Impact of Colonial Institutions on Economic Growth and Development in India: Evidence from Night lights data*

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Abstract

We study the implications of two historical institutions, direct British rule, and the heterogeneous land tenure institutions implemented by the British, on the disparity in present-day development using district-level data from India. Using nightlights per capita as a proxy for district-level per capita income, we find that modern districts that were historically under direct British rule had significantly less nightlights per capita in 1993 relative to modern districts that were historically under indirect British rule. The large gap persists even after including correlates of development such as educational attainment, health, and physical and financial infrastructure. Looking at the growth pattern from 1993 to 2013, directly ruled districts had a lower annual growth rate compared to indirectly ruled districts. Much of the development gap between areas under the indirect rule and direct rule can be accounted for by the adverse effect of landlord-based revenue collection systems in the directly ruled areas.

JEL Codes: O11, O43, P16, P51

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I. Introduction

Many cross-country studies find that the quality of historical institutions is a major cause of disparity in present-day economic development as measured by income per capita.[1] Due to the unavailability of data on a comprehensive measure of development such as per capita income, studies examining the role of historical institutions on development at the sub-national levels use alternate proxies of economic well-being in their analysis.[2] In this paper, we examine the long-term effects of British colonial institutions on overall economic development within India using satellite nightlights data.

During the period of British rule, India was divided into two types of territories: British India and Native or Princely States. British India comprised areas where the British administration had full autonomy in the internal and external affairs and hence were under the 'direct rule' of the British. Princely states, on the other hand, were areas that were ruled by the local kings (or hereditary rulers) and therefore, were under the 'indirect rule' of the British. While the external affairs of the princely states were under British control, the local kings (or hereditary rulers) had full autonomy in the internal affairs of these areas. This interesting characteristic of the native states makes these regions a good counterfactual to the areas that were directly governed by British colonial rule. After the Independence of India in 1947, all these regions collectively came under uniform governance. We exploit this division of India into areas that came directly under British rule and areas that were indirectly governed by the British during the colonial period and investigate the effect of being directly ruled by the British on present-day economic development.

The effect of this colonial institution was first studied by Iyer (2010). Her key finding is that after controlling for the selection effect, the areas under direct rule by the British had lower levels of investment in public goods such as health, education, canals, and roads. She also finds directly ruled areas to have higher levels of poverty, inequality, and infant mortality but similar levels of literacy. Iyer (2010) notes that "One major drawback of district-level data in India is the absence of data on per capita income, consumption, or net domestic product (these are available only at the state level)", as a result, her study is unable to study the impact of this historical institution on overall development. We extend Iyer's analysis by constructing a proxy for overall

[1] See Acemoglu et al. (2001), Rodrik et al. (2004), Nunn (2008), Feyrer and Sacerdote (2009).
[2] See Dell (2010), Dell and Olken (2019), Banerjee and Iyer (2005), Banerjee et al. (2005), Iyer (2010).

economic development at the district level in India using satellite nightlights data. The satellite nightlights data has many advantages including its availability at higher levels of spatial disaggregation and has been widely accepted as a proxy for overall economic development at the national and sub-national levels in the growth and development literature.[3]

From our benchmark OLS specifications, we find that modern districts that were historically under direct British rule had 39.47% less nightlights per capita in 1993 relative to modern districts that were historically under indirect British rule. Using an estimate of the elasticity of GDP per capita with respect to nightlights per capita of 0.22, this translates into 8.68% less GDP per capita.[4] Looking at the growth pattern from 1993 to 2013, a period of rapid growth following the liberalization that began in 1991, we find that conditional on the initial levels of nightlights per capita, areas that were under direct British rule had a 1.84% lower annual growth rate compared to indirectly ruled areas. Using an elasticity of 0.32 for the growth in per capita GDP with respect to nightlights per capita, this translates into 0.59% lower annual growth in GDP per capita.[5] The negative coefficient of the initial level of nightlights per capita provides evidence of convergence, that is, areas that were initially less developed were growing faster. On analyzing the rate of convergence across areas under the direct and indirect rule, we find that areas under direct British rule were converging at a slower rate compared to areas under indirect British rule.

Our OLS results could be subject to selection bias if the British selectively annexed areas that came under their direct rule. For example, if they annexed areas with low development potential (they were weaker to put up too much fight), this could drive a negative relationship between direct British rule and nightlights per capita without a causal relationship. As a first check on the selection issue, we restrict our sample to only those directly ruled districts which have an adjacent indirectly ruled district. Adjacent districts are not likely to differ much in their development potential. Even in this restricted sample of neighboring districts, directly ruled districts have significantly lower nightlights per capita.

Iyer (2010) provides convincing evidence that the British selectively annexed areas that had higher agricultural productivity. Using an instrument for direct British rule, based on the policy

[3] Henderson et al. (2012), Chen and Nordhaus (2011), Donaldson and Storeygard (2016), Pinkovskiy and Sala-i-Martin (2016), Chanda and Kabiraj (2020), Prakash, Rockmore, and Uppal (2019)

[4] Chanda and Kabiraj (2020) provide a range of 0.2 to 0.24 for the elasticity of state domestic product per capita with respect to nightlights per capita using state level data from India.

[5] Using the state level data in Chanda and Kabiraj (2020) we estimate this elasticity to be 0.32 which also corresponds to the elasticity estimated in Henderson et al. (2012).

of *Doctrine of Lapse* adopted by the British from 1848-1856 whereby the death of a ruler of a princely state without an heir would be automatically annexed, Iyer (2010) shows that direct British rule was much more damaging in terms of public investment in physical and human infrastructure than what is captured by the OLS estimates. Using the same instrument as Iyer (2010), we find that directly ruled modern districts had 46.69 – 48.88% (depending on the specification) less nightlights per capita in 1993 relative to indirectly ruled modern districts. Our finding that directly ruled districts are doing worse when correcting for the selection effect is consistent with the story of the British annexing more productive areas which would make the OLS results underestimate the adverse effect of direct British rule.

Next, we turn to the possible channels through which direct British rule may account for the relative backwardness of these districts compared to the indirectly ruled districts. Given the importance of human capital in the development process, and the debate on the primacy of institutions vs human capital[6], we include the level of human capital measured by literacy rate as an additional regressor. While the literacy rate is strongly positively related with nightlights per capita, the coefficient of direct British rule increases upon the inclusion of the literacy rate. This is explained by the slight positive correlation between direct British rule and the literacy rate. Therefore, inadequate human capital due to direct British rule cannot explain the relative backwardness of these areas.[7]

Looking at other correlates of development, we find that directly ruled districts have worse health outcomes (as measured by infant mortality rate), roads per capita, and female labor force participation rate, but better railroad per capita and financial infrastructure as measured by the number of bank branches per capita. That is, some of the adverse effects of direct British rule may be occurring through worse health, roads, and female labor force participation rate.

In trying to understand the mechanisms through which direct British rule may have adversely affected development, Iyer (2010) finds a role for the land revenue collection systems (land tenure systems) developed by the British. She finds that within the areas under direct British rule, districts under non-landlord-based revenue collection systems had more investment in physical and human infrastructure than those under landlord-based revenue collection systems. No such difference existed in areas under indirect rule.

[6] See Glaeser et al. (2004) and Acemoglu et al. (2014).
[7] In our robustness exercise we also use some alternative measures of human capital such as the proportion of population above 25 with completed secondary schooling and obtain similar results.

Studying the implications of different land tenure systems in the colonial period on nightlights per capita, we find that a large part of the difference in overall development between directly and indirectly ruled districts is driven by directly ruled landlord districts doing much worse. Also, the differential revenue collection institutions do not affect overall development across indirectly ruled districts. More importantly, the landlord districts under direct rule perform much worse compared to non-landlord districts under the direct rule on all correlates of development, and the lower levels of these correlates can explain the underperformance of landlord districts. Restricting the sample to only those landlord districts which have a neighboring non-landlord district yields similar results.

Looking at the growth effects of land tenure institutions over the period 1993-2013, we find that, controlling for initial lights per capita, the landlord districts in directly ruled areas had slower growth than the non-landlord districts in directly ruled areas. The rate of growth in the latter was roughly similar to that in the indirectly ruled districts. However, when we control for geographical variables and the initial levels of correlates of development, the impact of land tenure institutions on growth disappears suggesting that any growth effect of land tenure institutions can be accounted for by geographical factors and correlates of development.

In sum, we have documented a significant difference in the level of development between districts under direct British rule and indirect rule. As well, direct British rule in combination with the landlord-based revenue system has a persistent effect on development.

What explains the pernicious effects of landlord-based systems in directly ruled areas? Banerjee and Iyer (2005) was the first study to document the adverse effects of landlord-based systems on agricultural investments and public good provision. They conjectured that landlords, who exercised a substantial amount of arbitrary power bestowed upon them by the British and unofficially assumed the role of local administrators, shared weaker ties with their constituents relative to districts with the non-landlord system that dealt directly with the British. A potential consequence of weaker ties between local administrators and constituents is lower levels of responsiveness of the administrators towards the constituents' needs.[8] Following Besley and Burgess (2002) we use the average voter turnout in legislative elections from 2008 to 2013 and the fraction of households within a district in which people 'regularly' read the newspaper as proxies

[8] Pandey (2010) provides corroborating micro-level evidence by comparing the governance and educational outcomes in landlord and non-landlord districts in Uttar Pradesh (the most populous state in India). She finds that villages in non-landlord districts did much better in terms of both governance and educational outcomes.

for the level of government responsiveness. Banerjee and Iyer (2005) also conjectured that the landlord-based system created an entrenched elite giving rise to class-based divide and conflict within the society with persistent effects. We try to capture this by using the fraction of households within a district that believes there is 'not much' conflict among communities in their village/neighborhood.

We find that the landlord districts under direct British rule had significantly lower voter turnout and higher levels of conflict compared to the non-landlord districts, however, the newspaper readership didn't differ much across the two types of districts. Additionally, the inclusion of these variables reduced the magnitude of the coefficient on direct British rule and rendered it statistically insignificant. Therefore, we conclude that lower voter turnout and higher levels of conflict are the deeper mechanisms through which direct British rule affected development adversely.

