitability in alternate specifications. Geographic controls include ruggedness, mean elevation, agricultural land suitability and distance to capital and rivers and sea coast. Population density and controls for slavery are included in all specifications in the full model. Lagos dummies are included and Lagos excluded in alternate specifications with results unchanged. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 11: Trust in local governing councils positively associated with locally administered services (improved pit latrines) but not federally administered services (power, grid). Negatively associated with wealth and years of education

	Power(grid)	Flush Toilet	Pit Latrine	Piped Water	Wealth	Education
	(1)	(2)	(3)	(4)	(5)	(6)
Trust in Local Governing Council	−0.350***	−0.214***	0.127*	−0.019	−1.249***	−3.867***
	(0.072)	(0.052)	(0.072)	(0.039)	(0.190)	(0.595)
Constant	0.998***	0.391***	0.201***	0.135***	4.669***	10.956***
	(0.069)	(0.058)	(0.068)	(0.039)	(0.175)	(0.539)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
N	120	120	120	120	120	120
R^2	0.158	0.225	0.031	0.002	0.264	0.230
Adjusted R^2	0.143	0.212	0.014	-0.015	0.252	0.217

Notes: Regressions estimated by OLS. Observations are LGAs. Robust standard errors in parentheses. Independent variable is from the 2012 Afrobarometer survey. Dependent variable from 2013 DHS survey. Population density controls are included in all specifications. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 12: Measures of Local Government quality ("keep community clean") positively associated with locally administered services (improved pit latrines) but not federally administered services (power, grid). Negative association with wealth and education.

	Power(grid)	Flush Toilet	Pit Latrine	Piped Water	Wealth	Education
	(1)	(2)	(3)	(4)	(5)	(6)
Local government cleaning	−0.087	−0.124**	0.132***	0.030	−0.432**	−1.468***
	(0.064)	(0.049)	(0.048)	(0.036)	(0.196)	(0.564)
Constant	0.880***	0.496***	0.019	0.058	4.522***	10.834***
	(0.144)	(0.115)	(0.096)	(0.080)	(0.424)	(1.213)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
N	127	127	127	127	127	127
R^2	0.050	0.127	0.063	0.007	0.122	0.087
Adjusted R^2	0.035	0.113	0.048	-0.010	0.108	0.072

Notes: Regressions estimated by OLS. Observations are LGAs. Robust standard errors in parentheses. Independent variable is from the 2012 Afrobarometer survey. Dependent variable from 2013 DHS survey. Population density controls are included in all specifications. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 13: Measures of local government quality ("maintain restaurant health standards") positively associated with locally administered services (improved pit latrines) but not federally administered services (power, grid)

	Power(grid)	Flush Toilet	Pit Latrine	Piped Water	Wealth	Education
	(1)	(2)	(3)	(4)	(5)	(6)
Local government health	−0.121	−0.141***	0.170***	0.013	−0.686***	−2.330***
	(0.081)	(0.050)	(0.054)	(0.040)	(0.231)	(0.663)
Constant	0.941***	0.520***	−0.056	0.093	5.034***	12.601***
	(0.177)	(0.115)	(0.107)	(0.086)	(0.491)	(1.393)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
N	117	117	117	117	117	117
R^2	0.073	0.169	0.097	0.002	0.171	0.148
Adjusted R^2	0.056	0.154	0.081	-0.015	0.156	0.133
χ^2 (df = 2)	8.810**	21.602***	11.970***	0.258	21.932***	18.762***

Notes: Regressions estimated by OLS. Observations are LGAs. Robust standard errors in parentheses. Independent variable is from the 2012 Afrobarometer survey. Dependent variable from 2013 DHS survey. Population density controls are included in all specifications. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

Table 14: Measures of local government quality ("maintain local marketplace") positively associated with locally administered services (improved pit latrines) but not federally administered services (power, grid)

	Power(grid)	Flush Toilet	Pit Latrine	Piped Water	Wealth	Education
	(1)	(2)	(3)	(4)	(5)	(6)
Local government marketplace	−0.146**	−0.193***	0.183***	0.028	−0.747***	−2.461***
	(0.074)	(0.044)	(0.058)	(0.039)	(0.222)	(0.670)
Constant	0.992***	0.632***	−0.084	0.055	5.154***	12.846***
	(0.158)	(0.105)	(0.115)	(0.081)	(0.462)	(1.383)
Population Density	Yes	Yes	Yes	Yes	Yes	Yes
N	124	124	124	124	124	124
R^2	0.073	0.205	0.100	0.006	0.181	0.151
Adjusted R^2	0.058	0.192	0.085	-0.010	0.167	0.137
χ^2 (df = 2)	9.410***	28.397***	13.023***	0.788	24.710***	20.304***

Notes: Regressions estimated by OLS. Observations are LGAs. Robust standard errors in parentheses. Independent variable is from the 2012 Afrobarometer survey. Dependent variable from 2013 DHS survey. Population density controls are included in all specifications. ***Significant at the 1 percent level, **Significant at the 5 percent level, *Significant at the 10 percent level.

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A Appendix

A.1 Tables

Table 15: Measures of horizontal inequality for years of education, 2003 and 2010 for populations age 15+ and 25+. Source: Author's calculations from DHS data.

