Colonial origins of comparative development in Ghana

Iddrisu Kambala, Mohammed

University of South Carolina, Colombia, United States

1 January 2022

Colonial Origins of Comparative Development in Ghana

Mohammed Iddrisu Kambala [a]

[a] *Department of Economics, University of South Carolina, Columbia, USA*

Darla Moore School of Business, University of South Carolina, 1014 Greene St. Columbia, SC 29208. iddrisu.kambala@grad.moore.sc.edu

Colonial Origins of Comparative Development in Ghana

A striking feature about Ghana's development landscape is the stark development disparity between a relatively developed South and a trailing North. Explanations for the disparity have often been hinged on differences in geography and past colonial experience. In this study, I provide an empirical justification to the historical hypothesis that the dynamics of colonial rule contributed significantly to the development divergence between the North and the South. I exploit the asymmetric regional distribution of past colonial public investments in education, health and infrastructure to show that the dynamics of colonial rule explain a significant portion of the development disparity between the two regions. I also survey compelling historical anecdotes to show that prior to the colonial project the North was a relatively prosperous region.

Keywords: Colonial Rule, Development Disparity, Colonial Investments, Northern Ghana, Southern Ghana.

> I would not at present spend upon the Northern Territories …. a single penny more than is absolutely necessary for their suitable administration…..
>
> –Sir Frederick Mitchell Hodgson, Governor of Gold Coast, 1898 – 1900 (as cited in Eades, 1993, p.29)

> Prior to [colonial rule], Ghana's economy was oriented towards trade ….. Commodities from the forest belt …. were traded along routes through the north of present day Ghana onwards to the Sudanese Kingdoms and North Africa. As a result, cities and states formed in the north of the country. At this time, trade flowed from south to north; Ghana's northern part was relatively more prosperous and populated than the south. (Geier et al., 2015, p.105)

I. Introduction

An incessant development problem in Ghana is the deep-rooted development divergence between Northern Ghana and Southern Ghana. The North, a region with more than 70 percent of its population living in disadvantaged rural areas (Yaro, 2013), trails the South in practically all metrics of development. It also records unencouraging growth performance: between 1991–2006 the North's growth rate was about 35 percent that of the South. Over the same period the North and South reduce their incidence of poverty by 9 percent and 59 respectively (Oteng-Ababio, Mariwah, & Kusi, 2017).

There are two prominent strands of literature that explain the development disparities between the two regions. The first strand, the geography hypothesis, associates the North's underdeveloped status to its geography (for example see Shaffer, 2015, 2017). A region devoid of mineral resource, the North has an arid climate and primarily covered in savannah woodland with no significant potential for cash crop cultivation (Dickson, 1968). The mineral-rich South, covering about 56 percent of total land area of Ghana and a population (24.5 million) four times that of the North, comprises mostly of rainforest with significant cash and export crop production.

The other strand attributes the North's long-term underdevelopment to its past colonial experience (Bening, 1975; Plange, 1979b, 1979a, 1984; Songsore, 2003). This historical school argues that prior to the colonial conquests, the North was relatively more prosperous having built a fortune entirely on trade and industry. Others such as Geier et al. (2015) hold that the North was relatively more developed than the South in precolonial times.

There are various colonial practices that acted to change the future development trajectories of the North. Principally, the Colonial State administered the North and the South respectively as a "periphery" and a "core" whereby Northern interest and development were sidelined (Brukum, 1998; Grischow, 1999; Plange, 1979b, 1979a, 1984; Songsore, 2003). Among other things, colonial investments and expenditures in the region were also kept at a minimum barely enough to keep the administration.

Even though there are compelling anecdotal evidences implicating colonialism as a principal cause of the North's long-run development problem, to my knowledge, no empirical work has yet justified this claim. In this study I investigate empirically the colonial roots of the North's underdevelopment, hence the development divergence. I exploit an empirically more feasible channel – past colonial investments – to examine the extent to which the dynamics of colonial rule contribute to the current development disparity between the North and the South.

I begin by estimating the current development gap between the North and the South using nighttime light as proxy for local development. Conditioning on numerous cell-level, geography controls, I estimate that a place in the North is on average 51 percent less developed relative to a comparable place in the South. This suggests that the geography hypothesis alone cannot entirely explain the development divergence between the two regions. The estimate also does not change when I confine the analysis to a defined corridor around the North-South border, where local observables are comparable.[1]

I then explore the spatial distribution of colonial public investments in education, health and infrastructure. A snapshot of regional distribution of past colonial public investments suffices. Northern Ghana had no class one road as at 1931 and no colonial railway throughout the colonial period. As at 1931, out of about 333 schools, the North had eight schools. It also had 6 places with hospitals while the South had 24. These statistics are robust to cell-level controls. Also, due to the inherent attributes of colonial investments – locally repetitive, increasing returns, longer physical duration, positive externality – the South continued to be a preferred destination for subsequent colonial investments.

Next I investigate how these investments stimulated local development in the South. I find that colonial investments, railways in particular, stimulated local economic activities, hence local development, in the South. This finding echoes Herranz-Loncán & Fourie's (2018) observation that economic activities in the colonial era followed the railway tracks.

Further, I demonstrate that past colonial investments still strongly determine contemporary development in Ghana. Places closer to locations of past colonial investments are still relatively more developed today. Current development outcomes in Ghana are also more heavily driven by colonial-era factors as opposed to contemporary (post-independence) factors.

I further show that these permanent effects are strong in both the North and the South. That is, even though the North received remarkably fewer colonial investments, areas closer to the locations of colonial investments in the North are relatively more developed today than other areas in the North, suggesting that colonial investments were equally productive in the North. I also show that initial conditions and/or colonial investments made prior to the formal colonization of the North do not explain the development gap.

Additionally, I use some proposed Northern railway lines as placebos and as counterfactuals for the Southern railway lines. This allows me to investigate the presence of spurious effects and the otherwise current development status of an average northern place had it got connected to a colonial railway. I find no spurious effects associated with the placebo lines, and my estimates suggest that an average place in the North should have been at least 4.5 times more developed had it got connected to a colonial railway line.

Lastly, I test the mediating power of colonial investments on the current development gap. I find substantial reduction in the size of the development gap once it is conditioned on past colonial investments, further corroborating that colonial rule can readily explain the development gap between the North and the South.

In the online Appendix A, I survey the historical development levels of the regions, focusing primarily on the political and economic history of the North. Anthropological data and historical anecdotes corroborate that the North was relatively a prosperous region in precolonial times. I also closely look at colonial policies and practices that might have acted to impede the future development of the North.

The rest of the study proceeds as follows. In the next section I explore the current development gap between the two regions using nighttime light and household survey data. I examine the asymmetric regional distribution of past colonial public investments in section III. In section IV, I combine a number of estimation strategies and investigate how the asymmetric regional distribution of past colonial investments stirred local development in the South and how it helps explain the North-South development divide. Section V concludes the study and provides some policy insights for development.

II. The Current Development Disparity

I use stable light density at night[2], sourced from the US Airforce Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS), as a proxy for local development. Nighttime light is a fine-grained, processed, high resolution satellite images that display the 'lightness' of a place at night. The processed satellite images are converted to pixels, each measuring approximately 1 sq. km. Each pixel is assigned a digital number (DN) ranging from 0 to 63, where 0 depicts unlit areas (Pinkovskiy, 2013). Nighttime light is used in the development literature as a proxy of local economic activity because it has a strong correlation with various measures of development in both national and subnational levels (Doll et al., 2006; C. D. Elvidge et al., 1997; Sutton & Costanza, 2002). It also provides an informational value for countries that have poor quality statistical systems (Chen & Nordhaus, 2011) and available at a finer geographic unit.

Following Jedwab & Moradi (2016), I construct 11km x 11km, 2091 cells and extract their nighttime lights. I measure local development by a cell's average nighttime light. Performing the analysis at such precise pixel level mitigates the "noise" associated with aggregate data and the effects of hard-to-account-for confounders. Map B.1 in the online appendix shows light density at night in Ghana in 2013.[3]

I estimate the development gap between Northern Ghana and Southern Ghana using the following specification:

$$\ln y_c = \beta_0 + \beta_1 \text{North}_c + \chi_c' \Phi + \varepsilon_c \qquad (1)$$

$\ln y_c$ is log average light density of cell c, where c = 1,2, 3,…,2091.[4] I add .01 to the luminosity data before log-transforming it, that is $\ln y_c \equiv \ln(0.01 + \text{luminosity})$.[5] This approach allows me to use the whole sample, and also reduces the skewness of the luminosity data.