Next, we perform a series of checks to ensure the robustness of our results. We first account for issues prevalent in the measurement of nightlights data such as top-coding and bottom censoring as well as the overglow and blooming effect of nightlights that could bias our results.[9] For this, we use an alternative nightlights dataset by Bluhm and Krause (2022) who correct the 'stable' nightlights images for top-coding and bottom censoring. We also control for the distance to the closest major city from the centroid of each district to account for the overglow and blooming effect of nightlights. Our results are robust to these measurement issues in nightlights data. Secondly, since our analysis is limited to a cross-section and focuses on outcomes in 1993, our results may vary with outcomes from different years. We check for this by using nightlights per capita in 2013 and 2019 (instead of 1993) as the outcome variable. We find that the adverse effect of direct British rule on present-day overall development has persisted till 2019. Interestingly, while directly ruled districts are still doing worse, the gap has narrowed down in 2019 compared to 1993 and most of this narrowing of the gap seems to have taken place towards the end of the period. Thirdly, our use of a dummy variable to represent if a modern district (1991-level) in India was historically under the direct rule of the British could potentially be a cause of worry as it omits the differences in the effect of direct rule stemming from differences in time spent under the direct British rule.[10] We use the duration spent under British rule as our main explanatory variable instead

[9] Pinkovskiy and Sala-i-Martin (2016), Henderson et al. (2012), Chanda and Kabiraj (2020), Prakash, Rockmore, and Uppal (2019)
[10] Feyrer and Sacerdote (2009)

of the direct British rule dummy and find that our results are unchanged. Next, we include the share of Scheduled Castes (SC) and the share of Scheduled Tribes (ST) in each district as an additional control and find the coefficient of direct British rule is virtually unchanged in the regressions without state fixed effects but declines in magnitude when state fixed effects are included. As a fifth robustness check, we account for differences in the measurement of nightlights, agricultural suitability, and initial differences across modern districts. For this, we include additional controls, specifically terrain ruggedness, agricultural suitability index, and historical controls, and find that our results are robust to the inclusion of these additional controls. Lastly, we use an alternative proxy of development, specifically consumption per capita data for rural districts only, instead of nightlights per capita and find that our results remain robust.[11]

Among other related papers, Castelló-Climent et al. (2018) study the implications of human capital for development using district-level nightlights data from India. To tackle the endogeneity of human capital, they use the historical location of Catholic missionaries in India in 1911 as an instrument for present-day human capital accumulation.[12] They find a large and significant positive effect of human capital on the density of lights across districts in India. Since human capital is a possible mechanism through which institutions can affect development, we not only control for human capital, but also use their instrument, the location of Catholic missionaries. In fact, along the lines of Acemoglu et al. (2014) where they instrument for both institutions and human capital, we also provide estimates where we instrument for both direct British rule and literacy rate (our preferred measure of human capital) and find that direct British rule has a large negative effect and literacy has a large positive effect on development measured by nightlights per capita.

Compared to other studies looking at the impact of the direct British rule and/or colonial land tenure institutions in India, we make 4 contributions: 1) Using a comprehensive measure of development, nightlights per capita, we show that the areas under direct British rule had a much lower level of development compared to areas under the indirect rule; 2) Conditional on the initial level of development, areas under direct British rule grew at a much slower pace during the period 1993-2013; 3) Much of the development gap between areas under the indirect rule and direct rule

[11] The per capita consumption data at the district level are available only for rural districts.
[12] Woodberry (2004), Gallego and Woodberry (2009, 2010), Becker and Woessmann (2009), Woodberry (2011), Acemoglu et al. (2014) are other studies using the location of Catholic/Protestant missionaries to instrument human capital.

can be accounted for by the adverse effect of the landlord-based revenue collection system in the directly ruled areas; 4) Weaker government effectiveness as proxied by lower voter turnout and lower newspaper readership, and greater local conflicts are some of the mechanisms through which landlord-based revenue systems still adversely affect development.

Our study contributes to the literature examining the persistent effects of historical institutions on present-day economic development across smaller geographical units within nations. Among studies not related to India, Dell (2010) studies the long-run effects of *mita*, an extensive forced mining labor system operational in Peru and Bolivia between 1573 and 1812. Using data from Peru, she finds that in *mita* districts household consumption was lower and the incidence of stunting higher compared to adjacent districts that were exempt from *mita*. Dell and Olken (2019) study the long-run impact of the Dutch Cultivation System in operation in 19th century Java for the production of sugar on present-day outcomes. They find that areas close to the location of sugar factories established by the Dutch in the mid-19th century are doing better in terms of infrastructure, industrialization, education, public goods provision, and household consumption compared to similar areas which did not get a factory.

The remainder of the paper is structured as follows. Section II provides details of the data used in the paper. Section III describes our empirical specifications and provides baseline results. Section IV provides results with land tenure institutions. Robustness checks are provided in Section V. Section VI provides some concluding remarks.

II. Data

Below we describe the main variables used in our empirical exercise. The details on each variable and its source are provided in the Data Appendix. Table 1 provides the summary statistics for the variables we use in our analysis.

II.1. Nightlights Per Capita

The nightlights data are obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC). The nightlights data are in the form of images of lights generated from the earth's surface. These images are available for years spanning

1992-2013.[13] We use the *sum of lights* statistic that represents the total luminosity of nightlights emitted in 1993 from each district and divide it by the district population to obtain *Nightlights Per Capita in 1993* which is our proxy for per capita income at the district level.[14] Figure 1 showcases the raw nightlights image for the year 1993 for India.

II.2. Institutional Data

The data on districts that were historically under direct British rule and districts that were historically a part of a Princely state are obtained from Iyer (2010).[15] Figure 2 depicts the distribution of the natural log of nightlights per capita in 1993 across the 466 districts in India. The directly ruled districts are in blue and the indirectly ruled districts are in red. Darker shades capture more light.

Though India was divided into 466 districts as per the 1991 district boundaries, we focus on 412 districts spread across 18 major states of India (1991 Census). Focusing on major states within India is a common practice and involves dropping observations from small States, Union Territories (UTs), and the North-Eastern States for several reasons including the quality of current data, problems in matching current and historic district boundaries, and availability of data.[16] Out of these 412 modern (1991-level) districts, 265 districts were historically under direct British rule while 147 districts were historically a part of princely or native states.

III. Empirical Specification and Main Results

[13] The NOAA makes multiple nightlights data products available publicly. In our main specification, we use the 'stable' nightlights product of the DMP-OLS nightlights data series. This data is top coded at 63. We deal with this issue as well as other measurement issues of the nightlights data in our robustness analysis in section V.

[14] Since district-level population is not available for 1993, we use the 1991 district-level population to compute *Nightlights Per Capita in 1993.*

[15] The historical background for why a district in India was under direct British rule or a Princely state (under indirect rule) is discussed in detail in Iyer (2010). Also, as described in detail in the data appendix and Table A16 in the online appendix, compared to Iyer (2010) we switched classifications for 5 districts based on the evidence provided in two recent papers, Verghese (2019) and Castelló-Climent et al. (2018), and our own reading of the evidence on this issue. The slight difference in the classification of modern districts into directly ruled or indirectly ruled in various studies arises because some districts contain areas from both British India and Princely states.

[16] The 18 major states we focus on are: Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal. Iyer (2010) conducts her analysis for 17 major states of India which excludes Delhi from our 18 states. Banerjee and Iyer (2005) conduct their analysis for 13 major states, Besley and Burgess (2000) for 16 major states, and Castelló-Climent et al. (2018) for 20 major states of India.

III.1. Empirical Specification: Baseline OLS level regressions

We first identify the long-term effects of the British colonial legacy using a simple cross-sectional OLS model described in equation (1).

$$y_{i,j} = \alpha + \beta Brit_{i,j} + \gamma X_{i,j} + \delta_j + \varepsilon_{i,j} \text{ .... (1)}$$

$y_{i,j}$ in equation (1) is the natural log of nightlights per capita in 1993 for district i in state j.[17] Our main independent variable, $Brit_{i,j}$ takes the value of 1 if the district was under direct British rule and 0 otherwise. $X_{i,j}$ represents the set of geographical controls. Following Pinkovskiy and Sala-i-Martin (2016) who also use nightlights per capita as the dependent variable, we control for the area of each district in 1991. This is mainly to account for potentially higher luminosity emissions from smaller areas due to the higher population densities. Our other geographical controls are average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to the nearest coast for each district to account for heterogeneity in geographical characteristics that leads to differences in agricultural productivity and eventually differences in development across the districts. These geographical characteristics also affect climatic conditions which further affect measurement errors in nightlights data. In addition to its effect on agricultural productivity and climate, distance to the nearest coast from the centroid of each district can also affect development through the trade channel as areas closer to the coast are more likely to be involved in trade and hence may have higher levels of economic development. In our results tables, we refer to the set of these controls as 'Geographical Controls'.

δ_j in equation (1) represents an indicator for state *j* of district *i.* The state here refers to the current Indian state that the district belongs to. We include these state fixed effects in some of our regressions to account for the heterogeneity in state-level policies and administrative decisions that could impact the development outcomes of districts spread across heterogeneous modern states. In all our regressions, we cluster standard errors at the native state level to account for potential

[17] Though the earliest available nightlights data are for the year 1992, we use the nightlights data from 1993 in our analysis. The main reason for this is the quality of the nightlights data. The 1992 district-level nightlights data for India has more observations with 0 *sum of lights* relative to the 1993 data which results in larger spikes in the data and increased noise in our regressions. About 3% of the entire 1992 nightlights data for India has *sum of lights* equal to 0 relative to the 1% in the 1993 nightlights data for India.

correlation in outcomes across modern districts that historically were a part of the same native state.[18] The native state here refers to the Princely state that the district belonged to during British rule.

The role of institutions as the key determinant of economic growth and development is widely accepted. An alternative view, originally ascribed to Lipset (1959), posits that improvement in institutional quality is a result of growth in income and human capital accumulation. Supporting this view, Glaeser et al. (2004) criticize the seminal study by Acemoglu et al. (2001) for not accounting for the role of human capital in their analysis. Glaeser et al. (2004) show that, after controlling for human capital accumulation, institutions no longer have a significant impact on long-run development. Responding to this criticism, Acemoglu et al. (2014) show that the impact of institutions on long-run development is robust and the significance of human capital in explaining the differences in per capita income across countries goes down when both institutions and human capital are instrumented. Chanda et al. (2014), in their persistence of fortune study, find results consistent with Glaeser et al. (2014). Since we are studying the implications of a historical institution on economic development, following this debate, we control for human capital in equation (1) above. Our measure of human capital is the literacy rate (denoted by $Lit.Rate_{i,j}$) in the district in 1991, but we also perform robustness checks with other measures such as the share of the population with completed secondary schooling.