Index (age 15+)	Year	Zone (Ethnicity proxy)	Ethnicity (imputed)	Language	Gender	Rural/urban	Capital/others
GCOV	2003	0.727	1.216	0.538	0.283	0.318	0.002
	2010	0.836	1.356	0.56	0.203	0.373	0.068
GGini	2003	0.179	0.194	0.151	0.1	0.111	0
	2010	0.204	0.219	0.154	0.072	0.126	0.006
GTheil	2003	0.055	0.06	0.048	0.02	0.024	0
	2010	0.073	0.094	0.044	0.01	0.034	0.002
Index (age 25+)	Year (age 25+)	Zone (Ethnicity proxy)	Ethnicity (imputed)	Language	Gender	Rural/urban	Capital/others
GCOV	2003	0.743	1.292	0.579	0.387	0.388	0.009
	2010	0.916	1.418	0.595	0.257	0.434	0.086
GGini	2003	0.188	0.206	0.161	0.137	0.135	0.001
	2010	0.225	0.232	0.165	0.091	0.146	0.008
GTheil	2003	0.059	0.066	0.054	0.038	0.036	0
	2010	0.089	0.104	0.052	0.017	0.046	0.002

Table 16: DHS Number of surveyed individuals (pop) and households (househ) by geopolitical zone 1990 to 2013. Source: Author's calculations from DHS data.

Year(pop)	Northcentral	Northeast	Northwest	Southeast	Southsouth	Southwest
1990		5655	4033	6198		7187
2003	3168	3291	3955	2562	2602	2955
2008	14978	13438	16505	9340	11651	12545
2010	2495	2465	2640	2628	2425	2077
2013	15891	14101	20083	11290	13578	14000
Year(househ)	Northcentral	Northeast	Northwest	Southeast	Southsouth	Southwest
1990		2014	1564	2371		3024
2003	1155	1187	1568	1034	1010	1254
2008	6197	5435	6692	4111	5353	6064
2010	994	969	1006	997	1006	911
2013	6763	5684	7926	4976	6097	6940

Table 17: Getis Gi* Intensity of High (hh) and Low (ll) clustering by geopolitical zone for socioeconomic variables 1990 to 2013. Source: Author's calculations from DHS data.

Year_avgwealth	Northcentral_gi_ll	Northeast_gi_ll	Northwest_gi_ll	Southeast_gi_ll	Southsouth_gi_ll	Southwest_gi_ll	Northcentral_gi_hh	Northeast_gi_hh	Northwest_gi_hh	Southeast_gi_hh	Southsouth_gi_hh	Southwest_gi_hh
1990		0.431	0.400	0.256		0.000		0.000	0.020	0.000	0.000	0.505
2003	0.089	0.421	0.197	0.091	0.000	0.000	0.018	0.000	0.158	0.091	0.264	0.369
2008	0.098	0.700	0.500	0.000	0.000	0.000	0.220	0.000	0.057	0.393	0.307	0.444
2010	0.000	0.725	0.300	0.000	0.000	0.000	0.025	0.000	0.000	0.375	0.425	0.718
2013	0.098	0.612	0.670	0.026	0.007	0.000	0.307	0.000	0.071	0.436	0.390	0.755
Year_avgedyrs	Northcentral_gi_ll	Northeast_gi_ll	Northwest_gi_ll	Southeast_gi_ll	Southsouth_gi_ll	Southwest_gi_ll	Northcentral_gi_hh	Northeast_gi_hh	Northwest_gi_hh	Southeast_gi_hh	Southsouth_gi_hh	Southwest_gi_hh
1990		0.708	0.580	0.128		0.000	0.000	0.000	0.020	0.064	0.000	0.657
2003	0.018	0.333	0.500	0.000	0.000	0.000	0.000	0.000	0.013	0.091	0.321	0.354
2008	0.085	0.536	0.776	0.000	0.000	0.000	0.207	0.000	0.000	0.308	0.564	0.411
2010	0.075	0.625	0.625	0.000	0.000	0.000	0.025	0.000	0.000	0.025	0.500	0.590
2013	0.043	0.440	0.780	0.009	0.000	0.000	0.307	0.000	0.022	0.291	0.426	0.541
Year_power	Northcentral_gi_ll	Northeast_gi_ll	Northwest_gi_ll	Southeast_gi_ll	Southsouth_gi_ll	Southwest_gi_ll	Northcentral_gi_hh	Northeast_gi_hh	Northwest_gi_hh	Southeast_gi_hh	Southsouth_gi_hh	Southwest_gi_hh
1990												
2003	0.125	0.140	0.171	0.109	0.000	0.000	0.036	0.000	0.184	0.036	0.170	0.323
2008	0.098	0.150	0.132	0.000	0.000	0.000	0.085	0.000	0.063	0.239	0.157	0.331
2010	0.075	0.225	0.000	0.000	0.000	0.000	0.075	0.000	0.000	0.000	0.050	0.538
2013	0.190	0.433	0.165	0.120	0.050	0.031	0.270	0.000	0.071	0.316	0.262	0.604
Year_sanitation	Northcentral_gi_ll	Northeast_gi_ll	Northwest_gi_ll	Southeast_gi_ll	Southsouth_gi_ll	Southwest_gi_ll	Northcentral_gi_hh	Northeast_gi_hh	Northwest_gi_hh	Southeast_gi_hh	Southsouth_gi_hh	Southwest_gi_hh
1990												
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.018	0.321	0.338
2008	0.128	0.207	0.063	0.034	0.121	0.040	0.049	0.007	0.224	0.470	0.221	0.238
2010	0.025	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.200	0.000	0.385
2013	0.129	0.187	0.132	0.171	0.177	0.094	0.061	0.127	0.253	0.470	0.106	0.264
Year_water	Northcentral_gi_ll	Northeast_gi_ll	Northwest_gi_ll	Southeast_gi_ll	Southsouth_gi_ll	Southwest_gi_ll	Northcentral_gi_hh	Northeast_gi_hh	Northwest_gi_hh	Southeast_gi_hh	Southsouth_gi_hh	Southwest_gi_hh
1990												
2003	0.000	0.368	0.013	0.000	0.000	0.000	0.000	0.000	0.039	0.091	0.321	0.292
2008	0.067	0.236	0.052	0.137	0.100	0.007	0.061	0.043	0.080	0.256	0.257	0.245
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.075	0.100	0.000
2013	0.092	0.179	0.121	0.068	0.099	0.025	0.055	0.015	0.148	0.197	0.085	0.113