North is a dummy equal to 1 if the (centroid of the) cell falls in the North and 0 otherwise. During colonial times Ghana was broadly divided into three regions (map 1): The Gold Coast (GC), Ashanti, and The Northern Territories (NTs).[6] I treat GC and Ashanti as South and NTs as North (see online Appendix A for detailed historical background). The coefficient of interest is β_1 which depicts the current development differential between the two regions. I hypothesize that $\beta_1 < 0$ and large.

The vector χ' captures cell-level geography, ecology and climate controls. These controls include average year precipitation (1970–2000), average year temperature (1970–2000), mean altitude, average soil caloric suitability, distance to a navigable river, presence of mineral mines, dummies for cells that border another country, and dummies for cells that border the seacoast.[7] These controls address concerns that the two regions diverge due to differences in geography, climate, ecology and land endowments.

I also include region fixed effects to control for region-wide varying, time-invariant regional, (un)observable characteristics.[8] Lastly, I cluster robust standard errors at the district level to allow for correlation of errors at the lowest subnational political unit. The definitions and sources of these variables are outlined in online appendix table B.1.

Table 1 reports the OLS estimates of the current North-South development gap. Controlling for only region fixed effects, column 1 shows that a cell from the North is about 81 percent[9] less developed relative to a comparable cell from the South. After adding the geography, climate, and ecology controls in the second column, the North coefficient dramatically drops from 1.622 to 0.591.[10] The coefficient is still however statistically and economically significant. The magnitudinous drop indicates that differences in geography, climate and ecology play important roles in the North-South development divide, yet these factors alone do not explain the divergence.

In column 3 I add controls for economic geography and land endowments. These factors moderately increase the North coefficient. The coefficient estimate in column 3 suggests that, conditioning on all cell-level observables and region fixed effects, a northern cell is on average 51 percent less developed relative to a comparable southern cell. The results generally suggest that differences in geography, climate, ecology and land endowments cannot fully explain the development gap.

Though the cell-level estimation mitigates the effects of aggregate-level, hard-to-account-for factors, the north-south cells may not have comparable local observables. Therefore, the true estimate could be upward or downward biased. To address this concern, in columns 4 and 5 I restrict the sample to cells that lie within 50km from the North-South border. The main identifying assumption is that cells within this corridor have roughly comparable cell-level observables. Therefore, estimation at this level should provide a purer local estimate of the development gap between the two regions.

The estimates in columns 4 and 5 reveal two important facts about the development gap. First, restricting the analysis to the 50km border area does not change the previously estimated development differential. A plausible explanation for this result is that northern cells are uniformly underdeveloped, hence the choice of sample area does not alter the estimate of the development gap between two average north-south cells. Second, column 5 shows that the cell-level controls do not change the unconditional estimates in column 4, implying that cells within this corridor are effectively comparable.

This border-window results would be particularly useful when choosing north-south counterfactual cells to extrapolate the effects of colonial investments in Southern Ghana.

In other words, the choice of the set of northern cells to be used as controls for southern cells should not change the counterfactual estimates.

A drawback with the above analysis is that Northern Ghana has more rural and uninhabited areas relative to Southern Ghana, hence cell-level estimation may inflate the development differential between the two regions. To address this, I corroborate the fined-grid, nighttime light findings in two ways. First, I show that there is a strong visual correlation between spatial public goods provision and nighttime light. I use rounds 5, 6 and 7 geocoded household survey data from Afrobarometer[11] to gauge access to public goods – electricity, school, health clinic, sewage, piped water, police station, post office, paved road – at the district level across the North and the South. Survey questioners input a value of 1 if a public good is available within a walking distance from the Primary Sampling Unit (PSU) and 0 otherwise.

Since districts have different sizes (Northern districts are generally larger), I normalize average access to public goods within a district by the area (km sq.) of the district. Maps B.2–B.9 in online appendix show the quintile distribution of access to public goods at the district level. The maps show a strong visual correlation with the nighttime light map. In all cases, the lower quintiles are heavily populated by Northern districts while the top quintile is dominated by southern districts.

Second, I exploit the same survey data to show differences in asset ownership including radio, television (tv), mobile phone, and motor vehicle. I also look at whether households have toilets and piped water inside the compound. Radio, tv, phone, and motor vehicle take a value 1 if the respondent personally owns it and 0 otherwise. Household toilet and water source take a value 1 if the toilet and piped water are located outside of the compound and 0 if inside. I control for respondents' education, age, gender, and place of residence (urban or rural). I also add survey rounds dummies to account for differences in survey structures and timings, and changes in socioeconomic conditions overtime.

The results, reported in appendix table B.2, suggest that northern households are relatively poorer than southern households. An average person in a northern household reported radio, tv, and mobile phone ownership of about 14.5, 21 and 9 percentage points lower than an average person from a southern household. Also, toilets and piped water sources are respectively 5.5 and 8.2 percentage points more likely to be located outside of the household in the North relative to the South. Northern households are only relatively better in terms of ownership of motor vehicle.

[Map 1 here]

[Table 1 here]

III. Colonial Public Investments

I now investigate the regional disparities in colonial public investments. I use four proxies of colonial public investments, namely railroads, class one roads, schools, and hospitals. I obtain geocoded data on colonial schools, hospitals, and class one roads from (Cogneau & Moradi, 2014; Jedwab & Moradi, 2016). The authors compiled the data on schools and hospitals from mainly the Government Education Reports and Statistical yearbooks and the Blue Books, and geocoded their locations using GEONet Names Server. They digitize the class one roads using maps from (Dickson, 1971).

There are 333 assisted colonial schools[12] and 30 places with hospitals. The exact number of hospitals is not known because the authors code hospitals as 1 or 0 for cells that have or do not have hospitals respectively. Therefore the minimum number of hospitals as at 1931 was 30. This also means that the centroids of the cells are the locations of colonial hospitals.

For the railway lines, I intersect the map of Ghana with the World Food Program (WFP) GeoNode's digitized global railway lines.[13] The global railway network is constructed by the Emergency and Preparedness Geospatial Information Unit of the WFP. I use railway lines that were built during the colonial era.

Maps 2, 3 and 4 respectively display the geographic distributions of colonial schools and hospitals, railways, and class one roads. Online appendix table B.3 tabulates this data. In 1901 the North had no school or hospital whereas the South had 125 schools and 8 places with at least one hospital. The North received its first assisted school in 1907. As at 1919, the North had 4 schools while the South had 209 schools.[14] By 1931 the number of schools in the South had jumped to 325 and places with hospitals increased to 24.

Conversely, the number of schools in the North had only doubled to 8 and only 6 places had at least one hospital.

The North also did not have immediate access to railroads and class one roads. Average distances to a colonial railroad were 324km and 59km for northern cells and southern cells respectively. Finally, whereas northern cells' average distance to a class one road in 1931 was about 196km, it was 32km for southern cells.

I test the robustness of the foregoing statistics to cell-level controls using specification (2):

$$\mathrm{CI_c} = \alpha_0 + \alpha_1 \mathrm{North_c} + \chi_c' \psi + \varepsilon_c \qquad (2)$$

where $\mathrm{CI_c}$ represents colonial investments – schools, hospitals, railways and roads. The coefficient of interest is α_1, which is expected to be negative for schools and hospitals, and positive for class one roads and railroads. In all specifications, I include dummies for cells that border another country and cells that lie within 10km from the coast. I also control for distance to a navigable river, mean altitude, and the presence of mineral mine as of 1931.

The motivation for these controls is that local terrain such as mean altitude and proximity to river can directly affect colonial investments, particularly the construction of rails and roads. Border areas would be less likely to receive colonial investments, whereas coastal belts would most likely be preferred since they facilitated long-distance trade. Mineral-endowed areas would most likely be selected into colonial investments due to the potentially high returns on investments.

I also add initial number of schools and presence of hospitals as of 1901 to control for "initial conditions". This accounts for colonial investments made prior to the formal colonization of the NTs. Controlling for initial investments also allows me to determine whether future colonial investments continued to be channeled to initially preferred areas or whether colonial investments had long duration. A positive coefficient, for example, means that initially preferred areas continued to receive more colonial investments in the future. It could also mean colonial investments, once made, lasted a longer period.

The results, displayed in table 2, confirm that colonial public investments primarily disfavored the North. An average northern cell had a significantly fewer colonial schools relative to an average southern cell. The hospital coefficient, though assumes the expected sign, is not statistically significant conditioned on cell-level controls. Compared to the insights from the summary statistics, the smaller sizes of the estimates here imply that local terrain and other location fundamentals strongly influenced the location of colonial schools and hospitals.

Class one roads and railway lines were also significantly farther away from northern cells. Compared to a southern cell, an average northern cell would "travel" an additional 230 km to reach a colonial railway line. Similarly, average distance to class one roads for a northern cell is about 150 km longer than that of average an average southern cell. The sizes of the class one roads and railroads point estimates point to the fact that the NT had none of these infrastructures.