III.2. Baseline OLS results on the level of development

Table 2 reports the baseline OLS results. In column 1, we report the OLS result obtained from the specification described in equation (1). The coefficient of $Brit$ in column 1 is negative and statistically significant and implies that modern districts that were under the direct rule of the British had 39.47% less lights per capita in 1993 compared to the districts that were under Princely states. As mentioned in the introduction, using the estimated elasticity of GDP per capita with respect to nightlights per capita of 0.22, this translates into 8.7% less GDP per capita in directly ruled districts. In column 2, we include $Lit.Rate$ as an additional regressor and find it to be positively and significantly related with nightlights per capita. The coefficient on $Brit$ remains

[18] And, following Iyer (2010), for districts under direct British rule, the clustering is done according to region and date of annexation.

negative and statistically significant. In fact, the negative coefficient on $Brit$ increases in magnitude in column 2 indicating a positive correlation between $Brit$ and $Lit.Rate$, which we confirm in the data as well. This result is somewhat at odds with the findings in Iyer (2010) that indirectly ruled districts have a greater investment in human capital in the form of the number of villages having primary, middle, and high schools. Higher investments in human capital do not seem to translate into higher literacy rates in indirectly ruled districts, something that was found by Iyer (2010) as well. More generally, the findings suggest that the direct British rule's adverse effect on long-run development occurs through channels other than human capital.

Having looked at the effect of direct British rule on the level of development in 1993, and before turning to the issues of selection bias, omitted variable bias, etc. in our OLS estimates, we next analyze if the direct British rule has any growth effects during the period for which we have nightlights data. This is an important question because India embarked on a policy of massive liberalization, both internal and external, starting in 1991 which resulted in a rapid growth in per capita income over the next couple of decades and it would be interesting to explore if direct British rule was a drag on growth during this period. Additionally, since we found directly ruled districts to have lower levels of development in 1993, and Chanda and Kabiraj (2020) found that poorer districts grew faster, one may expect the directly ruled districts to grow faster, leading to a convergence in the levels of development of directly and indirectly ruled districts. As shown below, for the period 1993-2013 we find the opposite.

III.3. Impact of direct British rule on Growth and Convergence

To examine if the British colonial legacy affected differentially the growth rates of districts that were under direct and indirect rules, we estimate the specification described in the equation below.

$$growth_{i,j,t,t-k} = \alpha + \rho y_{i,j,t-k} + \beta Brit_{i,j} + \delta\left(y_{i,j,t-k} \times Brit_{i,j}\right) + \phi Lit.Rate_{i,j,t-k} + \varepsilon_{i,j} \quad \ldots.(2)$$

$growth_{i,j,t,t-k}$ represents the growth in nightlights per capita of district i in state j between years t (2013) and t-k (1993). $y_{i,j,t-k}$ denotes nightlights per capita in 1993 which is included as a regressor to test for convergence across districts following the prediction of the neoclassical growth model that countries/regions that are poorer tend to grow faster. The inclusion of $Brit_{i,j}$ and $Lit.Rate_{i,j}$ allow for conditional convergence as we describe below.

Table 3 reports the regression results of the specification described in equation (2). In column 1, we only include $y_{i,j,t-k}$. The coefficient on $y_{i,j,t-k}$ is -0.0231 which is very close to the estimate in Chanda and Kabiraj (2020) who also use nightlights data and provide evidence across districts within India from 1996-2010. The convergence coefficient of -0.0231 implies that districts across India converged at a rate of 3.1% per year and at this rate it will take 30 years to close half the gap.[19] To capture the impact of direct British rule on growth, in column 2 we add $Brit$ as an explanatory variable and find the coefficient to be negative and significant implying that after accounting for heterogeneity in the initial nightlights per capita, modern districts that were under direct British rule experienced a 1.84% lower growth rate annually compared to districts that were under indirect British rule. Using an elasticity of 0.32 for the growth in per capita GDP with respect to nightlights per capita, this translates into 0.59% lower annual growth in GDP per capita. In column 3 we add the interaction of $Brit_{i,j}$ with $y_{i,j,t-k}$ to see if the directly ruled districts converged at a different rate. The coefficients in column 3 imply that the indirectly ruled districts were converging at 5.7% per year, while the districts under direct British rule were converging at 2% per year.[20] That is, while the poorer districts were catching up with the richer districts in both groups (directly and indirectly ruled districts), the catch-up rate was slower among the directly ruled districts.

Adding $Lit.Rate$ as an explanatory variable in column 4 we find that the districts with higher literacy in 1993 grew faster. Conditional on initial literacy, British areas still grew slower and converged at a slower rate. Overall, not only did the directly ruled districts have lower levels of development in 1993, but they also grew at a slower rate during the period 1993 to 2013.

Therefore, both our level and growth regressions suggest the adverse impact of direct British rule on overall development as measured by nightlights per capita.

In the remainder of the paper, we establish the robustness of OLS results and explore the mechanisms through which direct British rule may have a persistent effect on development.

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[19] Convergence rate is calculated using $\rho=-(1-e^{-\pi k})/k$, where π is the convergence rate and ρ is the convergence coefficient. Half-life is calculated using $h=\ln(0.5)/\rho$, where h is number of years taken to close half the gap.

[20] The convergence coefficient for indirectly ruled districts is 0.341 while that for directly ruled districts is (0.341-.0176) = .0165. These translate into 5.7% and 2%, respectively, using the formula in footnote 19.

III.4. Neighborhood district analysis

It is conceivable that some omitted factors may explain the negative association between development and directly ruled districts. One way to reduce the influence of omitted factors is to restrict the sample to only neighboring districts. That is, we restrict the sample to only those directly ruled districts which have a bordering indirectly ruled district. This reduces the number of districts to 221 but other omitted factors are likely to be similar in these neighboring districts. Figure 3 shows lights per capita in the neighboring districts sample. The regression results are reported in columns 3 and 4 of Table 2. The coefficient of $Brit$ is negative but fails to be statistically significant in column 2. However, quantitatively it is still significant implying that indirectly ruled districts have 17% more lights per capita than directly ruled districts. When we include $Lit.Rate$ as an additional control in column 4, the coefficient of $Lit.Rate$ is positive and significant as was the case in column 2 for all districts. Also, the inclusion of $Lit.Rate$ increases the magnitude of the coefficient of $Brit$ in addition to making it statistically significant. Therefore, our neighboring district analysis confirms the validity of our baseline OLS results. Later we discuss why the coefficient of $Brit$ is likely to have a downward bias.

Next, we turn to the endogeneity issues afflicting the OLS estimates.

III.5. Instrumental Variable (*IV*) Regressions

III.5.1. Endogeneity of $Brit_{i,j}$ *stemming from selective annexation:*

In the OLS specification described in equation (1), the assumption is that the annexation of areas by the British was random. However, Iyer (2010) finds evidence that the British annexation policy was selective towards areas more favorable for agriculture. Our geographical controls already alleviate this concern, but we use an instrumental variable approach to account for the underlying endogeneity of $Brit$ stemming from selective annexation. We use the instrument, *Lapse*, first constructed and used by Iyer (2010) who also provides a detailed description of the rationale behind using this instrument. Here is a brief description of it. The British used a specific annexation policy, called the *Doctrine of Lapse*, from 1848-1856 under which if the hereditary ruler of a princely state died without a natural heir, the state would automatically be annexed by the British i.e., it would lose its princely status and come under the direct rule of the British. The death of a ruler without a natural heir is a random event and is unlikely to affect development outcomes in the post-colonial period. According to this annexation policy, a princely state whose hereditary ruler died without a natural heir was relatively more likely to be annexed by the British between 1848-1856. Therefore, our instrument for direct British rule, $Brit_{i,j}$, is a dummy variable $Lapse_{i,j}$ for each modern 1991 district i in state j which takes the value 1 if the district was part of a princely state that was not annexed before 1848 and the hereditary ruler of that princely state died without a natural heir between 1848-1856 and a value of 0 if the princely state was not annexed before 1848 and the hereditary ruler of that state did not die without a natural heir between 1848-1856.

Similar to Iyer (2010), in our *IV* analysis we only consider areas that were either never annexed throughout the colonial rule in India or were annexed by the British between 1848-1856. The total sample size is reduced to 181 districts out of which 143 were historically part of princely states that were never annexed and the hereditary rulers of these princely states did not die without a natural heir between 1848-1856. 4 districts were historically part of princely states whose hereditary rulers died without a natural heir between 1848-1856 but were never annexed by the British due to extraneous factors while 19 districts were historically part of princely states whose hereditary rulers did not die without a natural heir between 1848-1856 but were annexed by the British through other means. The remaining 15 districts were historically part of native states whose rulers died without natural heirs between 1848-1856 and consequentially were brought under the direct rule of the British through the *Doctrine of Lapse*.

III.5.2. Endogeneity of Literacy rate:

Since our main interest lies in ascertaining the importance of direct British rule on development, the endogeneity of literacy rate (reverse causality from nightlights to literacy) which is included as a key regressor in our baseline regression is not a prime concern. However, it also allows us to run a horse-race regression between institutions and human capital as the alternative determinants of development where both these endogenous variables are instrumented as in Acemoglu et al. (2014). We use the historical location of Catholic missionaries in the early 20th century from Castelló-Climent et al. (2018) as an instrument for the present-day literacy rate. The historical location of catholic missionaries could violate the exclusion restriction in two ways: 1) if Catholic missionaries positively selected districts and thus located in richer and more educated districts that could independently impact present-day human capital outcomes and, 2) if the historical location of Catholic missionaries affects present-day development levels through channels other than contemporary higher education. Both these possibilities have been investigated thoroughly by Castelló-Climent et al. (2018) and they conclude that the instrument satisfies the exclusions restrictions. However, a recent paper by Jedwab et al. (2022) raises questions about the validity of this instrument using data from Sub-Saharan Africa. They show that missions were established in healthier, more accessible, and richer places before expanding to economically less developed places. As well, the endogeneity problem is amplified when using data from Christian missionary Atlases where reporting is biased in favor of prominent missions established early.

Having described our instruments, we now discuss our main results in the next section.

III.6. Instrumental Variable Regression Results

IV regression results for our baseline estimating equation are presented in Table 2. As mentioned earlier, our IV sample has only 181 districts while the OLS sample has 412 districts. To keep the IV results comparable to the OLS results, in column 5 we provide the OLS results for the IV sub-sample of 181 districts, and they are similar to the OLS results for the full sample presented in column 2. The IV results when $Brit$ is instrumented by $Lapse$ is shown in column 6. The corresponding first-stage results are reported in the same column in panel B of Table 2. The coefficient on $Lapse$ in the first stage is positive and significant implying that if the hereditary ruler of a princely state died without a natural heir between 1848-1856, the probability that it was automatically annexed to the British empire through the *Doctrine of Lapse* was 59.5%.[21] The coefficient on $Brit$ in column 6 is negative and significant and close to the OLS coefficient in column 5. More interestingly, the coefficient of $Brit$ in column 6 is larger than the coefficient for the full sample in column 2 suggesting that the selective annexation in the pre-1848 period is causing a downward bias in our OLS estimates. This is consistent with the finding in Iyer (2010) that in the pre-1848 period, the British annexation policy was selective towards areas more favorable for agriculture. Since agriculture accounted for a significant proportion of GDP in 1993, we would expect the agricultural GDP per capita to be higher in British districts annexed before 1848, and this factor by itself would create a positive relationship between direct British rule and

[21] The Kleibergen and Paap F statistics for the first stage is 10.399 which lies above the Stock and Yogo (2005) critical value for 15% maximal IV size of 8.96. Hence weak identification is not an issue.

the level of development. Therefore, our OLS finding of a negative relationship between our measure of development and the dummy for direct British rule is likely to be biased downwards due to the selection effect. However, we should also mention that the *IV* estimate could be biased upwards due to measurement error issues.