Table 18: Gini Indices for individuals (vertical inequality) in each zone for socioeconomic variables 1990 to 2013. Source: Author's calculations from DHS data.

	Year	Northcentral_gini_edyrs	Northeast_gini_edyrs	Northwest_gini_edyrs	Southeast_gini_edyrs	Southsouth_gini_edyrs	Southwest._gini_edyrs
1	1990		0.854	0.839	0.574		0.423
2	2003	0.522	0.702	0.739	0.433	0.364	0.42
3	2008	0.502	0.726	0.753	0.39	0.311	0.363
4	2010	0.545	0.734	0.756	0.349	0.292	0.36
5	2013	0.448	0.673	0.731	0.36	0.289	0.318
6	Year	Northcentral_gini_wealth	Northeast_gini_wealth	Northwest_gini_wealth	Southeast_gini_wealth	Southsouth_gini_wealth	Southwest _gini_wealth
7	1990		0.282	0.289	0.265		0.126
8	2003	0.261	0.297	0.257	0.222	0.227	0.223
9	2008	0.256	0.305	0.298	0.177	0.188	0.172
10	2010	0.25	0.308	0.266	0.117	0.156	0.136
11	2013	0.206	0.3	0.3	0.169	0.142	0.125
12	Year	Northcentral_gini_power	Northeast_gini_power	Northwest_gini_power	Southeast_gini_power	Southsouth_gini_power	Southwest _gini_power
13	1990						
14	2003	0.491	0.617	0.543	0.463	0.396	0.301
15	2008	0.631	0.752	0.632	0.386	0.434	0.318
16	2010	0.586	0.722	0.58	0.334	0.391	0.242
17	2013	0.506	0.682	0.57	0.352	0.365	0.182
18	Year	Northcentral_gini_sanitation	Northeast_gini_sanitation	Northwest_gini_sanitation	Southeast_gini_sanitation	Southsouth_gini_sanitation	Southwest _gini_sanitation
19	1990						
20	2003	0.849	0.936	0.925	0.784	0.688	0.701
21	2008	0.573	0.657	0.415	0.4	0.474	0.446
22	2010	0.648	0.712	0.407	0.521	0.614	0.402
23	2013	0.616	0.555	0.44	0.435	0.582	0.483
24	Year	Northcentral_gini_water	Northeast_gini_water	Northwest_gini_water	Southeast_gini_water	Southsouth_gini_water	Southwest _gini_water
25	1990						
26	2003	0.633	0.806	0.604	0.477	0.46	0.539
27	2008	0.531	0.696	0.537	0.467	0.509	0.367
28	2010	0.623	0.564	0.53	0.433	0.367	0.444
29	2013	0.433	0.532	0.424	0.375	0.447	0.37

Table 19: Horizontal (by geopolitical zone) and vertical inequality indices for socioeconomic variables 1990 to 2013. Source: Author's calculations from DHS data.