The results also show that initially preferred areas were also more likely to be selected into future colonial investments.[15] One extra colonial school as at 1901 is associated with about one extra colonial school as at 1931. Places that had a minimum of one colonial hospital as at 1901 were about 87 percentage points more likely to have a hospital as at 1931. Average distances to class one roads and railroads reduce by about 8.6km and 15km for every additional colonial school as at 1901. Conversely, average distance to railway lines is relatively longer for places that had hospitals as at 1901. This is probably because railways lines were not primarily built to serve hospitals.

The results also suggest that the presence of minerals might have influenced the spatial distribution of colonial public investments. Average distance to railway lines reduces by about 32km for mineral cells relative to non-mineral cells. Mineral cells had about two extra schools relative to non-mineral cells; they were also about 40 percentage points more likely to have hospitals. The fact that colonial public investments strongly favored areas endowed with mineral resources may partly explain the lack of colonial investments in the NTs, a region devoid of mineral resources.

[Map 2 here]

[Map 3 here]

[Map 4 here]

[table 2 here]

IV. Colonial Public Investments and the Development Gap

I now explore a number of estimation strategies to determine the extent to which the asymmetric geographic distribution of colonial public investments contributes to the development gap between Northern Ghana and Southern Ghana.

(1) *Effects of Colonial Public Investments in Southern Ghana*: I first examine how the substantial colonial public investments in Southern Ghana stimulated local development. I create dummies for cells that lie within 10km, 10km – 20km, and 20km – 30km from the location of colonial public investments. I focus mainly on the 10km cells as the effects of confounders aggravate as distance increases. To be able to infer causality, I test whether the 10km and 10km – 20km rail and road cells are significantly different from each other.[16] Panel A of online appendix table B.4 shows that the 10km and 10-20km railway cells are not significantly different from each other. However, for roads, the 10km cells are marginally closer to the sea and farther from the border and have relatively flat plain (Panel B of table B.4).

I use a similar approach to test the degree of comparability of cells located closer to schools and hospitals. However, unlike railways and roads which were more clustered together and followed specific spatial terrain, schools and hospitals were geographically more broadly distributed, implying that the 10km and 10-20km cells may not necessarily have similar observables. Notwithstanding, for hospitals I find that, except differences in proximities to the seacoast and the border, the 0-10km and 10-20km cells are not significantly different from each other. This is likely due to the remarkably fewer number of hospitals.

My analysis focuses heavily on railways because unlike the other investments, the dates of construction and completion of railway lines are well documented. This allows me to examine the before-and-after effects of railway lines on outcomes of interest. Also, the mechanisms via which railway lines affect local development are more apparent. Railways reduced cost of transportation (Donaldson, 2018), thereby facilitating the easy movement of labor, goods, capital, raw materials, and minerals in surrounding areas. Once built, railways spurred economic activities in the surrounding areas (Due, 1979) and generated a spatial economic geography (Herranz-Loncán & Fourie, 2018).

The mechanisms via which roads affect local economic activities should be generally identical to those of railways albert road transportation was relatively more expensive and was not suitable for heavy-duty freight. Roads and railways might have complemented each other in some respects, as in feeding each other with passengers, raw materials, and commodities.

Schools and hospitals, on the other hand, could spur local population growth, hence economic activities, if people are willing to move to or settle in areas with easier access to these amenities. However, schools and hospitals could also be endogenous to local conditions because they might have been provided to meet demands of more populated areas. Indeed, I find that the 10km railway cells had more hospitals and schools (unreported estimates). Jedwab & Moradi (2016) argue that either the railway lines stirred local population growth which led to the construction of hospitals and schools to meet demand or railways and these local amenities were built simultaneously, thereby increasing population growth. I address this challenge below.

The railway lines (map 3) were built at different times. The first line was the Sekondi-Tarkwa line which started in 1898 and completed in 1901. The line was extended to Obuasi and Kumasi in 1902 and 1903 respectively. By 1930, all the railway lines except the Kotoku-Achiasi line and the Achimota-Tema-Shai Hills lines had completed. The last line Achiasi-Kotoku was opened in 1956, barely a year before political independence.

I show that the constructions of these lines in the South stimulated local economic activities as evidenced by increased local population. I use pre-and-post railway populations to show the effects of railway construction on population growth. I standardize the population variable (z-scores) because population automatically grows over time.[17] One major limitation is that the data contains only one pre-railway cells' urban population data in 1891.

In column 1, table 3, I regress the 1891 cells' urban population on sites that had railway lines by 1930, and find no effects. In other words, prior to the construction of the railways, population growth around sites that subsequently got connected to railway lines was not different from other areas. This finding is in line with that of (Jedwab & Moradi, 2016) even though their analysis focuses mainly on cocoa-growing areas.

Rerunning the same regression with post-railway populations as dependent variables, I find a significant, robust impact of railway construction on local population growth. Colonial-era local populations (1931 and 1948), hence local economic activities, followed the railway tracks. These results confirm the narratives that railways, which paved hitherto uncultivated, forested lands and lowered cost of transportation, pulled labor from other parts of the country and from the neighboring countries (Austin, 2007). The rest of the columns show that the railway effects on local economic activities in Southern Ghana persisted long after colonial rule.[18]

For schools, hospitals and roads I cannot run pre-and-post regressions to determine their effects on local population growth because their dates of construction are not properly documented. Since I only have data on schools, hospitals and roads as at 1931, I can however control for initial population conditions. Thus, I include 1891 and 1901 cell population as additional controls in the specification. Panels A, B and C of online appendix table B.5 show that conditioned on initial population conditions, population continued to grow in areas with colonial hospitals, schools and roads during and after colonial rule. The effects of schools are however not statistically significant in the postcolonial period.

I check whether the effects of schools and hospitals are driven by spillover effects of railway lines since these amenities were closer to railway lines. In panels D and E of online appendix table B.5, I exclude all cells that are within 20km from railway lines. The magnitudes of the hospital coefficients record significant drops but they maintain their statistical power. The effects of schools are now statistically significant in both the colonial and postcolonial periods.

(2) ***The Permanent Effects of Colonial Investments***: I now examine whether these effects persist till present day using the whole sample. The persistence of the effects of past colonial public investments implies that the North, deprived of these investments, would be relatively less developed today.

I investigate the permanent effects of past colonial public investments on current development using the following specification:

$$\ln y_c = \beta_0 + \beta_1 CI_c + \chi_c' \Phi + \gamma POP_{c,t} + \lambda Road_c + \varepsilon_c \qquad (3)$$

$POP_{c,t}$ is z-scores of cell c's population at time t, where t = 2000, 1984, 1970, 1960, 1948 and 1931 and 1901.[19] $Road_c$ represents cell c's access to modern road which includes access to good roads and class one roads. It is necessary to control for road network because the constructions of roads rapidly increased in postcolonial Africa while the constructions of railways stagnated (Due, 1979). So the road control accounts for the development effects brought about by roads in the postcolonial era. In addition to the previous cell-level controls, I also control for distance to the capital city to net out the effects of clustered development in and around the capital city.

A concern is that the North was belatedly colonized (1901) and colonial investments made prior to its official colonization may also still influence current development. So I control for 'initial conditions' by adding number of colonial schools and hospital dummies as at 1901 in addition to the z-score of 1901 population. In all specifications I add region fixed effects and cluster robust standard errors at the district level. The estimates are reported in table 4. Panel A reports the estimates with only region fixed effects while Panel B adds all the controls.[20]

The results show that past colonial public investments have strong permanent effects on local development. The effects also vary depending on the type of investment. Compared to roads, the effects of railroads on local economic activities are stronger and persist for longer distance. Average local development[21] is about 46.5 percent and 32 percent higher for 10km railway and roads cells relative to other cells.

Schools and hospitals have similar permanent effects on local development – both are significant up to 20km although hospitals have slightly larger effect within 10km. Compared to other cells, average local development is respectively 47.5 percent and 52 percent higher for cells within 10km of a colonial school and hospital. Remember that the effect of school on postcolonial population growth was statistically insignificant. Unlike population, however, nighttime lights data are more precisely and objectively collected, providing more informed statistical estimates.

The results also show that initial conditions do not have strong, long-term positive effects on current local development. Places that had colonial hospitals by 1901, for example, are relatively less developed today. Likewise, 1901 population is negatively correlated with current development outcomes. Only 1901 schools have some positive correlation with current development in some of the specifications. This suggests that initial conditions cannot readily explain the current development divergence between the two regions.