In columns 7 and 8 of Table 2, we account for the endogeneity of the literacy rate by instrumenting it with the historical location of Catholic missionaries. Not instrumenting $Brit$ in column 7 allows us to see the impact of instrumenting literacy for the whole sample of 412 districts. This makes our estimates in column 7 comparable to the estimates in Castelló-Climent et al. (2018) whose main interest is in studying the impact of human capital on development where they also use nightlights as a proxy for district-level development. The first stage results reported in panel C show that the literacy rate in 1991 is 5.9 percentage points greater on average in districts that had a Catholic missionary in 1911 relative to districts that did not have one.[22] The coefficient of literacy in the second stage is positive and significant which is in line with the results of Castelló-Climent et al. (2018).

Castelló-Climent et al. (2018) use the share of the population above 25 with higher education and separately the share of the population above 25 with primary and middle education as their measures of human capital. In the online appendix Table A1 we show that our results are robust to including both these measures of human capital. In addition to instrumenting the 1991 (present-day) share of higher education variable with the historical location of Catholic missionaries (denoted by $Cath_{i,j}$), we follow Castelló-Climent et al. (2018) and use historical primary school attainment (share of individuals with only primary school completion in 1961) as an instrument for the 1991 share of primary & middle education variable. Again, our key results on the difference between directly and indirectly ruled districts in nightlights per capita remain robust as shown in the online appendix Table A1.[23]

In column 8 of Table 2, we run the same regression as in Column 7 but for the *IV* sub-sample of 181 districts. The results are qualitatively similar to those in column 7. Finally, in column 9 of Table 2, we account for the endogeneity of both the explanatory variables and

[22] The Kleibergen and Paap (KP) F statistics for the first stage in column 7 is 15.73 which lies above the Stock and Yogo (2005) critical value for 15% maximal IV size of 8.96. In column 6, the KP F statistics is 7.72 which is above the Stock and Yogo (2005) critical value for 20% maximal IV size of 6.66.

[23] Castelló-Climent et al. (2018) use nightlights density per unit of area instead of nightlights per capita as their dependent variable in their main specifications. In our online appendix Table A3 we use nightlights density as the dependent variable and their measures of human capital and obtain results similar to those reported in column 7 in Table 2.

instrument $Brit$ and $Lit.Rate$ using their respective instruments ($Lapse$ and $Cath$ respectively). Panel B reports the first stage for $Brit$ and shows that both $Lapse$ and $Cath$ are significantly positively related with $Brit$. In panel C only $Cath$ is significantly positively related with $Lit.Rate$.[24] The coefficient on $Brit$ in the second stage is negative and significant and slightly larger in magnitude than the corresponding OLS coefficient in column 5. The literacy rate remains positively significant and is also larger in magnitude than the corresponding OLS coefficient in column 5. Therefore, even after instrumenting both direct British rule and literacy, we find that directly ruled districts have significantly less nightlights per capita in 1993.

III.7. Robustness to Spatial Correlation

In a recent paper Kelly (2019) argued that the estimates in many papers studying the implications of historical institutions on development suffer from spatial correlation problems. Using the approach developed by Colella et al. (2019), we check for spatial correlation. For each specification, we use a cut-off distance at which the respective Moran's I becomes insignificant and report these cut-off distances as well as the respective Moran's I at that cut-off distance. Then we calculate the Conley standard errors (Conley, 1999) for each specification in Table 2 and report the results in the online appendix Table A5 and confirm that the results in Table 2 are robust to controlling for spatial correlation.[25]

Note that, so far, our identification of the effect of direct British rule on overall development relies on both variations in districts across different modern Indian states and districts within modern Indian states. In the next set of regressions, we use state fixed effects to see if the results survive if we just rely on variations within modern Indian states. That is, in the exercises below we are comparing the levels of development of directly and indirectly ruled districts within

[24] Since we instrument both the endogenous regressors in column 9 of Table 2, the Stock and Yogo (2005) critical values for column 9 are different from columns 6, 7, and 8 where we instrument only one endogenous regressor. The KP F statistics of 3.71 in the first stage is above the Stock and Yogo (2005) critical value for 25% maximal IV size of 3.63.

[25] We also use spatial randomization inference to check the robustness of our key results to spatial correlation. We follow Dincecco, Fenske, and Menon (2020) and Dincecco et al. (2022) and generate artificial spatially correlated noise placebo variable to replace our key independent variable, reallocating the British direct rule dummy randomly across districts in our dataset. Then we re-estimate our regressions in Table 2 and repeat this process 999 times for each regression. In unreported results we find that these simulations outperform the original specification in an insignificantly small percentage of cases. Additionally, the estimates of β coefficient in equation (1) are mainly concentrated around zero. This further shows that our results are robust to spatial correlation.

the same modern state. Since the districts which have been a part of the same Indian state after independence have faced similar policies, any effect of colonial policies may be diluted over time.

III.8. State Fixed effect regression results

The results of the estimation of equation (2) with state fixed effects are reported in Table 4. Relative to column 1 of Table 2, the coefficient on $Brit$ in column 1 of Table 4 is much smaller in magnitude suggesting that part of the variation in overall development across districts stems from the variation in state-level policies practiced since independence. That is, the difference in the level of development across directly and indirectly ruled districts is much less if they belong to the same state than if they were in different states. However, on the inclusion of literacy rate in the subsequent columns of Table 4, we find that the coefficient on $Brit$ increases and is now much closer in magnitude to the respective coefficients in Table 2. Similar to the findings in Table 2, the increase in the magnitude of the coefficient on $Brit$ stems from the positive correlation between $Brit$ and $Lit.Rate$, and this correlation is much stronger within states than across states.

Columns 3 and 4 in Table 4 report the results of the neighborhood regressions. Restricting the neighborhood districts to be in the same modern Indian state restricts the sample to only 151 districts compared to 221 in Table 2. The results from the within state neighborhood regressions are qualitatively similar to those in columns 3 and 4 in Table 2. Columns 5-9 in Table 4 repeat the same regressions as in Table 2 but add the state fixed effects and show that the coefficient on $Brit$ is negative and significant except in column 9. The coefficient of $Brit$ in column 9, when we instrument both $Brit$ and $Lit.Rate$, is negative and large in size but is not precisely estimated.[26]

Similar to the exercise we performed to control for spatial correlation for our baseline regressions reported in Table 2, online appendix Table A6 provides Conley standard errors (Conley, 1999) along with the cutoff distances and Moran's I for the key specifications in Table 4. Again, the results remain robust to the spatial correlation correction and continue to have similar levels of significance as in Table 4.

[26] As was done with the regressions without state fixed effects, for the regressions with state fixed effects the online appendix Table A2 shows that the results are robust to the inclusion of the alternative measures of human capital used by Castelló-Climent et al. (2018). As well, the online appendix Table A4 shows that the results are also robust to using nightlights per area as the measure of development.

Overall, the results we obtain from Tables 2 and 4 confirm that the colonial institutions in the form of direct British rule are continuing to cause a disparity in present-day economic development. The results persist after controlling for human capital suggesting that there may be other channels through which the legacy of direct British rule affects development which we explore next.

III.9. Other Correlates of Development

We examine some other correlates of development to see if they can help explain the relative underdevelopment of directly ruled districts. We use the infant mortality rate (IMR hereon) to capture health, and road length per capita and railroad length per capita to capture physical infrastructure. We use the number of bank branches per capita as a measure of financial infrastructure. We also use the female labor force participation rate which is a strong correlate of development whose low average rate in India is a puzzle.

The results from including these additional correlates of development are reported in Table 5. The first 4 columns present estimates of regressions without state fixed effects while the last 4 columns include state fixed effects. From the results reported in column 1, we note that the coefficient of IMR is negative but fails to be significant. Both roads and railroads are positively associated with nightlights per capita, and their coefficients are statistically significant. The coefficient of the financial infrastructure variable, the number of bank branches per capita, is also positive and significant as is the coefficient of the female labor force participation rate. After including these additional regressors, we find that the coefficient of $Brit$ is almost the same as in column 2 in Table 2 and remains negative and significant. To understand the results better, we regress all these variables on $Brit$ and geographical controls and report the results in Table 6. We find that direct British rule is positively associated with literacy, IMR, railroad length per capita, and bank branches per capita and negatively associated with road length per capita and female labor force participation rate. Therefore, from this list of correlates, the adverse effects of direct British rule are occurring through higher IMR, lower road length per capita, and lower female labor force participation rate. At the same time, direct British rule is also having a positive impact through higher literacy, better railroads, and more bank branches per capita. When all these correlates are included simultaneously, their combined effect is a wash as the coefficient of $Brit$ in column 1 of Table 5 is very similar to that in column 2 of Table 2.

Column 2 of Table 5 produces the results from the sub-sample of neighboring districts and the results are similar to the corresponding result in column 4 of Table 2. Column 3 presents the OLS results for the IV sample and again they are similar to the corresponding results in column 5 of Table 2. Column 4 presents the IV results when $Brit$ is instrumented by $Lapse$ and the IV coefficient of $Brit$ is larger in magnitude than in Table 2. Similarly, the results with state fixed effects in columns 5-8 are qualitatively similar to the corresponding results in Table 4.

Since several of the correlates included in the regressions in Table 5 capture physical, human, and financial infrastructure variables, in a development accounting sense what is left to account for is the total factor productivity across directly and indirectly ruled districts. In an attempt to capture productivity differences, we constructed district-level measures of labor productivity in manufacturing using ASI data. Labor productivity in manufacturing is slightly higher in indirectly ruled districts as shown in column 7 of Table 6. When we include manufacturing labor productivity as an additional regressor in addition to those discussed above (results shown in online appendix Table A7), we find it to be significantly positively related with nightlights per capita. The coefficient of $Brit$ remains negative and significant. This suggests that productivity differences in other sectors of the economy are more significant.[27]

Since these correlates of development together cannot explain the channels through which adverse effects of direct British rule occur, we explore some other channels in section 4. But before turning to that we study the relationship between these correlates of development and the growth of nightlights per capita during 1993-2013.