	Year_zone	nos_zones	GGini_wealth	GCov_wealth	GTheil_wealth	Gini_wealth	theil_wealth	frac_zone	polar_zone
1	1990	4	0.112	0.372	0.022	0.256	0.114	0.740	0.761
2	2003	6	0.074	0.278	0.009	0.262	0.117	0.829	0.563
3	2008	6	0.130	0.510	0.028	0.270	0.122	0.828	0.566
4	2010	6	0.135	0.553	0.030	0.243	0.104	0.832	0.558
5	2013	6	0.131	0.535	0.030	0.247	0.105	0.828	0.566
6	Year_zone	nos_zones	GGini_edyrs	GCov_edyrs	GTheil_edyrs	Gini_edyrs	theil_edyrs	frac_zone	polar_zone
7	1990	4	0.317	0.975	0.158	0.644	0.081	0.740	0.761
8	2003	6	0.179	0.720	0.055	0.550	0.084	0.829	0.563
9	2008	6	0.216	0.884	0.081	0.530	0.081	0.828	0.566
10	2010	6	0.209	0.853	0.076	0.512	0.078	0.832	0.558
11	2013	6	0.199	0.822	0.070	0.492	0.075	0.828	0.566
12	Year_zone	nos_zones	GGini_power	GCov_power	GTheil_power	Gini_power	theil_power	frac_zone	polar_zone
13	1990	4						0.740	0.761
14	2003	6	0.109	0.384	0.019	0.477		0.829	0.563
15	2008	6	0.184	0.770	0.057	0.544		0.828	0.566
16	2010	6	0.176	0.718	0.051	0.482		0.832	0.558
17	2013	6	0.166	0.638	0.044	0.456		0.828	0.566
18	Year_zone	nos_zones	GGini_sanitation	GCov_sanitation	GTheil_sanitation	Gini_sanitation	theil_sanitation	frac_zone	polar_zone
19	1990	4						0.740	0.761
20	2003	6	0.313	1.254	0.165	0.826		0.829	0.563
21	2008	6	0.100	0.401	0.018	0.499		0.828	0.566
22	2010	6	0.146	0.583	0.034	0.553		0.832	0.558
23	2013	6	0.082	0.335	0.011	0.517		0.828	0.566
24	Year_zone	nos_zones	GGini_water	GCov_water	GTheil_water	Gini_water	theil_water	frac_zone	polar_zone
25	1990	4						0.740	0.761
26	2003	6	0.155	0.559	0.045	0.597		0.829	0.563
27	2008	6	0.107	0.352	0.022	0.523		0.828	0.566
28	2010	6	0.097	0.382	0.015	0.495		0.832	0.558
29	2013	6	0.048	0.167	0.004	0.431		0.828	0.566

Table 20: Horizontal (by GREG ethnicity) and vertical inequality indices for socioeconomic variables 1990 to 2013. Source: Author's calculations from DHS data.

	Year_ethnicity	nos_ethnicities	GGini_wealth	GCov_wealth	GTheil_wealth	Gini_wealth	theil_wealth	frac_ethnicity	polar_ethnicity
1	1990	19	0.139	0.798	0.032	0.256	0.114	0.831	0.519
2	2003	22	0.097	0.657	0.017	0.262	0.117	0.870	0.427
3	2008	24	0.137	1.006	0.032	0.270	0.122	0.885	0.386
4	2010	18	0.135	0.859	0.032	0.243	0.104	0.881	0.400
5	2013	25	0.141	0.893	0.033	0.247	0.105	0.878	0.406
6	Year_ethnicity	nos_ethnicities	GGini_edyrs	GCov_edyrs	GTheil_edyrs	Gini_edyrs	theil_edyrs	frac_ethnicity	polar_ethnicity
7	1990	19	0.321	1.700	0.180	0.644	0.081	0.831	0.519
8	2003	22	0.195	1.222	0.060	0.550	0.084	0.870	0.427
9	2008	24	0.234	1.616	0.097	0.530	0.081	0.885	0.386
10	2010	18	0.223	1.375	0.098	0.512	0.078	0.881	0.400
11	2013	25	0.212	1.329	0.085	0.492	0.075	0.878	0.406
12	Year_ethnicity	nos_ethnicities	GGini_power	GCov_power	GTheil_power	Gini_power	theil_power	frac_ethnicity	polar_ethnicity
13	1990	19						0.831	0.519
14	2003	22	0.167	1.168		0.477		0.870	0.427
15	2008	24	0.218	1.668		0.544		0.885	0.386
16	2010	18	0.184	1.281		0.482		0.881	0.400
17	2013	25	0.203	1.341		0.456		0.878	0.406
18	Year_ethnicity	nos_ethnicities	GGini_sanitation	GCov_sanitation	GTheil_sanitation	Gini_sanitation	theil_sanitation	frac_ethnicity	polar_ethnicity
19	1990	19						0.831	0.519
20	2003	22	0.381	2.552		0.826		0.870	0.427
21	2008	24	0.138	1.032		0.499		0.885	0.386
22	2010	18	0.159	1.043		0.553		0.881	0.400
23	2013	25	0.095	0.786		0.517		0.878	0.406
24	Year_ethnicity	nos_ethnicities	GGini_water	GCov_water	GTheil_water	Gini_water	theil_water	frac_ethnicity	polar_ethnicity
25	1990	19						0.831	0.519
26	2003	22	0.196	1.407		0.597		0.870	0.427
27	2008	24	0.143	0.987		0.523		0.885	0.386
28	2010	18	0.171	1.168	0.062	0.495		0.881	0.400
29	2013	25	0.093	0.752		0.431		0.878	0.406

Table 21: Horizontal (by language (Yoruba, Hausa, Igbo, Other, English)) and vertical inequality indices for socioeconomic variables 1990 to 2013. Source: Author's calculations from DHS data.