I also condition the estimates in Panel A separately on contemporary and colonial-era factors,[22] and find that the economic and statistical significance of the estimates are heavily driven by colonial-era factors (estimates from this exercise are not shown). This emphasizes the fact that colonial-era conditions exert stronger effects on current development outcomes in Ghana.

I test the sensitivity of the results on additional controls and specifications. The estimates, not shown, are robust to i) using non-standardized population variables ii) using log of population iii) adding ethnic fixed effects iv) including up to fourth-order polynomial of latitudes and longitudes to control for spatial autocorrelation v) replacing the distance dummies (10km, 10-20km, 20-30km) with distance (km) to locations of colonial public investments.[23]

It is imperative to address a concern that the results are possibly driven by the South since it received almost all the investments; and it is also a relatively more developed region today. Another related concern is that even if the North received relatively fair amount of colonial investments, these investments may not necessarily engineer long-run development in the region. To address these two concerns, I divide the sample into North and South and explore the permanent effects of past colonial public investments in each region. The results are reported in online appendix table B.6.[24]

For Southern Ghana the estimates are generally consistent with those from the whole sample. This is because almost all the investments went to the South. The estimates of hospitals are statistically significant up to 20km in the South while they are only significant within 10-20km in the North. For both samples, schools are statistically significant up to 20km although the effects are stronger in the North – for the 10km window the coefficient estimate in the North is twice that of the South.

The results suggest the permanent impacts of past colonial public investments are not peculiar to one region. They also suggest that the strong permanent effects would have persisted in the North if the region had substantial colonial investments. In other words, northern cells closer to the remarkably fewer number of colonial schools and hospitals in the North are today relatively more developed than their counterparts.

There are several reasons why the effects of past colonial investments persist. First, the locations of colonial investments were repetitive. Areas initially selected into colonial investments were also the most preferred areas for future colonial investments. It would be more cost effective or more convenient to extend an existing railway line, for example, than to survey unexplored terrain for new railway lines. Initial colonial investments might have also led to more political stability which induces more colonial investments in the future. All the railway lines in Ghana were offshoots from the first Sekondi-Tarkwa line. As table 2 shows, the locations of amenities were also repetitive. Areas that had colonial schools and hospitals as at 1901 were more likely to have these amenities as at 1931.

Second, there were positive externalities across colonial investments, a feature which prolonged the effects of these investments. If railway lines stirred population growth in an area, local demand for healthcare services and education increased, leading to more health facilities and schools being provided. Paved roads may increase school attendance, which then increases demand for education. My results confirm these positive externalities across colonial investments: table 2 shows that an area that had at least one hospital as at 1901 had about 4 schools as at 1931 relative to areas that had no hospital. Similarly, one additional 1901 school increases the probability of a place having a hospital as at 1931 by about 3 percentage points. 1901 schools were also closer to roads and railway lines.

Third, colonial investments had relatively longer physical duration. It takes a longer time for railway lines to decay; and their initial effects continued to persist regardless. Amenities (schools and hospitals) also had long duration. It would be costlier to build a new school or hospital to post a teacher or health practitioner than to post them to an existing facility. Therefore, existing facilities continued to function for relatively longer periods. As mentioned earlier, another interpretation of the positive coefficients of 1901 amenities is that colonial amenities lasted longer period – once established in period 1, they did not cease to exist in period 2. Almost all current operational railway lines in Ghana are colonial legacies, further pointing to the longevity of colonial investments.

Fourth, colonial investments had greater increasing returns. The unique feature of colonial investments is the fact that they were installed in colonies that hitherto had no such investments, hence higher returns. Building railway lines in a place for the first time unearths otherwise unavailable economic opportunities. Having schools and hospitals for the first time may also increasingly shoot up average local health and human capital. Places with improved health and higher human capital levels would have competitive advantage for future colonial investments, which also in turn increase health and human capital. Therefore, the process becomes a vicious cycle of continuous improvements in socioeconomic outcomes.[25]

(3) ***Placebo and Counterfactual Analysis***: In the colonial era, proposals were advanced to extend railway lines to Northern Ghana. Two proposed lines, starting from Kumasi in the South to Navrongo in the North, were drawn but were never built (see map B.10 in online appendix). The construction of the Northern railway lines was stalled due to three main "shocks". The first shock was the sudden death of George Ekem Ferguson. Ferguson was a native British agent who had been sent to survey the North, to make treaties, and to advise the colonial administration. He recommended and supported the construction of a railway line in the region to help revitalize the interior trade (Thomas, 1973). In one of his trips to the North in 1897, his party was ambushed and he was killed. The second event was the death of Lt. Col. Northcott, the first Commissioner and Commandant to the North. He sought to implement Ferguson's recommendations, including the building of the railway line, but died in the Anglo Boer War in 1899 before any concrete plans could be executed.

The third shock that stalled the construction of the northern lines was the Great Depression in 1929-1930 (Austin, 2007). Because of the retrenchment of government revenues the period 1929–1943 saw no railway constructions. No railway line close to the length of the proposed Northern lines (about 440km) was constructed after 1930. Even the 81km Achiasi-Kotoku line, the longest line built after 1930, came to full operational use in June 1957, three months after Ghana became politically independent.

I exploit the randomness that put off the construction of the proposed Northern lines to carry out two exercises. First, I use them to further justify the permanent effects of colonial railway lines by showing that there are no spurious effects associated with the placebo lines. Second, I use their nearby cells as counterfactuals for the nearby cells of southern railway lines.[26] In effect, this depicts what the current development outcome of a northern cell would be had it got access to a colonial railroad.

In panel C, online appendix table B.4, I report mean cell-level observables of southern railway lines and the proposed northern railway lines within 10km. As the placebo lines start from the South (Ashanti), the estimates would be biased downward since some Southern cells, which are more locally developed, would be counted as placebo cells. To overcome this challenge, I drop Ashanti colonial administrative region and compare only the North and the Gold Coast 10km cells.

The railroad cells have relatively higher mean annual precipitation and are flatter than the placebo cells. However, they have significantly low mean soil caloric suitability and lie farther away from navigable rivers. There is very little difference in terms of mean temperature and proximity to border and sea. Mean temperature, proximity to border and sea differ by 1.74, 0.07 and 0.07 respectively. The direction of the bias, therefore, is indeterminate. To the extent that the differences in cell mean observables are not systematic, I am able to use the two set of cells as counterfactuals.

The no-spurious effects and counterfactual estimates are displayed in table 5. In estimating the no-spurious effects, I use same controls as those used in estimating the permanent impacts of colonial investments since the goal is to justify these permanent impacts. On the other hand, the choice of controls for the counterfactual estimates is guided by the controls used in specification (1), which estimates the current development gap between the two regions.

The estimates in column 1, table 5, show that there are no spurious effects associated with the placebo lines. The counterfactual estimates (column 2) indicate that being a 10km southern cell is associated with about 365 percent increase in average local development[27] relative to being a 10km placebo northern cell. Alternatively, if North-South 10km railway cells are proper counterfactuals, average local development of the northern placebo cells would have been more than 4.5 times as more developed as its current status had they got connected to colonial railway lines.

Remember that when estimating the development differentials between the North and the South, the estimates did not depend on the choice of the sampling window. I argued there that this is as a result of the relatively uniformly underdeveloped status of the northern cells (the standard deviation of nighttime light in the North is 1.13 while that of the South is 5.52). Therefore, the finding that an average 10km proposed northern railway cell should have been significantly more developed today had it had access to railway lines, should be applicable to all northern cells. In other words, if there is no substantial variation in northern cells' local development, then the restricted counterfactual estimates above should be roughly applicable to all northern cells.

(4) ***Mediating Effects***: Lastly, if past colonial public investments matter for the development gap between the North and the South, it follows that the gap should diminish once it is conditioned on past colonial public investments.

To test this, I rerun specification (1) controlling for colonial schools, hospitals, railway lines and roads.[28] The results are reported in table 6. Columns 2, 3, 4 and 5 respectively condition the coefficient estimate in column 1 on distance to colonial schools, hospitals, railway lines, and class one road. For comparison purposes, column 1 repeats the estimated coefficient from specification (1).

The results reveal two important findings. First, local development decreases as distance to location of past colonial public investments increases. This is consistent with the permanent effects of colonial investments previously investigated. Second, except class one roads, all past colonial public investments have strong mediating effects on the development gap. Once conditioned on schools, hospitals and railroads, the coefficient of North loses its statistical significance. Thus, the importance of past colonial investments for the North-South development disparity cannot be deemphasized.

[table 3 here]

[table 4 here]

[table 5 here]

[Map 6 here]

VI. Conclusion and Policy Implications

The most important development problem in Ghana is arguably the deep-rooted development disparity between Northern Ghana and Southern Ghana. The North is acutely underdeveloped, trailing the South in practically all metrics of development. Explanations for the underdevelopment status of the North often underscore its geography and past colonial experience.