III.10. Growth regressions with other correlates of development

The results of including these additional correlates of development alongside geographical controls in the growth regression are presented in column 5 of Table 3. We find that literacy and road length per capita are positively and significantly related with growth while IMR is negatively and

[27] Since the number of districts drops to 385 when we include manufacturing labor productivity because ASI data has this information for only 385 districts in our sample, we kept the results with this variable separate and in the online appendix. We also computed district level manufacturing TFP and found the results to be similar to those obtained using labor productivity in manufacturing.

significantly related with growth. Railroad length per capita, bank branches per capita, and female labor force participation rate are positively related with growth but their coefficients are not statistically significant. Including all these controls in addition to geographical controls significantly reduces the gap between the growth rates of indirectly and directly ruled districts compared to the estimates in column 2 of Table 3.[28] Looking at the relationship of these correlates to direct British rule in Table 6, we can conclude that the poor growth performance of directly ruled districts can be partly ascribed to their worse initial levels of IMR, road length per capita, and female labor force participation rate.

We also studied the potential role of trade liberalization in explaining the differential growth performance of directly and indirectly ruled districts. In results not reported but available upon request we found that districts that had the larger decreases in tariffs from 1987 to 1997 had higher growth in nightlights per capita between 1993 and 2013.[29] We also found that directly ruled districts experienced larger decreases in tariffs. Therefore, a lower degree of trade liberalization cannot account for the lower growth performance of directly ruled districts.[30]

In the next section, we explore the role of the types of land tenure systems adopted by the British in explaining the differences across directly and indirectly ruled districts.

IV. Land Tenure Institutions, Development, and Growth

Land revenue was the biggest source of government revenue during the colonial period (Iyer, 2010). The collection of land revenue was facilitated by land revenue collection systems referred to as the land tenure systems developed by the British. These land tenure systems essentially determined who had proprietary rights over the land. In the landlord-based system, the landlord paid a fixed amount of revenue to the British but was free to exploit the tenant. In the individual cultivator-based system, the cultivator was responsible for paying the revenue while in the village-based system the village was responsible for it. The landlord-based system has been shown to be

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[28] The coefficients of $Brit$ and its interaction with initial lights in column 5 of Table 3 add up to -1% at the mean value of initial nightlights per capita suggesting that the gap in the growth rate of indirectly and directly ruled districts decreases to 1% compared to 1.84% in column 2 of Table 3.

[29] We obtain data on changes in tariffs from 1987 to 1997 from Topalova (2010).

[30] We also looked at the rate of structural transformation as measured by the employment share changes of different sectors. We found the growth rate during this period to be positively correlated with a decline in the share of the workforce in agriculture and an increase in the share of the workforce in the tertiary sector. However, there was no significant difference in these variables between directly and indirectly ruled districts.

more exploitative with persistent adverse effects on development. Looking at only the directly ruled areas, Banerjee and Iyer (2005) found that landlord districts had lower investments in agriculture and worse public goods provision. Iyer (2010) also looked at indirectly ruled areas and found that there was not much difference in the public good provision between landlord and non-landlord districts in indirectly ruled areas. In her micro-level study of villages in 26 districts of UP, Pandey (2010) found that governance and educational outcomes were worse in villages in landlord districts compared to non-landlord districts.

IV.1. Land Tenure Institutions and Development

We first explore the implications of the land tenure system for overall development measured by nightlights per capita and later we also study if it was related to the growth performance during 1993-2013. We use data from Iyer (2010) which has information on the proportion of land under the non-landlord tenure system in each district. We use the dummy variable *NLT* which takes the value 1 if a majority of the area was under a non-landlord-based system and zero, otherwise. We augment the specification described in equation (1) with an additional explanatory variable, the interaction of $Brit_{i,j}$ and $NLT_{i,j}$, to obtain the following estimating equation.[31]

$$y_{i,j} = \alpha + \beta Brit_{i,j} + \lambda\left(Brit_{i,j} \times NLT_{i,j}\right) + \gamma X_{i,j} + \varepsilon_{i,j} \dots (3)$$

Given the specification in equation (3), the omitted category is the indirectly ruled districts. β captures the difference between directly ruled landlord districts and indirectly ruled districts. $\beta + \lambda$ captures the difference between indirectly ruled districts and directly ruled non-landlord districts.

In equation (3), the NLT variable could potentially suffer from similar endogeneity issues that we discussed previously in the case of $Brit$. To tackle this selection bias, Banerjee and Iyer (2005) extend their analysis to an instrumental variable strategy wherein they use a dummy

[31] We also included *NLT* directly to see if the land tenure institutions mattered for indirectly ruled districts, however, the coefficient of *NLT* was always very small and insignificant. The results with *NLT* included as a separate regressor are available in the online appendix Table A8. The results are similar when we use *NLT* to denote the proportion of area under non-landlord tenure system as shown in columns 8-10 of Table A8.

variable, that takes the value of 1 if the respective area was annexed between 1820 and 1856, as an instrument for the proportion of land area that had the non-landlord-based system. They argue that areas where the British took control of the land revenue collection between 1820 and 1856 are more likely to have the majority of their land area fall under the non-landlord-based system. They find their OLS estimates to be biased downwards and treat their OLS results as the benchmark estimates in their paper due to the potential upward bias in their IV estimates. Based on the analysis by Banerjee and Iyer (2005), we maintain that the endogeneity of land tenure institutions is not a concern.

The data on land tenure systems in place are available only for a total of 356 modern 1991 districts. Out of 356 districts, 245 districts came under direct British rule and 111 districts were part of native states and hence came under indirect British rule. Of the 245 directly ruled districts, about 51% had the majority of their land area under the non-landlord-based system. For the 111 indirectly ruled districts it was about 64%. Figure 4 showcases the distribution of land tenure systems across directly and indirectly ruled districts with different land tenure systems.

Table 7 reports the results of estimating equation (3). Since the land tenure systems data are available only for 356 districts, we replicate our benchmark specifications from column 1 of Table 2 with this restricted sample of 356 districts and report the results in column 1 in Table 7. In column 2, we report the results obtained for the specification described in equation (3). We find that landlord districts have a significantly lower level of nightlights per capita than the non-landlord districts under direct rule. The latter have only slightly lower levels of nightlights per capita than indirectly ruled districts. This confirms that the underdevelopment of directly ruled districts is primarily driven by the backwardness of landlord districts under direct rule.

Just as we looked at how the correlates of development differ across directly and indirectly ruled districts in Table 6 earlier, we also analyzed whether these correlates had any relationship to the land tenure systems. The results are presented in columns 8-14 in Table 6. We found that non-landlord districts under direct rule were doing better than landlord districts under direct rule on all the correlates of development. This suggests that the underperformance of landlord districts can be explained by these correlates of development. When we include these correlates in the regressions in Table 7, first literacy in column 3 and then the remaining correlates in column 4, the coefficient of $Brit$ is negative and significant and the coefficient of the interaction of $Brit$ and NLT is positive and significant suggesting that landlord districts under the direct rule are doing worse even after controlling for these correlates. However, compared to column 2, the coefficients decline in magnitude in columns 3 and 4. Comparing the results in columns 2 and 4, we can say that the correlates of development included in column 4 partially explain the relative backwardness of landlord districts under direct rule.[32]

To check the robustness of the above results we also did a neighborhood district analysis where we restricted our sample to only those districts which only had a neighboring district with a different land tenure system. Figure 5 shows the distribution of lights per capita in adjacent landlord and non-landlord districts. Our sample size is reduced from 356 to 170 districts. The regression results are presented in columns 5-7 in Table 7. The key difference compared to the results in columns 2-4 is that the coefficient of the interaction term, $Brit \times NLT$, becomes smaller in magnitude and loses statistical significance. That is, the gap between landlord and non-landlord districts under direct rule becomes much smaller. However, it is still the case that the directly ruled landlord districts have less nightlights per capita than the other 3 types of districts. We also tried to include state fixed effects in our regressions with land tenure, however, the results are less robust. This is mainly because the land tenure systems varied more across districts that are parts of different modern Indian states than districts within modern Indian states.

As mentioned earlier, Banerjee and Iyer (2005) and Iyer (2010) found significant differences in the public good provision between landlord and non-landlord districts in directly ruled areas. Our results using nightlights data suggest differences in the overall development between landlord and non-landlord districts under direct rule.

Since our growth regressions earlier suggested a negative impact of the direct British rule on growth during the period 1993-2013, we next check if land tenure institutions had any effect on growth.

IV.2. Land Tenure Institutions and Growth

The results reported in Table 3 column 6 show that controlling for initial nightlights per capita, the landlord districts in directly ruled areas had slower growth than the non-landlord districts in directly ruled areas. The rate of growth in the latter was roughly similar to that in the indirectly

[32] In Table A9 in the online appendix we reproduce Table 7 with labor productivity in manufacturing as an additional regressor. The results in columns 4 and 7 in Table A9 show that manufacturing labor productivity is positively related with nightlights per capita and the overall results in these two columns are very similar to those in the corresponding columns in Table 7.

ruled districts. The results are similar after controlling for the initial literacy rate as shown in column 7 of Table 3. However, when we control for geographical variables and the initial levels of other correlates of development, the impact of land tenure institutions on growth disappears as shown in column 8 of Table 3.[33] Note from Table 6 columns 8-14 that non-landlord districts under direct rule had significantly better literacy, lower IMR, and more bank branches per capita. They also had better roads, railroads, and higher female labor force participation rates (though differences are not statistically significant), which are all positively correlated with growth. Therefore, the superior growth performance of non-landlord districts in directly ruled areas can be explained by these correlates of development and once these are controlled for, the difference between the growth performance of landlord and non-landlord districts under direct rule disappears.

IV.3. Mechanisms Behind the Adverse Effects of Land Tenure Institutions

Having looked at the adverse effects of direct British rule in combination with the landlord-based tenure system on development, we now examine two deeper mechanisms through which this may have occurred: 1) the role of government responsiveness, captured by the degree of participation in the democratic process (voter turnout) and the exposure to mass media (fraction of households within a district in which people 'regularly' read the newspaper), and 2) the role of trust and conflict captured by the fraction of households within a district that believes there is 'not much' conflict among communities in their village/neighborhood.

The motivation for undertaking this exercise is as follows. Banerjee and Iyer (2005) conjecture that landlords, who exercised a substantial amount of arbitrary power bestowed upon them by the British and unofficially assumed the role of local administrators, shared weaker ties with their constituents relative to districts with the non-landlord system that dealt directly with the British. A potential consequence of weaker ties between local administrators and constituents is lower levels of responsiveness of the administrators towards the constituents' needs.[34] Using state level data from India Besley and Burgess (2002) find a positive association between newspaper

[33] In fact, conditional on these controls, non-landlord districts under direct rule have a slightly lower growth rate compared to landlord districts under direct rule or indirectly ruled districts.