	Year_language	nos_language_zone	GGini_wealth	GCov_wealth	GTheil_wealth	Gini_wealth	theil_wealth	frac_language	polar_language
1	1990					0.256	0.114		
2	2003	5	0.062	0.266	0.008	0.262	0.117	0.688	0.767
3	2008	5	0.099	0.404	0.018	0.270	0.122	0.671	0.776
4	2010	5	0.098	0.401	0.018	0.243	0.104	0.687	0.774
5	2013	5	0.111	0.393	0.021	0.247	0.105	0.687	0.781
6	Year_language	nos_language_zone	GGini_edyrs	GCov_edyrs	GTheil_edyrs	Gini_edyrs	theil_edyrs	frac_language	polar_language
7	1990					0.644	0.081		
8	2003	5	0.151	0.542	0.049	0.550	0.084	0.688	0.767
9	2008	5	0.176	0.616	0.058	0.530	0.081	0.671	0.776
10	2010	5	0.157	0.569	0.047	0.512	0.078	0.687	0.774
11	2013	5	0.173	0.565	0.055	0.492	0.075	0.687	0.781
12	Year_language	nos_language_zone	GGini_power	GCov_power	GTheil_power	Gini_power	theil_power	frac_language	polar_language
13	1990								
14	2003	5	0.097	0.406	0.020	0.477		0.688	0.767
15	2008	5	0.162	0.654	0.050	0.544		0.671	0.776
16	2010	5	0.146	0.541	0.037	0.482		0.687	0.774
17	2013	5	0.147	0.576	0.041	0.456		0.687	0.781
18	Year_language	nos_language_zone	GGini_sanitation	GCov_sanitation	GTheil_sanitation	Gini_sanitation	theil_sanitation	frac_language	polar_language
19	1990								
20	2003	5	0.246	0.958	0.109	0.826		0.688	0.767
21	2008	5	0.113	0.423	0.023	0.499		0.671	0.776
22	2010	5	0.160	0.572	0.045	0.553		0.687	0.774
23	2013	5	0.105	0.389	0.020	0.517		0.687	0.781
24	Year_language	nos_language_zone	GGini_water	GCov_water	GTheil_water	Gini_water	theil_water	frac_language	polar_language
25	1990								
26	2003	5	0.095	0.408	0.019	0.597		0.688	0.767
27	2008	5	0.109	0.360	0.021	0.523		0.671	0.776
28	2010	5	0.061	0.223	0.007	0.495		0.687	0.774
29	2013	5	0.073	0.244	0.009	0.431		0.687	0.781

Table 22: Horizontal (by gender) and vertical inequality indices for years of education 1990 to 2013. Source: Author's calculations from DHS data.

	Year_gender	nos_gender	GGini_edyrs	GCov_edyrs	GTheil_edyrs	Gini_edyrs	theil_edyrs	frac_gender	polar_gender
1	1990	2	0.132	0.373	0.035	0.644	0.081	0.500	0.999
2	2003	2	0.108	0.836	0.023	0.550	0.084		
3	2008	2	0.093	0.264	0.017	0.530	0.081		
4	2010	2	0.079	0.222	0.012	0.512	0.078		
5	2013	2	0.082	0.233	0.013	0.492	0.075		

A.2 Simple Theoretical Model: Sketch

The sections below outline a simple, stylized model driving the empirical specifications and results in this paper. The relationship between ethnic state leaders and the federal autocratic regimes can be conceptualized as 2 distinct but related sequential move games: Game 1 and Game 2. Game 1 outlines the average payoffs of a game between the ethnic state leaders and the British colonial autocrats spanning years 1885-1960. Game 2 continues from the close of Game 1 and outlines the average payoffs of a game between the ethnic state leaders and the Military postcolonial autocrats spanning years 1966-1999. Overall payoffs to ethnic state leaders and corresponding ethnic states is the sum of payoffs over these 2 games.

A.3 Game 1: Sequential-Move Game Between the Ethnic State Leaders (P2) and the British Colonial Autocrats (P1)

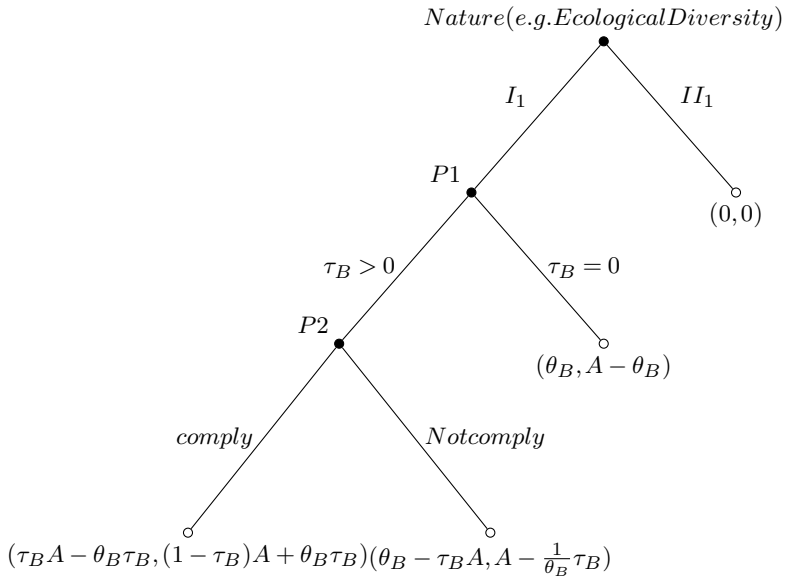

Figure 30: Sequential Move Game: (I_1, $\tau_B > 0$, comply) is a Nash equilibrium outcome