In this study, I build on the historical school and investigate empirically the colonial roots of the North-South development divide. I first estimate the current development disparity between the two regions. Conditioning on geography, climate, ecology and location fundamentals an average place in the North is at least 51 percent less developed relative to an average place in the South. This dispels arguments that the development divergence is purely a result of differences in geography and climate between the two regions.

Next I exploit the North-South asymmetric receipts of past colonial public investments in education, health, and infrastructure to examine the extent to which colonial rule explain the current development disparities between the two regions. The South received almost all colonial public investments, which helped stir local development.

I show that the effects of past colonial investments persist till present day and still strongly determine current development outcomes in Ghana. These permanent effects are not driven by the South for the fact that it received almost all the investments. Northern areas closer to the locations of the remarkably fewer colonial investments in the region are today relatively more developed than their counterparts. This implies that colonial investments could have yielded similar effects in the North and contribute significantly to its long-term development.

I justify the permanent impacts of colonial railway lines by demonstrating that there are no spurious effects associated with some placebo lines. I also perform some counterfactual analysis to determine what the current development level of an average northern cell would be had it got connected to a colonial railway. I estimate that an average place in the North would have been at least 4.5 times more developed had it got a colonial railway line. Lastly, I show that past colonial public investments strongly mediate the development gap between the North and the South.

In the online appendix, I provide detailed historical background and compelling anecdotal evidences that prior to the colonial conquest the North was a relatively prosperous region. It was a highly politically centralized region and played a crucial role in Ghana's precolonial trade network, building a fortune that revolved entirely around trade.

There have been numerous programs to develop the North since Ghana gained political independence in 1957. Unfortunately, most of the policies either underperformed or failed mainly because the potential of the North has not been properly diagnosed. The North's historical fortune was oriented towards trade and industry. At the onset of colonial rule, the modernization of its trade system depended on the extension of railway lines to the region. After several decades of political independence, the North still has no railways connecting the South, despite it being the potential "food basket" of Ghana owing to its staple-favorable climate. Roads meant to transport comestibles to the South are also in deplorable conditions, hence produce are often left to rot in the North (Harding, 2015).

Development policies in the North have often targeted food production (see a review by Nyantakyi-Frimpong & Bezner Kerr, 2015, for example) with little emphasis on infrastructural developments. However, the fact that the transformation of the North via increased food production was only possible through improved transportation has been echoed since the colonial era (I. Sutton, 1989).

It follows that the transformation of the North largely depends on improved transportation. The construction of the Ghana Railway Masterplan, designed in 2013 to connect the North and the

South with modern railway lines, has since not started. The severally mooted Eastern Corridor Road project, the shortest North-South route by road, has also never seen concrete progress. These two lofty projects, when finally and fully executed, would arguably be the most important, farfetched real development-focused programs that would undeniably transform the North.

References

Austin, G. (2007). Labour and Land in Ghana, 1874-1939: a shifting ratio and an institutional revolution. *Australian Economic History Review*, *47*(1), 95–120.

Bening, R. B. (1975). Colonial Development Policy in Northern Ghana, 1898—1950. *Bulletin of Ghana Geographical Association*, *17*, 65–79.

Brukum, N. J. K. (1998). Studied Neglect or Lack of Resources? The Socio-economic Underdevelopment of Northern Ghana Under British Colonial Rule. *Transactions of the Historical Society of Ghana*, 117–131.

Chen, X., & Nordhaus, W. D. (2011). Using luminosity data as a proxy for economic statistics. *Proceedings of the National Academy of Sciences*, *108*, 8589–8594.

Cogneau, D., & Moradi, A. (2014). Borders That Divide: Education and Religion in Ghana and Togo Since Colonial Times. *The Journal of Economic History*, *74*, 694–729.

Dickson, K. B. (1968). Background to the Problem of Economic Development in Northern Ghana. *Annals of the Association of American Geographers*, *58*, 686–696.

Dickson, K. B. (1971). *A historical geography of Ghana*. Cambridge: Cambridge University Press.

Doll, C. N. H., Muller, J.-P., & Morley, J. G. (2006). Mapping regional economic activity from night-time light satellite imagery. *Ecological Economics*, *57*(1), 75–92.

Donaldson, D. (2018). Railroads of the Raj: Estimating the Impact of Transportation Infrastructure. *American Economic Review*, *108*, 899–934.

Due, J. F. (1979). The Problems of Rail Transport in Tropical Africa. *The Journal of Developing Areas*, *13*, 375–393.

Eades, J. (1993). *Strangers and Traders: Yoruba Migrants, Markets and the State in Northern Ghana*. London: Edinburgh University Press for the International African Institute.

Elvidge, C. D., Baugh, K. E., Kihn, E. A., Kroehl, H. W., Davis, E. R., & Davis, C. W. (1997). Relation between satellite observed visible-near infrared emissions, population, economic activity and electric power consumption. *International Journal of Remote Sensing*, *18*, 1373–1379.

Geier, R., Owusu-Donkor, P., Agyemang, F., Amedzro, K., Lange, K., Awo, A., & Choukri, T. (2015). *Ghana National Spatial Development Framework (2015-2035) Volume I: Conditions and Main Issues* (No. IDA4870 GH). Accra: Government of Ghana.

Grischow, J. D. (1999). *A History of Development in the Northern Territories of the Gold Coast, 1899-1957* (Unpublished Doctoral Dissertation). Queen's University, Kingston.

Harding, R. (2015). Attribution and Accountability: Voting for roads in Ghana. *World Politics*, *67*, 656–689.

Herranz-Loncán, A., & Fourie, J. (2018). "For the public benefit"? Railways in the British Cape Colony. *European Review of Economic History*, *22*(1), 73–100.

Huillery, E. (2009). History Matters: The Long-Term Impact of Colonial Public Investments in French West Africa. *American Economic Journal: Applied Economics*, *1*, 176–215.

Jedwab, R., & Moradi, A. (2016). The Permanent Effects of Transportation Revolutions in Poor Countries: Evidence from Africa. *Review of Economics and Statistics*, *98*, 268–284.

Michalopoulos, S., & Papaioannou, E. (2013). National Institutions and Subnational Development in Africa. *The Quarterly Journal of Economics*, *129*(1), 151–213.

Nyantakyi-Frimpong, H., & Bezner Kerr, R. (2015). A political ecology of high-input agriculture in northern Ghana. *African Geographical Review*, *34*(1), 13–35.

Oteng-Ababio, M., Mariwah, S., & Kusi, L. (2017). Is the underdevelopment of northern Ghana a case of environmental determinism or governance crisis? *Ghana Journal of Geography*, *9*, 5–39.
Pinkovskiy, M. L. (2013). *Economic Discontinuities at Borders: Evidence from Satellite Data on Lights at Night*.
Plange, N. K. (1979a). 'Opportunity Cost' and Labour Migration: A Misinterpretation of Proletarianisation in Northern Ghana. *The Journal of Modern African Studies*, *17*, 655–676.
Plange, N. K. (1979b). Underdevelopment in Northern Ghana: Natural causes or colonial capitalism? *Review of African Political Economy*, *6*, 4–14.
Plange, N. K. (1984). The Colonial state in Northern Ghana: The political economy of pacification. *Review of African Political Economy*, *11*, 29–43.
Shaffer, P. (2015). Colonialism and Seasonal Poverty in the Northern Territories of the Gold Coast, circa 1900-1940. *Q-Squared Working Paper No. 65*, 19.
Shaffer, P. (2017). Seasonal Hunger in the Northern Territories of the Gold Coast, 1900-40. *Economic History of Developing Regions*, *32*, 270–300.
Songsore, J. (2003). *Regional Development in Ghana: The Theory and the Reality*. Accra: Woeli Pub. Services.
Sutton, I. (1989). Colonial Agricultural Policy: The Non-Development of the Northern Territories of the Gold Coast. *The International Journal of African Historical Studies*, *22*, 637.
Sutton, P. C., & Costanza, R. (2002). Global estimates of market and non-market values derived from nighttime satellite imagery, land cover, and ecosystem service valuation. *Ecological Economics*, *41*, 509–527.
Thomas, R. G. (1973). Forced Labour in British West Africa: The Case of the Northern Territories of the Gold Coast 1906–1927. *The Journal of African History*, *14*(1), 79–103.
Thomas, R. G. (1974). Education in Northern Ghana, 1906-1940: A Study in Colonial Paradox. *The International Journal of African Historical Studies*, *7*, 427–467.
Tsey, C. E. (1986). *Gold Coast Railways: The Making of a Colonial Economy, 1879-1929.* (Doctoral Dissertation). Retrieved from https://theses.gla.ac.uk/2799/.
Wooldridge, J. M. (2018). *Introductory Econometrics: A Modern Approach* (7th ed.). Boston: Cengage Learning, Inc.
Yaro, J. A. (2013). The Story of Northern Ghana. In Yaro, J.A. (Ed.), *Rural Development in Northern Ghana* (pp. 1–17). New York: Nova Science Publishers, Inc.