[34] Pandey (2010) corroborates this hypothesis using micro level evidence and suggests that the elite have "little stake" in the provision of public goods in landlord areas which mainly benefit the non-elite.

circulation and government responsiveness as well as between electoral turnout and government responsiveness. Following Besley and Burgess (2002) we use the average voter turnout in legislative elections from 2008 to 2013 (obtained from the Trivedi Elections Data housed on the Shrug Open Data Platform) and the fraction of households within a district in which people 'regularly' read the newspaper (obtained from IHDS-II (2012) dataset) as proxies for the level of government responsiveness.

Regarding trust and conflict, since landlords had the right to set the land revenues and penalize those who defaulted, they exercised a considerable degree of political power over the constituents in their jurisdiction. The significant arbitrary power bestowed upon the oppressive and absent *zamindars* by the British created an entrenched elite, thus giving rise to a class-based divide, lack of trust, as well as increased conflict within the society. Banerjee and Iyer (2005) conjecture that this class-based divide, mistrust, and conflict persisted well into the post-independence period.[35] To see if there is greater conflict and mistrust in the landlord districts and whether it can account for some of the development gaps, we use the fraction of households within a district that believes there is 'not much' conflict among communities in their village/neighborhood (obtained from IHDS-II (2012) dataset) as a proxy for local trust and conflict.

We first check the relationship of these variables to direct British rule and land tenure institutions and present the results in Table 8. Column 1 shows that voter turnout is lower in directly ruled districts but the coefficient is insignificant. Column 2 finds the same result by restricting the sample to those districts for which we have information on the land tenure systems. Column 3 shows that the non-landlord districts under direct rule had similar levels of voter turnout as indirectly ruled districts but the landlord districts under direct rule had significantly lower voter turnout relative to the indirectly ruled districts. Column 4 shows that directly ruled areas had significantly lower newspaper readership while column 5 reproduces this result by restricting the sample to the districts with information on land tenure.[36] Column 6 shows that newspaper readership was roughly similar in landlord and non-landlord districts under direct rule. Columns 7

[35] This culture of mistrust has also been examined empirically as a potential explanation for 'persistence' in the context of slave trade within Africa (Nunn and Wantchekon, 2011). Furthermore, a number of additional studies have also documented the importance of trust for economic development (Knack and Keefer, 1997; Fafchamps, 2006; Tabellini, 2010; Algan and Cahuc, 2010) as well as examined the historical determinants of the same (Guiso et al., 2007).

[36] IHDS-II data on newspaper readership and conflict are available for only 280 districts out of which the land tenure information is available for only 248 districts.

and 8 show that directly ruled districts had higher levels of conflict in the full sample as well as the restricted sample with land tenure information. Finally, column 9 shows that landlord districts under direct rule had significantly higher levels of conflict than non-landlord districts under direct rule. The latter, in turn, had slightly higher levels of conflict than districts under indirect rule.

Next, we turn to examine whether these variables can be a mechanism through which direct British rule and land tenure institutions affected development. Since these new variables come from IHDS-II (2012), we use nightlights per capita in 2013 as the dependent variable.[37] The results are presented in Table 9. Column 1 reproduces the baseline result with lights per capita in 2013. In column 2 when we include the voter turnout, we find that this variable is significantly positively correlated with lights per capita. Also, the coefficient of $Brit$ decreases significantly. The same pattern holds in column 4 when we include newspaper readership and in column 5 when we include the conflict variable. Note that the latter two variables are available for only 280 districts and, therefore, to facilitate comparison we present the baseline results for these 280 districts in column 3. In column 6 we include all 3 of them simultaneously and the coefficient of $Brit$ decreases significantly and fails to remain statistically significant. The coefficients of all 3 mechanism variables are positive but the conflict variable fails to be significant. Therefore, this exercise suggests that these 3 variables capture the possible channels through which direct British rule may be affecting development adversely. One caveat to these results is that the sample size in columns 3-6 is reduced by one-third.

Turning to see the role of land tenure institutions, we present the baseline result in column 7 which shows that nightlights per capita are significantly lower in landlord districts under direct rule. When we include the voter turnout in column 8, we find that the coefficients of $Brit$ and its interaction with *NLT* go down substantially compared to their coefficients in column 7. The results suggest that the lower government effectiveness captured by lower voter turnout in the landlord districts under direct rule partially accounts for their relative backwardness.

Since the other two variables are available in only 248 districts for which we have information on land tenure institutions, column 9 in Table 9 presents the baseline results for land tenure institutions for these 248 districts. Columns 10 and 11 show what happens when we include

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[37] Considering the history of district bifurcations and boundary changes, we refer to Kumar and Somanathan (2009) and http://www.statoids.com/yin.html in matching the 2011 district boundaries to the 1991 district boundaries and obtain the population of all the 466 districts (as per the 1991 Census) in 2011. Since population data in 2013 at the district level is not available, we use 2011 population data and the *Sum of lights* statistic for 2013 to construct the *Nightlights Per Capita* variable for 2013 for all the 466 districts.

newspaper readership and the conflict variable, respectively. In both cases, the coefficient of $Brit$ drops in magnitude but the drop is much less than in the case of voter turnout. The coefficient of the interaction between $Brit$ and *NLT* does not change much. Therefore, there is weak evidence of these two variables explaining the relative backwardness of landlord districts under direct rule. When all 3 variables are included simultaneously in column 12, the coefficients of $Brit$ and its interaction with *NLT* drop significantly compared to the baseline in column 9, and all 3 mechanism variables are positively related with nightlights per capita but the conflict variable is not statistically significant. Comparing column 12 to columns 8, 10, and 11, we infer that voter turnout is the key variable accounting for the decline in the coefficients of $Brit$ and its interaction with NLT.

To sum up, we found that the inclusion of various correlates of development in section III did not reduce the coefficient of *Brit.* Then we found that landlord districts under direct rule were doing much worse than non-landlord districts under direct rule. And the latter had similar levels of development as the indirectly ruled districts. To understand why landlord districts under the direct rule are doing worse, we looked at the roles of voter turnout, newspaper readership, and the conflict variable. We found that landlord districts under direct rule had lower voter turnout and higher levels of the conflict variable and their inclusion not only reduced the magnitude of *Brit* but rendered it insignificant. Therefore, we conclude that lower voter turnout and higher levels of conflict are the deeper mechanisms through which direct British rule affected development adversely.

In the next section, we perform a series of robustness checks to examine the sensitivity of our main results.

V. Robustness Exercises

We treat the specification in columns 1 and 5 of Table 5 as our baseline results (OLS regressions with and without state fixed effects). In addition to these specifications, we also check the robustness of the results with land tenure systems in column 5 of Table 7.

V.1. Measurement issues in nightlights data

Overglow and blooming of nightlights: A potential concern in the measurement of nightlights data is the spillover of nightlights from urban cities in close proximity. As a robustness check, we follow Chanda and Kabiraj (2020) and account for the distance to the closest major city from each district to account for the overglow and blooming effect prevalent in measuring nightlights.[38] The results without state fixed effect are reported in column 1 and with state fixed effect in column 2 of Table 10. The coefficients are similar in magnitude and significance to those reported in columns 1 and 5 of Table 5. For the land tenure regressions, column 1 in Table 11 reports the results of adding this additional regressor to the regression reported in column 5 of Table 7. Again, the results are very similar.

In Tables 2 and 5 we presented the neighboring district analysis for a subset of districts and found the results to be qualitatively similar to that for all districts. Note, however, that the spillover problems are likely to be more acute for the neighboring district analysis because lights from adjacent districts can affect the lights in a district of interest. However, this would suggest that any difference in nightlights found between directly and indirectly ruled areas in the neighboring district analysis underestimates the true difference in nightlights per capita. Pinkovskiy (2017) makes this point in the context of border discontinuities where he finds: "light from the faster-growing side of the border illuminates the slower-growing side, making it appear to be growing faster than it really is."[39]

In any case, we control for overglow and blooming effects by including the distance to the closest city in the neighboring district regression and report the results without state fixed effect in column 3 and with state fixed effect in column 4 of Table 10. The results are very similar to the corresponding results presented in Table 5 earlier. For the neighboring district analysis with land tenure institutions, the results, when the distance to the major city is included as an additional regressor, are provided in column 2 of Table 11. Again, the results are very similar to those in column 8 of Table 7.

Top-coding and Bottom censoring in Nightlights Data: The nightlights data (stable lights product) that we utilize in our main specification is censored at a DN of 63 at the top (top-coded) and 0 at

[38] We find the distance from the centroid of each district to the closest major city in ArcGIS using the 1993 district-level shapefile. The major cities as per the 1991 Census are Mumbai, Delhi, Bangalore, Kolkata, Chennai, Ahmedabad, Hyderabad, Pune, Surat, Kanpur, Jaipur, and Lucknow.

[39] In his study of the impact of transit networks on development using nightlights data from India, Khanna (2016) shows that ignoring the presence of spatial spillovers leads to an underestimation of the true effects of road and rail networks. In particular, he finds that a 1% decrease in distance from major highways raises income by 0.06% when spillovers are ignored but raises it by 0.23% after accounting for spillovers.

the bottom. This implies that all the brightest areas have a DN of 63 resulting in negligible variation in their nightlight intensity measurement. Similarly, if nightlight intensity from the least bright areas does not meet the minimum requirement to be captured by the satellite, a DN of 0 is assigned to these areas.[40] The top-coding of nightlights data may limit variation in our outcome variable of $Nightlights\ Per\ Capita$ and could potentially affect the significance of our results. As a robustness check, we use an alternative nightlights dataset by Bluhm and Krause (2022) (BK hereon) that corrects for top coding.[41] We obtain the corrected nighttime lights image for the year 1993 from BK.[42] Columns 5 and 6 in Table 10 report results from using this alternative measure of nightlights. Note that the results in columns 5 and 6 are very similar to the corresponding results in columns 1 and 2 in Table 10. Similarly, for the land tenure regressions, the results using nightlights from BK reported in column 3 of Table 11 are very similar to those in column 1 of Table 11. Therefore, our main results are robust to the use of an alternative nightlights data free of top coding.

To check for the robustness of our growth results to top coding issues, we re-run the regressions presented in Table 3 using the BK data and present the results in Table A10 in the online appendix. The results are very similar to those in Table 3.

V.2. Year-specific results

One limitation of our level analysis is its cross-sectional nature and focus on the outcome in a particular year (1993). It is possible that results may vary for outcome variables from different years. We already saw the results of running the baseline regression for 2013 in column 1 of Table 9 because those mechanism variables were available for years closer to 2013. As a further robustness check, we use nightlights (BK) per capita in 2013 as the outcome variable instead and report the results in columns 1 and 2 in Table A11 in the online appendix. In both these columns,

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[40] See Henderson et al. (2012), Pinkovskiy and Sala-i-Martin (2016), Prakash, Rockmore, and Uppal (2019), and Chanda and Kabiraj (2020) for more information on the top-coding issue of nightlights data.