The game tree in Figure 30 depicts the average payoffs of a sequential move game (Game 1) between the British colonial autocrats (Player 1 denoted as P1 above) and a "continuum" of ethnic state leaders (Player 2 denoted as P2) lasting from 1885-1960 (Nunn, 2007). P2 can be from two types of ethnic states defined as below:

- I_1= centralized ethnic state in Game 1 (denoted as the $Cent_e$= 1 in the empirical specification)
- II_1 = non-centralized ethnic state in Game 1 (denoted as $Cent_e$= 0 in the empirical specification)

"Nature" (or ecological diversity used in this paper) determines P2's type. If P2 is of type II_1, the game ends with null payoffs, since bilateral bargaining under a strict form of indirect rule is impossible without an identified sovereign. If P2 is of type I_1, the game proceeds as depicted in Figure 30 with P1 as the initial mover in the first stage. The payoffs of the game are determined by a bilateral bargaining and reward/punishment scheme between the British colonial autocrats and the centralized ethnic state leaders. When the centralized ethnic state leaders were compliant with British colonial autocrats, they were rewarded with some proportion of federal benefits $\theta_B \in (0,1)$ (e.g. in terms of public service provision like railroad construction (Gardner, 2012) and increased political autonomy in their region (Ogbomo, 2005; Otoide, 2005)). When the centralized ethnic state leaders were not compliant with the British colonial autocrats, they were punished by a withdrawal of these benefits (e.g. forfeited autonomy through bloody depositions and exiles (Ogbomo, 2005; Otoide, 2005)). The ethnic state leader's centralized status allows the British autocrats to monitor and target punishment in a so-called punishment regime (Magaloni, 2006). compliance in Game 1 with the British colonial autocrats entailed adherence to the fiscal policy instrument described below.

In the first stage of Game 1, the British colonizer (P1) moves, choosing a fiscal policy instrument τ_B. The instrument, $\tau_B \in (0,1)$ is a fiscal transfer or a "rate of extraction" that defines the proportion of the initial wealth of the ethnic state A (with $A \in [0,1]$) (measured in amounts of agricultural commodities produced- most notably cash crops like cocoa, groundnuts and palm kernel) that is expropriated by the British colonial regime (Nunn, 2007). The policy instrument τ_B can be taxes collected by the British federal autocratic regime, levies or any fiscal transfers to the federal autocratic regime from the centralized ethnic state leader P2 of type II_1.

If the British colonizer chooses the no tax regime ($\tau_B = 0$), then the game ends and the expected payoff to the colonizer is θ_B, the benefit that would have been transferred to the ethnic

state leader. The expected payoff to the centralized ethnic state leader is $A - \theta_B$, their initial wealth minus the foregone benefits from the tax instrument.

If the British colonizer chooses the positive tax regime ($\tau_B > 0$), then the centralized ethnic state leader, in the second stage of the game, can choose to "comply" and hand over collected tax revenue or "Not comply" and do the opposite. When the centralized ethnic state leader chooses to comply, the expected payoff to the British colonial autocrats is $\tau_B A - \theta_B \tau_B$ or the proportion of the initial wealth expropriated minus the amount of the benefit given to the ethnic state leader, scaled by the amount of the tax. The expected payoff the centralized ethnic state leader from compliance is $(1 - \tau_B)A + \theta_B \tau_B$ or the proportion of the initial wealth transferred to the British colonial autocrats plus the corresponding benefit.

When the centralized ethnic state leader chooses not to comply under the positive tax regime, the expected payoff to the British colonial autocrat is $\theta_B - \tau_B A$, the withheld benefit. The expected payoff to the centralized ethnic state leader from non-compliance under the positive tax regime is $A - \frac{1}{\theta_B}\tau_B$, the full value of the initial wealth minus the foregone benefit or punishment scaled as the inverse of θ_B times the tax. A weak restriction on the parameters is placed as follows: $\theta_B \leq \tau_B \leq A$.

Proposition A.1. *For values of $A \gg (\tau_B, \theta_B)$ and $\tau_B - \theta_B = \epsilon \to 0$, the second stage subgame has a Nash equilibrium in which $(I_1, \tau_B > 0, comply)$ is an equilibrium outcome.*

A.4 Game 2: Sequential-Move Game Between the Ethnic State Leaders (P2) and the Military Postcolonial Autocrats (P1)

The game tree in Figure 31 depicts the average payoffs of a sequential move game (Game 2) between the Military postcolonial autocrats (Player 1 denoted as P1 above) and a continuum of ethnic state leaders (Player 2 denoted as P2) lasting from 1966-1999. Continuing from Game 1 and following differential British policy between the Muslim north and the south of the country, P2 can be from two types defined as below:

- $I_2|I_1$= hegemonized ethnic state in Game 2 given was centralized in Game 1 (denoted as the $S.Muslim_e$= 1 and $Cent_e = 1$ in the empirical specification)