Table 1. Estimated Development Gap: Northern Ghana & Southern Ghana

	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	whole sample			50km	
Log luminosity					
North	-1.622***	-0.591***	-0.718***	-0.743**	-0.721**
	(0.271)	(0.211)	(0.240)	(0.313)	(0.340)
Avg. yr. precipitation		-0.00232***	-0.00270***		-0.00244*
		(0.000871)	(0.000755)		(0.00134)
Mean altitude		-0.00747***	-0.00546***		-0.00217
		(0.00112)	(0.00101)		(0.00174)
Avg. yr. temperature		-1.281***	-0.989***		-0.633*
		(0.183)	(0.169)		(0.338)
Avg. soil caloric suitability		0.00141	0.00232**		-0.000538
		(0.00123)	(0.00112)		(0.00214)
Border cells (1/0)			-0.418**		-0.920***
			(0.180)		(0.215)
Dist. navigable river (km)			0.00671***		-0.00661
			(0.00149)		(0.00416)
Mineral (1/0)			2.086***		0.161
			(0.628)		(0.257)
Sea cells (1/0)			1.103**		-
			(0.460)		-
Observations	2,091	2,085	2,085	466	466
R-squared	0.217	0.259	0.282	0.034	0.074
REGION F.E.	YES	YES	YES	YES	YES

The table reports OLS estimates of the development gap between Northern Ghana and Southern Ghana using nighttime light as proxy for local development. Column 1 reports the development gap with only region constants whereas columns 2 and 3 add cell-level controls. Columns 4 and 5 restrict the analysis to cells that lie within 50km from the North-South border. Robust standard errors, reported in parenthesis below the estimates, are clustered at the district level (240 clusters). *** p<0.01, ** p<0.05, * p<0.1

Table 2. Past Colonial Public Investments: North & South

	(1) Schools	(2) Hospitals 1/0	(3) dist. class 1 road	(4) Dist. Col. Railway line
		Panel A. No Controls		
North	-0.272***	-0.0143***	164.1***	257.9***
	(0.0333)	(0.00494)	(3.285)	(3.413)
Observations	2,091	2,091	2,091	2,091
R-squared	0.025	0.004	0.586	0.750
		Panel B. Controls		
North	-0.184***	-0.00274	147.8***	228.9***
	(0.0300)	(0.00439)	(3.162)	(3.359)
Hospital 1901 (1/0)	4.175***	0.873***	19.64	46.66**
	(1.580)	(0.0672)	(13.72)	(20.43)
School 1901	0.936***	0.0288*	-8.620***	-15.28***
	(0.106)	(0.0165)	(1.633)	(2.916)
Dist. Navigable River	-0.000783***	-2.62e-06	-0.139***	-0.287***
	(0.000221)	(2.86e-05)	(0.0145)	(0.0171)
Mean altitude	0.000290*	9.24e-06	0.249***	0.182***
	(0.000154)	(2.31e-05)	(0.0227)	(0.0208)
Sea cells	0.139	0.00716	53.59***	28.36***
	(0.141)	(0.0169)	(5.198)	(6.399)
Mineral 1931	1.750**	0.391*	3.631	-32.09***
	(0.816)	(0.220)	(7.869)	(10.46)
Border cells	-0.0603***	-0.00916***	49.15***	67.24***
	(0.0155)	(0.00267)	(5.804)	(5.165)
Observations	2,091	2,091	2,091	2,091
R-squared	0.556	0.301	0.661	0.802

The table reports the OLS estimates of differential colonial public investments across Northern Ghana and Southern Ghana. Proxies of colonial public investments are colonial schools, hospitals, railways, and class one roads. Panel A reports the unconditional estimates while panel B adds controls as shown. Robust standard errors are reported in parenthesis below the estimates. *** p<0.01, ** p<0.05, * p<0.1

Table 3. The Effects of Railway Lines in Southern Ghana

	(1) Pop. 1891 (z-score)	(2) Pop. 1931 (z-score)	(3) Pop. 1948 (z-score)	(4) Pop. 1960 (z-score)	(5) Pop. 1970 (z-score)	(6) Pop. 1984 (z-score)	(7) Pop. 2000 (z-score)
10km rail	0.0732	0.967***	0.713***	0.608**	0.573**	0.649**	0.684***
	(0.128)	(0.231)	(0.275)	(0.260)	(0.262)	(0.261)	(0.262)
10-20km rail	-0.0151	0.226**	0.181**	0.0999*	0.108**	0.117**	0.132***
	(0.106)	(0.0894)	(0.0747)	(0.0516)	(0.0506)	(0.0498)	(0.0471)
20-30km rail	0.0777	0.151	0.183**	0.106**	0.128**	0.0971**	0.0876**
	(0.162)	(0.100)	(0.0735)	(0.0523)	(0.0521)	(0.0452)	(0.0422)
avg. yr. prec.	-0.0001	-0.0006**	-0.0002	-0.0003	-0.0006	-0.0006	-0.0008**
	(0.0002)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)
mean altitude	0.0008	0.0011	0.0010	0.0014	0.0015	0.0017*	0.0019*
	(0.0006)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)
avg. yr. temp.	0.193**	0.0949	0.0562	0.101	0.133	0.157	0.197
	(0.0783)	(0.104)	(0.120)	(0.121)	(0.124)	(0.123)	(0.126)
soil caloric Suit.	0.0028***	0.0029***	0.0010***	0.0007***	0.0008***	0.0008***	0.0007***
	(0.0007)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
sea cells	0.619**	0.916***	1.139**	1.022**	0.812	0.906*	0.729*
	(0.314)	(0.310)	(0.458)	(0.472)	(0.502)	(0.478)	(0.433)
border cells	-0.0979	-0.119*	-0.0043	-0.0016	0.0217	0.0262	0.0350
	(0.0658)	(0.0651)	(0.0766)	(0.0733)	(0.0809)	(0.0762)	(0.0705)
dist. river	0.0043***	0.0045***	0.00118	0.0012	0.0022**	0.0022**	0.0028***
	(0.0012)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
dist. capital	-0.0026***	-0.0031***	-0.0012*	-0.0011	-0.0015**	-0.0015**	-0.0016**
	(0.0006)	(0.0005)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0006)
mineral cells	-0.159*	1.042**	1.822**	1.181***	0.538*	0.936**	0.632
	(0.0870)	(0.517)	(0.764)	(0.425)	(0.299)	(0.414)	(0.431)
Observations	1,152	1,152	1,152	1,152	1,152	1,152	1,152
R-squared	0.128	0.313	0.158	0.108	0.095	0.112	0.106

The table reports the OLS estimates of the effects of railway constructions in Southern Ghana. 1891 population is a pre-railway population outcome variable, which is regressed on all railway lines as at 1930. For columns 2-7, z-scores of cell population at time t are regressed on all available railway lines as at time t. Robust standards are reported in parenthesis below the estimates.
*** p<0.01, ** p<0.05, * p<0.1