[41] The *Global Radiance Calibrated Nighttime Lights* product that is made publicly available by the NOAA's NGDC is also free of the top-coding issue. This product however is only available of years 1996, 1999, 2000, 2003, 2004, 2006, and 2010. Since we are interested in an outcome variable closer to the 1991 census year, we use the Bluhm and Krause (2022) nightlights dataset that is corrected for top-coding for all years spanning 1992-2013. For example, the *sum of lights* in the original data for Delhi in 1993 is 86073 while in the BK corrected data it is 141691. For 2010 the correlation between the *sum of lights* statistic obtained from BK and the radiance calibrated data for the 466 districts of India is 0.987 which gives us confidence that the BK data is successful in correcting for top coding.

[42] The Bluhm and Krause (2022) nightlights data was retrieved on Aug 12, 2020 from https://lightinequality.com/top-lights.

the coefficient of $Brit$ remains negative and significant.[43] We find a similar pattern when we use the nightlights (BK) for 2013 in the regressions with land tenure systems. In the regression presented in column 7 of Table A11 for the year 2013 note that the coefficient of $Brit$ is still negative and significant while the coefficient of $Brit \times NLT$ is positive and significant, similar to that in column 3 of Table 11 for 1993.

We validate these results further by using nightlights data of a higher resolution (15 arc-second, about 0.5 km) captured by the JPSS-VIIRS (Elvidge et al., 2021) and was recently made available.[44] This data spans 2012-2020 and hence is available for more recent years. Compared to the DMSP-OLS nightlights data, the JPSS-VIIRS nightlights data is free of over-saturation and has the provision for onboard calibration which significantly enhances the data quality. For our analysis, we replicate specifications in columns 1 and 2 of Table A11 using nightlights (JPSS-VIIRS) per capita in 2013 and 2019 as the dependent variable and report the results in columns 3 – 6 of Table A11.[45] The coefficient of $Brit$ remains negative and significant. Comparing the coefficient of $Brit$ in column 1 with that in column 3 of Table A11, we note that while the former implies that directly ruled districts had 33% less nightlights per capita than indirectly ruled districts, the latter implies that they had 35.4% less nightlights per capita. Therefore, while the JPSS-VIIRS data are of higher quality, our results for the year 2013 using this data are similar to those using our original 2013 data which gives us confidence that the results we obtain for the years 1993 to 2013 are robust. Note that the coefficient of $Brit$ in column 5 Table A11 in the online appendix is much lower than in column 3 suggesting that the gap between the directly and indirectly ruled districts is lower in 2019 than in 2013. This is also confirmed by the growth analysis below.

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[43] Note that the magnitude of the coefficient on $Brit$ is lower in 2013 than in 1993 for the regressions with and without fixed effects. This may seem odd given the results from the growth regressions in Table 3 where we found that directly ruled districts were growing slower and had a lower rate of convergence. The reasons for the lower coefficient of $Brit$ are the controls. Without any controls the directly ruled districts had 36% less nightlights per capita compared to indirectly ruled districts in 1993 while in 2013 they had 45% less nightlights per capita. This is consistent with the findings in Table 3.

[44] The JPSS-VIIRS nightlights dataset has 8 data products for each year. In our analysis, we use the masked average radiance product in which background, biomass burning, and aurora have been zeroed out. The JPSS-VIIRS nightlights data was retrieved on April 8, 2021 from https://eogdata.mines.edu/nighttime_light/annual/v20/. Similar results are obtained using their unmasked average radiance data.

[45] Due to the unavailability of district-level population data for year 2019, we use 2020 population from the Gridded Population of the World, version 4.11 (GPWv4), which is extracted at the district-level using ArcGIS, to compute nightlights per capita for 2019 respectively. GPWv4 is constructed and maintained by the SEDAC (Socioeconomic Data and Applications Center), which is hosted by CIESIN (Center for International Earth Science Information Network) of the Columbia Climate Schools at Columbia University. It is important to note that the 2020 population in GPWv4 represents projected values obtained by extrapolation of official national data from countries around the world.

We also ran the land tenure regression reported in column 7 of Table A11 with the JPSS-VIIRS data for the years 2013 and 2019 and the results are reported in columns 8 and 9 of Table A11. Again, for 2013 the results in column 8 are similar to those in column 7 of Table A11.[46]

Since the JPSS-VIIRS nightlights data are in different units from the nightlights data for earlier years, we were unable to extend our growth analysis to the longer period 1993-2019. However, using the JPSS-VIIRS data we can look at the growth in nightlights per capita for the years 2012-2019.

V.3. Growth regressions for 2012-19

We present the growth results for the sub-period 2012-2019 in the online appendix Table A12. The first thing that stands out for this sub-period is that the estimate in column 1 suggests a very rapid rate of convergence of 9.5% per annum for all districts in India compared to the convergence rate of 3.1% for the period 1993-2013. The estimates in column 2 imply that conditional on nightlights per capita in 2012, the growth rate in the directly ruled districts was 0.13% less than in the indirectly ruled districts, however, the difference is statistically insignificant. Looking at the convergence coefficients based on estimates in column 3, it turns out that in a reversal from the results for 1993-2013, the rate of convergence in the directly ruled districts was faster than in the indirectly ruled districts during this period. This pattern holds in columns 4 and 5, but the difference in the convergence rate becomes much smaller and statistically insignificant in column 5 when other correlates of development and geographical controls are included. Looking at the impact of land tenure institutions on growth during this period, we find in column 6 that conditional on initial nightlights per capita in 2012, the non-landlord districts under direct British rule are growing slower during this period. This pattern holds even after controlling for other correlates in columns 7 and 8 even though the gap narrows. Therefore, landlord districts under direct British rule grew faster during the period 2012-19 which also led to more rapid convergence among directly ruled districts and narrowed the gap between directly and indirectly ruled districts consistent with the smaller coefficient of $Brit$ in 2019 compared to 2013 mentioned earlier. The

[46] The results in column 9 of Table A11 show a much smaller coefficient of $Brit$ and the small and insignificant coefficient of $Brit \times NLT$ implies that the gap between landlord and non-landlord districts under direct rule has disappeared conditional on other correlates and geographical controls. Without any controls, landlord districts under direct rule still had 8% less nightlights per capita than non-landlord districts under direct rule in 2019.

faster growth in nightlights in landlord districts during this period is consistent with the findings of Burlig and Preonas (forthcoming) who study a large electrification program, the Rajiv Gandhi Grameen Vidyutikaran Yojana program (RGGVY), launched in India in 2005 which focused on unelectrified and under-electrified villages in India. They find that the program significantly increased nightlights in the eligible villages, however, the impact on development measured by per capita expenditure is more nuanced. While the relationship between growth in lights and growth in per capita income is robust over a longer period, it may be volatile during short periods of time, and therefore, should be interpreted with caution.

V.4. Duration of colonial rule

Feyrer and Sacerdote (2009) find that the variation in the amount of time spent as a colony has a differential impact on present-day economic development. Considering this, we examine the robustness of our results to an alternate measure of direct British rule. We use the number of years spent under direct British rule as the main explanatory variable in place of the $Brit_{i,j}$ indicator variable. We obtain data on the duration of direct British rule from Iyer (2010). We replicate specifications in columns 1 and 2 of Table 10 with $DuraBrit_{i,j}$, which represents the number of years a district *i* in state *j* was under direct British rule, in place of $Brit_{i,j}$ as the main explanatory variable and report the results in columns 7 and 8 of Table 10. The coefficient on $DuraBrit$ is negative and significant in both these columns suggesting that the duration of direct British rule has a negative effect on nightlights per capita in 1993. Similarly, we do this exercise for the specification where the land tenure system is included and report it in Table 11. Column 4 in Table 11 replaces $Brit$ with $DuraBrit$ and $Brit \times NLT$ with $DuraBrit \times NLT$ as the main explanatory variables and the results are qualitatively similar to those in column 1.

V.5. Additional Controls

In their study of the impact of human capital on development, Castelló-Climent et al. (2018) controlled for a district's share of scheduled castes (SC) and scheduled tribes (ST). It is conceivable that the adverse effect of direct British rule that we are finding on development may be due to a high share of SC and ST populations and these districts tend to be poor for historical reasons even predating British rule. In Table 12 we add the share of SC and the share of ST as additional controls to the regressions that we reported in Table 10. We find that the coefficient of *Brit* hardly changes in regressions without state fixed effects but it does go down in regressions with state fixed effects, however, it remains negative and statistically significant. The coefficient of the share of ST is consistently negative suggesting that these areas are indeed poor but the coefficient of the share of SC is generally positive. The last 4 columns of Table 11 include the share of SC and the share of ST in the land tenure regressions and the results are very similar to those obtained without these controls.

Considering the blooming and overglow effect prevalent in nightlights data (Chanda and Kabiraj, 2020) as well as the fact that the measurement of nightlights data is affected by the terrain type of a region (Pinkovskiy and Sala-i-Martin, 2016), we include a measure of terrain ruggedness as an additional control in our specifications to account for these issues prevalent in the measurement of nightlights. Next, we include a measure of the agricultural land suitability index in our set of controls to account for exogenous differences in agricultural suitability across districts as well as the selectivity of the British towards areas more favorable for agriculture. In addition to these two controls, we also include a set of historical controls to capture any possible differences in the initial conditions across modern districts that may bias our main results.[47]

We augment the specifications in columns 1 and 2 of Table 12 with these controls and report the resulting estimates in Table A13 in the online appendix. We also include these controls in the specification of column 5 in Table 11 and report the corresponding results in Table A14 in the online appendix. Our main results are robust to the inclusion of these additional controls.

V.6. Alternate proxy of development

Finally, we use an alternate proxy of development, specifically the average consumption per capita in each district, instead of nightlights per capita, and examine if our main results still hold. We obtain the 1993-1994 district-level measure of average consumption per capita from Topalova (2010). One limitation of this data is that while it is available at the district level for the rural sector, for the urban sector it is only available at the regional level. Since our main analysis is at the district

[47] Historical controls include the share of urban population in 1931, the share of tribal population in 1931, the share of brahman population in 1931, the presence of railways in 1909, population density in 1931, and the number of Europeans in 1931.

level, we perform this robustness test only for the rural sector. We match the districts (1991 level) in our sample to the districts (1987 level) in Topalova (2010) and follow the method of Castelló-Climent et al. (2018) in assigning data to the unmatched districts.[48] We replicate the specifications in columns 1 and 2 of Table 10 using the log of consumption per capita (rural district) as the outcome variable and report the resulting estimates in Table A15 in the online appendix. Column 3 in Table A15 uses the log of per capita consumption as the dependent variable in the land tenure regression and the results are similar to those obtained using nightlights. Overall, the results are robust to using this alternative proxy of overall economic development.