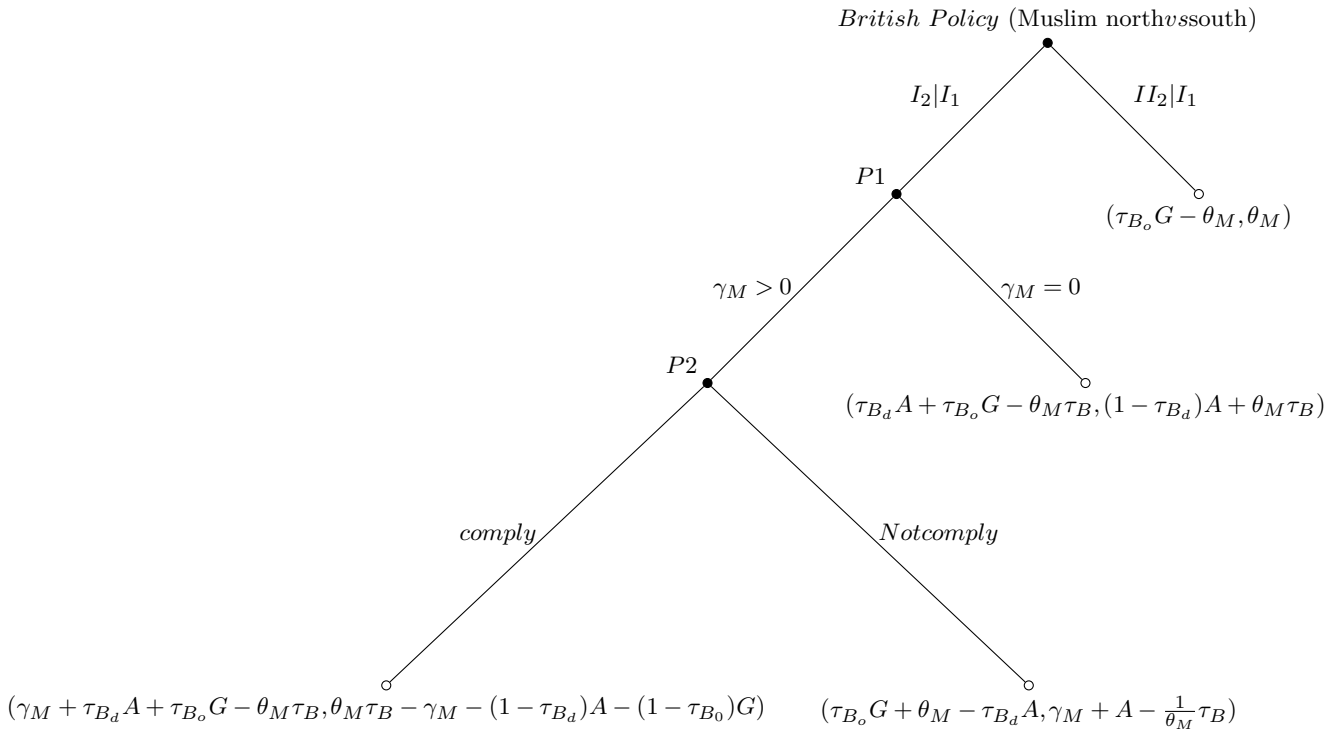

Figure 31: Sequential Move Game: ($I_2|I_1$, $\gamma_M > 0$, Not comply) is a Nash equilibrium outcome

- $II_2|I_1$ = non-hegemonized ethnic state in Game 2 given was centralized in Game 1 (denoted as the $S.Muslim_e$= 0 and $Cent_e = 1$ in the empirical specification)

Differential British policy between the Muslim north and the south of Nigeria led to strengthening of sovereignty among centralized ethnic state leaders in the Muslim north of the country, a process termed pre-independence hegemonization here. It led to the weakening of sovereignty among centralized ethnic state leaders in the south of the country, a process termed non-hegemonization here. Centralized ethnic state leaders in the south (including the non "super-majority Muslim" north) were eventually replaced by mostly democratically elected local officials, marking a gradual to near complete loss of sovereignty in their regions by the beginning of the military era with the reverse process occurring in the Muslim north as a result of differential British policy towards both regions (Mamdani, 1996; Dudley, 1968; Tonwe and Osemwota, 2013). It was the policy that determined Player 2's type in Game 2. The early part Game 2, notably the 1970s, marked a change in the composition of federal revenue with the share of oil revenue in government revenue rising to over 80%