Table 4. The Permanent Effects of Past Colonial Public Investments

Dependent Variable: Log luminosity	(1) school	(2) hospital	(3) railway	(4) road
Panel A. No Controls				
10km	3.882***	4.752***	2.622***	2.130***
	(0.233)	(0.295)	(0.365)	(0.354)
10-20km	1.877***	2.269***	1.056***	0.208
	(0.210)	(0.241)	(0.367)	(0.284)
20-30km	0.453**	1.004***	0.910**	-0.360
	(0.176)	(0.204)	(0.357)	(0.243)
Observations	2,091	2,091	2,091	2,091
R-squared	0.372	0.340	0.263	0.274
Region F.E.	YES	YES	YES	YES
Panel B. Controls				
10km	1.550***	1.697***	1.518***	1.051***
	(0.261)	(0.484)	(0.287)	(0.230)
10-20km	0.918***	0.895***	0.542**	-0.116
	(0.179)	(0.215)	(0.261)	(0.182)
20-30km	0.131	0.219	0.534**	-0.257*
	(0.138)	(0.161)	(0.260)	(0.155)
Avg. yr. prec.	-0.0024***	-0.0019***	-0.0019***	-0.0022***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)
Mean altitude	-0.0021*	-0.0025**	-0.0027**	-0.0027**
	(0.0011)	(0.0011)	(0.0010)	(0.0011)
Avg. yr. temp.	-0.317**	-0.436***	-0.363***	-0.476***
	(0.144)	(0.138)	(0.134)	(0.137)
Soil caloric suit.	0.0002	0.0005	0.0017*	0.0007
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Border cells	0.0663	0.0567	0.0444	0.0481
	(0.157)	(0.160)	(0.159)	(0.160)
Dist. river	0.0052***	0.0042***	0.0044***	0.0047***
	(0.0014)	(0.0014)	(0.0014)	(0.0015)
Dist. capital	-0.0016*	-0.0019*	-0.0017*	-0.0025***
	(0.0009)	(0.0010)	(0.0009)	(0.0010)
10km class 1 roads cells	0.372***	0.366***	0.418***	0.464***
	(0.0970)	(0.102)	(0.102)	(0.105)
10km good roads cells	0.477***	0.546***	0.551***	0.508***
	(0.0931)	(0.0938)	(0.0943)	(0.0945)
z-score pop. 2000	0.658**	0.684***	0.699***	0.645***
	(0.262)	(0.258)	(0.239)	(0.233)
z-score pop. 1984	0.198	0.159	0.0872	0.250
	(0.519)	(0.519)	(0.439)	(0.437)
z-score pop. 1970	-0.0295	-0.0339	-0.0253	-0.132
	(0.331)	(0.333)	(0.282)	(0.290)
z-score pop. 1960	-1.820***	-1.902***	-1.954***	-1.920***
	(0.405)	(0.420)	(0.418)	(0.400)

z-score pop. 1948	1.076***	1.185***	1.205***	1.192***
	(0.273)	(0.279)	(0.277)	(0.272)
z-score pop. 1931	0.777***	0.807***	0.889***	0.873***
	(0.140)	(0.145)	(0.142)	(0.142)
z-score pop. 1901	-0.182**	-0.192*	-0.164*	-0.150*
	(0.0919)	(0.0983)	(0.0893)	(0.0897)
Mineral cells	0.958*	0.796	0.587	0.908*
	(0.498)	(0.543)	(0.465)	(0.509)
School 1901	0.204*	0.268**	0.247**	0.122
	(0.120)	(0.135)	(0.125)	(0.120)
Hospital 1901	-3.052***	-3.905***	-2.537**	-2.634**
	(1.055)	(1.187)	(1.137)	(1.040)
Sea cells	0.302	0.354	0.750*	0.574
	(0.348)	(0.425)	(0.382)	(0.415)
Observations	2085	2085	2085	2085
R-squared	0.508	0.500	0.503	0.507
Region F.E.	YES	YES	YES	YES

The table reports the OLS estimates of the permanent effects of past colonial public investments in education, health, and infrastructure. Panels A and B report the estimates without and with controls respectively. Robust standard errors, reported in parenthesis below the estimates, are clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1

Table 5. The No-Spurious Effects and Counterfactual Estimates

	(1) placebo	(2) counterfactual estimate
10km Placebo lines	0.208	
	(0.145)	
10-20km Placebo lines	-0.0902	
	(0.111)	
20-30km Placebo lines	0.0124	
	(0.116)	
10km rail		9.612***
(Placebo as control)		(1.095)
Observations	933	324
R-squared	0.392	0.525
R.E.	YES	YES
Cell Controls	YES	YES

The table reports the OLS estimates of the no-spurious effects associated with the proposed northern railway lines, and the counterfactual estimate. The controls in column 1 are same as in table 4 while those of column 2 are same as in table 1. Robust standard errors, clustered at the district level, are reported in parenthesis below the estimates.
*** p<0.01, ** p<0.05, * p<0.1

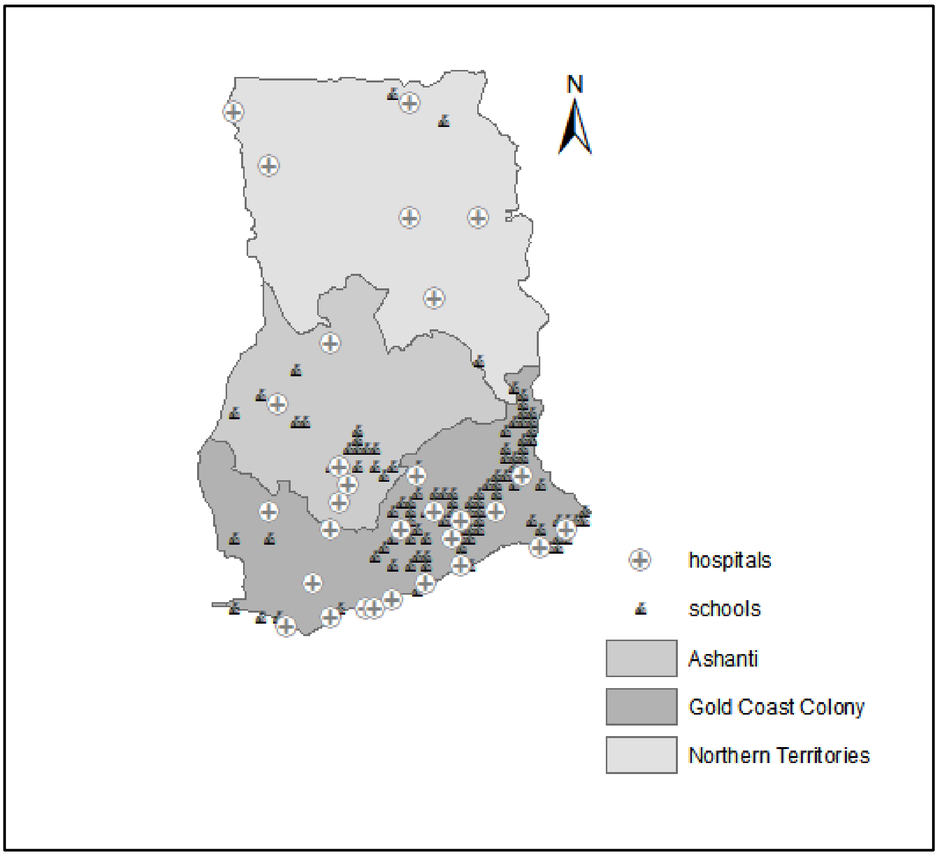
Table 6. The Mediating Effects of Past Colonial Public Investments

Dependent Variable: Log luminosity	(1) development gap	(2) schools	(3) hospital	(4) railway	(5) roads
North	-0.718***	-0.322	-0.103	-0.390	-0.727***
	(0.240)	(0.244)	(0.247)	(0.249)	(0.234)
Avg. yr. prec.		-0.00374***	-0.00235***	-0.00249***	-0.00298***
		(0.000703)	(0.000811)	(0.000744)	(0.000842)
Mean altitude		-0.00404***	-0.00290***	-0.00354***	-0.00465***
		(0.00103)	(0.00107)	(0.00114)	(0.00117)
Avg. yr. temp.		-0.727***	-0.690***	-0.637***	-0.880***
		(0.171)	(0.167)	(0.202)	(0.178)
Avg. soil caloric suit		0.00180*	0.00151	0.00407***	0.00278**
		(0.00107)	(0.00114)	(0.00127)	(0.00115)
Sea cells		0.854*	1.130**	1.234***	1.156**
		(0.439)	(0.478)	(0.459)	(0.463)
Border cells		-0.0562	-0.0130	-0.226	-0.343*
		(0.184)	(0.174)	(0.181)	(0.180)
Dist. Nav. River		0.00961***	0.00518***	0.00814***	0.00757***
		(0.00186)	(0.00179)	(0.00165)	(0.00171)
Mineral		2.076***	1.875***	2.066***	2.125***
		(0.565)	(0.578)	(0.606)	(0.628)
Dist. School		-0.0193***			
		(0.00321)			
Dist. Hospital			-0.0192***		
			(0.00296)		
Dist. Railway				-0.00535***	
				(0.00168)	
Dist. class 1 road					-0.00272
					(0.00173)
Observations	2,085	2,085	2,085	2,085	2,085
R-squared	0.282	0.321	0.325	0.289	0.284
REGION F.E.	YES	YES	YES	YES	YES