and the share of agricultural revenue falling dramatically in comparison. The change was driven by an oil boom and rising oil prices leading to huge windfalls for the regime in revenue from petroleum (Tonwe and Osemwota, 2013; Mustapha, 2006; Olasupo, 2001). Wealth from oil is denoted as $G \in [0,1]$ in Game 2. The tax instrument, modeled after the British system, is $\tau_B = \tau_{B_d} + \tau_{B_o}$, the sum of domestic taxes of primarily sourced from agricultural commodities initial wealth A, denoted as τ_{B_d} and corporate taxes of foreign oil companies sourced from oil wealth G, denoted as τ_{B_o}. As before, $\tau_B \in (0,1)$. Nationwide public service provision by the military autocrats in the 1970s-1980s, particularly regarding investments in grid based electricity and sanitation infrastructure like flush toilets, was funded, primarily, by the oil windfall (Tonwe and Osemwota, 2013; Uduku, 1994). These military funded federal benefits are denoted as $\theta_M \in (0,1)$ here. Rules of the game regarding bilateral bargaining and reward/punishment scheme are as in Game 1. When the hegemonized ethnic state leaders (P2 of type $II_2|I_1$) were compliant with military postcolonial autocrats, they were rewarded with some proportion of federal benefits θ_M (e.g. access to federal state controlled public services). When the hegemonized ethnic state leaders (P2 of type $II_2|I_1$) were not compliant with the military postcolonial autocrats, they were punished by a withdrawal of these benefits. As in Game 1, the ethnic state leader's hegemonized status allows the military autocrats to monitor and target punishment in a punishment regime (Magaloni, 2006). Compliance in Game 2 with the military postcolonial autocrats entailed adherence to the legal policy instrument described below.

When P2 is of type $II_2|I_1$, the game ends trivially with an expected payoff to the military autocrat of the proportion of the taxed oil revenue less the national public service provision described above, and the expected payoff to non-hegemonized ethnic states of the public service provided $\theta_M \tau_B$ as depicted in Figure 31.

In the first stage of Game 2, the military autocrat (P1) moves, choosing a legal policy instrument γ_M. The instrument, $\gamma_M \in [0,\infty)$ is a legal transfer of political autonomy from ethnic state leaders to the federal military government through the landmark 1976 Local Government Reform law. The 1976 law removed ethnic state leaders from their posts as official representatives of local government, and banned them from participation in democratically elected local governments propped up by the military party system. It relegated them to advisory roles only. It also allowed

for an official grant for the local government leaders as a proportion of mostly oil-fueled federal revenue (Tonwe and Osemwota, 2013; Hickey, 1984; Mustapha, 2006; Blench et al., 2006).

If the military autocrat chooses the no legal policy regime ($\gamma_M = 0$), then the game ends and the expected payoff to the military autocrat is similar to the equilibrium scenario in Game 1 (described in Proposition A.1), with the expected payoff to the military autocrat equal to $\tau_{B_d}A + \tau_{B_o}G - \theta_M\tau_B$, or the sum of the proportion of initial wealth and government revenue appropriated minus the proportion spent on public benefits or public service provision $\theta_M\tau_B$. The expected payoff to the hegemonized ethnic state leader is $(1-\tau_{B_d})A + \theta_M\tau_B$ or the sum of the proportion of initial wealth retained and and public services provided by the federal regime.

If the military autocrat chooses the positive legal policy regime ($\gamma_M > 0$), then the hegemonized ethnic state leader, in the second stage of the game, can choose to "comply" and step down from their official post without inciting rebellion among their constituents or "Not comply" and refuse to step down, typified by refusal to abstain from local governance politics, withholding tax revenue and, notably from the historiography, inciting rebellion among their constituents (Hickey, 1984; Tonwe and Osemwota, 2013). When the hegemonized ethnic state leader chooses to comply, the expected payoff to the military autocrats is $\gamma_M + \tau_{B_d}A + \tau_{B_o}G - \theta_M\tau_B$ or the sum of the political autonomy transferred from the ethnic state leader to the military autocrat, some proportion of the initial wealth and government revenue minus the proportion spent on public benefits or public service provision. The expected payoff to the hegemonized ethnic state leader is $\theta_M\tau_B - \gamma_M - (1-\tau_{B_d})A - (1-\tau_{B_0})G$ or the public service provision issued from the military autocrat minus the political autonomy given up, along with the proportion of initial wealth and government revenue given up by the ethnic state leader with the relinquishing of their position as an official local government representative.

When the hegemonized ethnic state leader chooses not to comply under the positive legal policy regime, the expected payoff to the military autocrat is $\tau_{B_o}G + \theta_M - \tau_{B_d}A$ or the proportion of oil wealth kept along with the share of public benefits θ_M minus the proportion of the initial wealth $\tau_{B_d}A$ withheld by the non-compliant ethnic state leader (note, there is no loss of political

autonomy by the military autocrat here since the aim of the legal policy is a unilateral transfer of autonomy). The non-compliant hegemonized ethnic state leader receives an expected payoff of $\gamma_M + A - \frac{1}{\theta_M}\tau_B$ or the withheld political transfer γ_M and initial wealth minus the withheld public services (or plus a punishment) from the federal regime equal to the scaled inverse of θ_M. A weak restriction on the parameters is placed as follows: $G > A$ and $\tau_{B_o} \gg \tau_{B_d}$.

Proposition A.2. *For values of A, γ_M, θ_M and τ_B such that (A, γ_M) $> \theta_M$ and $\tau_B < \theta_M$ with $\tau_{B_d} \to 0$ (note in alternate, simplified versions of the model, τ_{B_d} can be normalized to 0 with no change in the results), the second stage subgame has a Nash equilibrium in which ($I_2|I_1$, $\gamma_M > 0$, Not comply) is an equilibrium outcome. When (A, γ_M) $> \theta_M$ and $\tau_B < \theta_M$, 'Not comply' is a dominant strategy for player 2 in Game 2.*