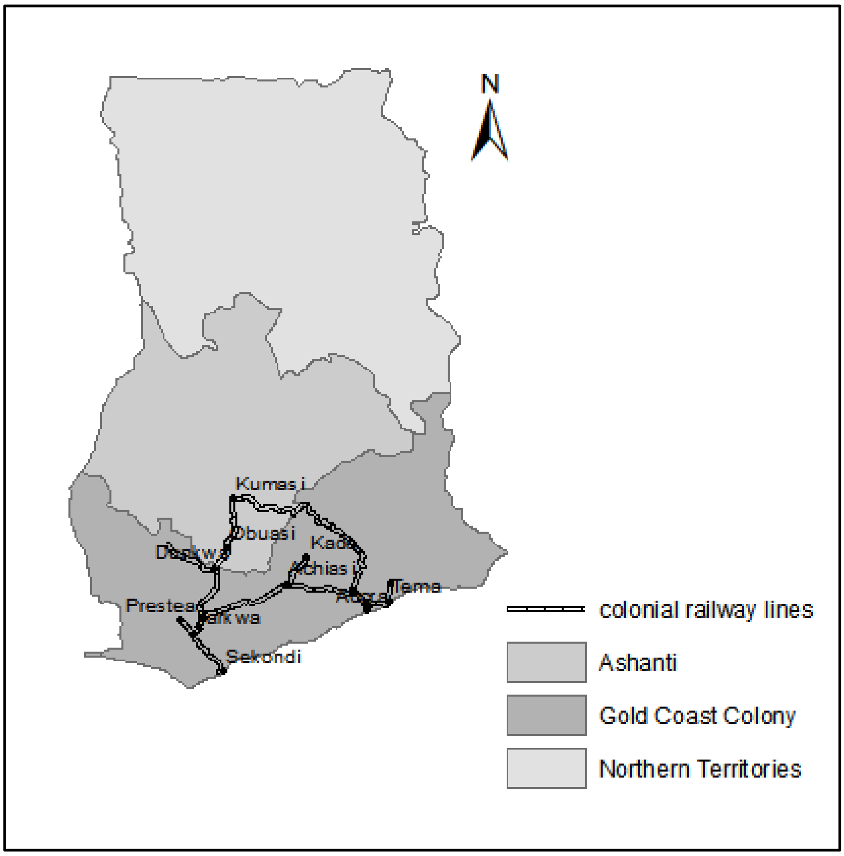
The table reports the mediating effects of past colonial investments on the development gap between Northern Ghana and Southern Ghana. Column 1 repeats the estimate from column 3 of table 1. Columns 2, 3, 4 and 5 respectively condition the development gap colonial schools, hospitals, railways and roads. Robust standard errors, reported in parenthesis below the estimates, are clustered at the district level.
*** p<0.01, ** p<0.05, * p<0.1

Map 1. Colonial Administrative Regions in Ghana

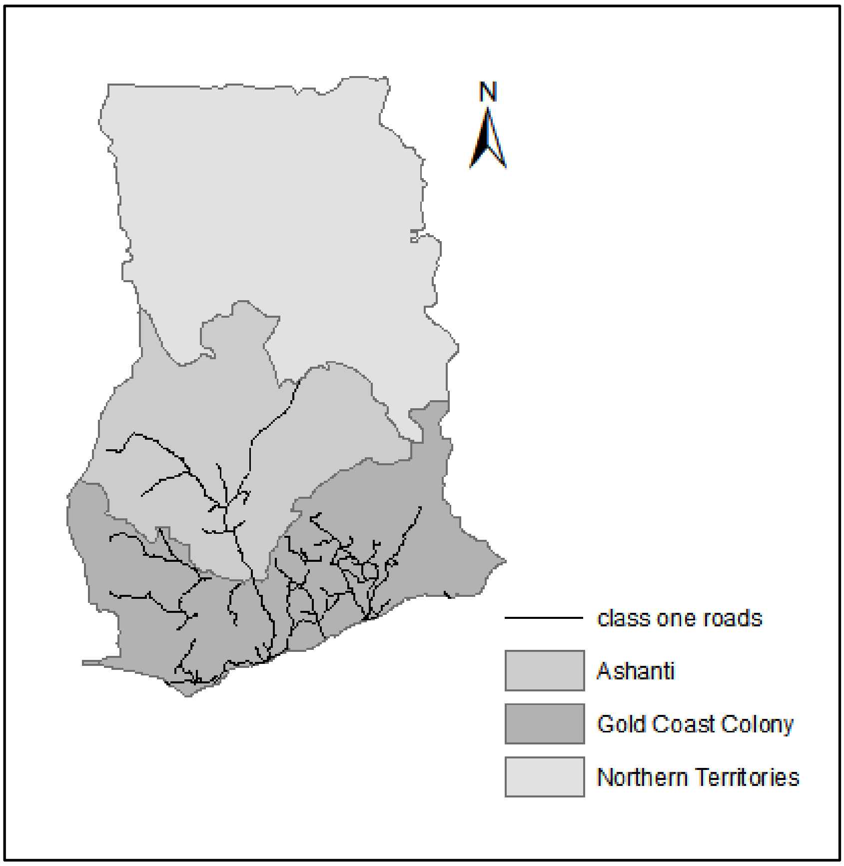
Map 2. Colonial Schools and hospitals (1931)



Map 3. Colonial Railway Lines



Map 4. Colonial Class One Roads



[1] Using survey data, I show that there is a strong visual correlation between light density at night and access to public goods at the district level. The survey data also shows that Northern households are relatively poorer.

[2] The terms light density at night, luminosity, and nighttime light mean the same and are used interchangeably.

[3] To the best of my knowledge, 2013 is the most recent year for which the light density data is available from the DMSP-OLS.

[4] In the specifications where I add cell-level controls, the number of observations reduces to 2085. The missing 6 are "sea cells" so their data could not be easily extracted using the tools of ArcGIS. Since they are all southern cells, hence relatively more developed, the development gap would likely be slightly underestimated.

[5] This approach is adopted from Michalopoulos & Papaioannou (2013a) who employ it because of the presence of zeros in the luminosity data. Zero in the luminosity data denotes cases where either the place has no electricity, or the place is so dim that the satellite sensors could not capture any light. Nighttime light is also blank for natural landmarks like lakes.

[6] The map is sourced from Map and Geospatial Spatial Information Centre, Lewis Library, Princeton University: https://earthworks.stanford.edu/catalog/princeton-b8515r88g. Date last accessed: 12/08/2021.

[7] Though the dummies for sea and border cells are controls for economic geography, they also control for differences in sizes of cells since cells that border the sea and/or another country may measure smaller than 11km x 11km.

[8] Regions here should not be confused with Northern Ghana and Southern Ghana. Regions as used here are the first subnational administrative units after the central government. There are currently 16 regions in Ghana, following new demarcations in 2019 which created additional 6 regions from the former 10 regions. I use the former 10 regions in this study.

[9] Since the outcome variable is log-transformed, percentage change in the dependent variable when the predictor variables record a one unit increase or change from 0 to 1 is more accurately calculated as [exp(B) – 1]*100 (Wooldridge, 2018, p.227).

[10] Unless otherwise indicated, all regression coefficients are reported in absolute values.

[11] Afrobarometer is a not-for-profit, independent body that conducts public opinion survey in Africa.

[12] Assisted schools were schools that depended on the colonial government for their financial maintenance.

[13] https://geonode.wfp.org/layers/geonode%3Awld_trs_railways_wfp#more
Date last accessed: 06/04/2020

[14] The data on the number of assisted colonial schools in 1919 is from (Thomas, 1974).

[15] An alternative interpretation is that colonial investments lasted longer period. For example, a school in 1901 is likely to be functional in 1931.

[16] This identification framework is heavily drawn from Jedwab & Moradi (2016).

[17] Standardizing accounts for changes in mean and standard deviations of population over time.

[18] Note that z-score of population at time t is regressed on all opened railway lines as at time t. Thus z-score of 1931 population, for example, is regressed on all lines opened as at 1931, and z-score of 1948 population regressed on all lines opened as at 1948, and so on. All lines were constructed and opened in the colonial era.

[19] These are population census years in both colonial and postcolonial eras. For 1960, 1948 and 1901, only urban population data are available.

[20] I do not control for 1891 population because the North lacks this data.

[21] Absolute average log nighttime light is 3.265.

[22] Contemporary factors are postcolonial population variables, distance to the capital city and access to modern road network. Colonial-era factors are the colonial-era population variables.

[23] Distance to colonial class one road is not statistically significant. The author did not include the result tables for the robustness checks to save space. They can be provided upon request.

[24] The North lacked colonial railways and class one roads, so their effects cannot be estimated in the North sample.

[25] The points discussed here are heavily taken from (Huillery, 2009).

[26] Donaldson (2018) uses a similar approach to study the effects of colonial railway lines in India. This approach assumes that the two set of cells have similar observables and economic potentials. In terms of economic profitability of the northern lines, feasibility studies had reported that the lines were

economically viable (Tsey, 1986) and the revenue could cover the cost of construction within a year of operation (Brukum).

[27] The absolute log mean nighttime light is 2.63 for this sample.

[28] I use absolute distance (km), rather than distance dummies. This choice is purely based on convenience as it eases the task of stacking the results into one table.