VI. Concluding Remarks

This paper has studied the implications of two historical institutions, direct British rule, and the heterogeneous land tenure institutions implemented by the British, on the disparity in present-day development district-level data from India. While these institutions have been studied previously by Banerjee and Iyer (2005) and Iyer (2010), due to a lack of data they were unable to look at the implications of these institutions on a comprehensive measure of development. Following the recent literature, we have used nightlights per capita as a proxy for district-level per capita income. We find that modern districts that were historically under direct British rule had significantly less nightlights per capita in 1993 relative to modern districts that were historically under indirect British rule. The gap was stable till 2013 but has narrowed significantly since 2013 as reflected in the recent JPSS-VIIRS data. A part of the relative backwardness of directly ruled districts can be attributed to higher IMR, lower roads per capita, and lower female labor force participation rate. Looking at the growth pattern from 1993 to 2013, a period of rapid growth following the liberalization that began in 1991, we find that areas that were under direct British rule grew at a slower rate and converged at a slower rate, however, this pattern seems to have been reversed since 2012 according to the growth analysis for the period 2012-19 using the JPSS-VIIRS data.

Looking at the impact of land tenure institutions, we find that much of the development gap between areas under the indirect rule and direct rule can be accounted for by the adverse effects

[48] Unmatched districts are a result of boundary changes between 1987 and 1991. In matching 1931 level districts to 2001 level districts, in the case of unmatched districts or districts with missing data, Castelló-Climent et al. (2018) assign the same data value to districts that were historically part of the same geographic boundary. We follow this method and assign the same data value to districts that were part of the same geographic boundary in 1987.

of the landlord-based revenue collection system in the directly ruled areas. Looking at deeper mechanisms, we find that lower government effectiveness captured in the lower voter participation rate and lower newspaper readership as well as perceptions of less trust and greater conflicts at the local levels can capture the channels through which land tenure institutions may still be affecting development.

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Table 1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Log Lights Per Capita 1993	412	-4.955861	1.258763	-13.05183	-2.771338
Log Lights Per Capita 1993 BK	412	-4.941857	1.260172	-13.05183	-2.768921
Log Lights Per Capita 2013 BK	412	-4.282473	0.9082515	-6.680486	-2.393828
Growth in Lights Per Capita 1993-2013	412	0.0316757	0.042288	-0.0562707	0.3507649
Growth in Lights Per Capita 1993-2013 BK	412	0.0329692	0.0418453	-0.0560964	0.3507649
Log Lights Density 1993	412	0.7410932	1.575447	-9.549381	4.401308
Log Lights Per Capita 2012 VIIRS (mask)	412	-5.628687	0.9673386	-8.805367	-3.534094
Log Lights Per Capita 2013 VIIRS (mask)	412	-5.408443	0.9333231	-8.444503	-3.446018
Log Lights Per Capita 2019 VIIRS (mask)	412	-4.937257	0.5835576	-7.121623	-3.546947
Growth in Lights Per Capita 2012-2019 VIIRS (mask)	412	0.0987758	0.0801639	-0.0983776	0.4983311
Brit (direct rule dummy)	412	0.6432039	0.4796363	0	1
Lapse (direct rule instrument dummy)	181	0.1049724	0.3073681	0	1
Cath Miss (dummy for catholic missionary)	412	0.3470874	0.4766226	0	1
Non-landlord (NLT) dummy	356	0.5533708	0.4978431	0	1
Brit x Non-landlord (NLT) dummy	356	0.3539326	0.4788616	0	1
Non-landlord (NLT) proportion	356	0.5437063	0.4331245	0	1
Brit x Non-landlord (NLT) proportion	356	0.3570715	0.4308896	0	1
Duration under direct rule (x 0.01)	412	0.9601497	0.7019899	0	2.57
Dur. under direct rule x NLT dummy	356	0.4985347	0.6488286	0	1.97
Literacy Rate 1991	412	0.5017138	0.1478411	0.1900832	0.957199
Share (25+) Higher Education 1991	412	0.1307432	0.0640106	0.0339682	0.4342449
Share (25+) Primary & Middle Education 1991	412	0.1997638	0.0878713	0.054044	0.5639171
Share Primary Education 1961	394	0.0632657	0.0453163	0.0035169	0.2750414
Infant Mortality Rate (IMR) 1991	412	78.44927	28.63653	22	166
Log Road Length (km) Per Capita 1992	412	-7.549692	0.8039137	-11.796	-3.259715
Log Railroad Length (km) Per Capita 1992	412	-9.095702	1.360772	-14.28573	-6.351312
Log Banks Per Capita 1993	412	-10.0903	0.5521808	-12.09739	-8.27174
Female Labor Force Participation Rate 1991	412	0.378113	0.1878612	0.0335299	0.8362752
Log Avg. Manufacturing Labor Productivity 1993-94	385	12.74495	0.7757584	9.463177	14.93498
Literacy Rate 2011	412	0.7215786	0.0960625	0.4029753	0.9720749
Infant Mortality Rate (IMR) 2011	412	57.51786	13.40141	22	105
Log Banks Per Capita 2011	412	-9.810779	0.574352	-11.2461	-8.162548
Female Labor Force Participation Rate 2011	412	0.4626753	0.139642	0.1561664	0.8154299
Avg. Voter Turnout (2008 - 2013)	412	0.6897341	0.0935677	0.38726	0.8900394
Frac. HHs 'regular' newspaper 2012	280	0.1466619	0.1213754	0	0.7166667
Frac. HHs 'not much' conflict 2012	280	0.5866108	0.2789443	0	1
Area (sq. km) 1991	412	7207.481	5838.631	174	45652
Log Population 1991	412	14.30509	0.7298461	10.35118	16.11066
Avg. Annual Temp (celsius) 1900-1993	412	24.5877	4.375674	-4.630096	28.79043
Avg. Precipitation (mm) 1900-1993	412	1246.673	722.7811	174.5461	4173.867
Avg. Elevation (m)	412	429.7069	692.1129	4.139117	4912.925
Log River Length (km) Per Capita 1992	412	-7.377772	0.9946077	-16.11066	-2.689159
Latitude	412	23.28523	5.991527	8.30512	34.53142
Min. Dist to Closest Major City (100 km)	412	2.642268	1.574567	0	8.844524
Dist. to Nearest Coast (100 km)	412	4.391992	3.279918	0.044902	13.28298
Terrain Ruggedness (100 m)	412	0.768727	1.421245	0.0282508	8.527494
Agricultural Suitability Index	377	0.5542667	0.2297723	0.0026452	0.972
Share of Urban Population 1931	394	0.1096216	0.0746501	0	0.4952972
Share of Brahman Population 1931	394	0.055564	0.0418288	0.0015112	0.2703725
Share of Tribal Poplation 1931	394	0.0322377	0.0807637	0	0.689738
Railway (dummy for presence of railway) 1909	394	0.8020305	0.3989757	0	1
Population Density 1931	394	309.3752	235.2362	33.88353	2105.109
European Population 1931	394	1427.882	2760.937	0	17699
Log Mean Consumption Per Capita (Rural Sector) 1993	396	5.63265	0.2500862	5.028798	6.498956

Table 2: Institutions, Human Capital, Long-Run Development - OLS and IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: OLS and Second-stage Regressions									
	Dependent variable: log lights per capita in 1993								
	Full Sample		Neighboring Districts		IV Sample		Full Sample	IV Sample	
	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS
Brit direct rule	-0.502**	-0.584***	-0.164	-0.361***	-0.625***	-0.629**	-0.646***	-0.650***	-0.671**
	(0.204)	(0.158)	(0.127)	(0.123)	(0.146)	(0.267)	(0.157)	(0.148)	(0.307)
Literacy rate 1991		4.314***		3.118***	3.205***	3.206***	7.581***	4.112*	4.147*
		(0.790)		(0.535)	(0.633)	(0.616)	(1.714)	(2.290)	(2.439)
R-squared	0.372	0.538	0.479	0.587	0.580	0.580	0.443	0.573	0.573
Panel B: First-stage Regressions for Brit direct rule									
	Dependent variable: Brit direct rule indicator								
Lapse						0.595***			0.594***
						(0.184)			(0.189)
Literacy rate 1991						0.150			
						(0.434)			
Catholic missionary									0.101**
									(0.050)
R-squared						0.394			0.401
Panel C: First-stage Regressions for Literacy rate									
	Dependent variable: Literacy rate in 1991								
Catholic missionary							0.059***	0.070***	0.071***
							(0.015)	(0.025)	(0.024)
Brit direct rule							0.008	0.018	
							(0.027)	(0.051)	
Lapse									0.023
									(0.043)
R-squared							0.378	0.431	0.431
Panel D: IV statistics									
K-P LM stat (p-value) (Underidentif. test)						0.1356	0.0046	0.0085	0.0071
K-P F stat (Weak Identif. test)						10.399	15.732	7.725	3.715
Observations	412	412	221	221	181	181	412	181	181
Brit Instrumented	NO	NO	NO	NO	NO	YES	NO	NO	YES
Lit. rate Instrumented	NO	NO	NO	NO	NO	NO	YES	YES	YES

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.

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

Table 3: Effect of Direct Rule and Land Tenure Institutions on Economic Growth from 1993-2013

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: growth in nightlights per capita from 1993-2013							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
log lights per capita in 1993	-0.0231***	-0.0243***	-0.0341***	-0.0345***	-0.0336***	-0.0180***	-0.0188***	-0.0225***
	(0.00269)	(0.00439)	(0.00219)	(0.00229)	(0.00401)	(0.00257)	(0.00272)	(0.00235)
Brit direct rule		-0.0184**	0.0671***	0.0563***	0.0394**	-0.0145**	-0.0149**	-0.00159
		(0.00746)	(0.0154)	(0.0175)	(0.0174)	(0.00703)	(0.00684)	(0.00497)
log lights PC 1993 × Brit direct rule			0.0176***	0.0157***	0.0100***			
			(0.00322)	(0.00340)	(0.00371)			
Brit direct rule × NLT (dummy)						0.0134*	0.0106	-0.00178
						(0.00687)	(0.00644)	(0.00312)
Literacy rate 1991				0.0407*	0.0607***		0.0255	0.0509**
				(0.0233)	(0.0203)		(0.0203)	(0.0218)
IMR 1991					-0.000226***			-0.000236***
					(6.82e-05)			(7.61e-05)
Log Road Length PC 1992					0.0177***			0.0179***
					(0.00337)			(0.00357)
Log Railroad Length PC 1992					0.000753			-0.00124
					(0.00138)			(0.00131)
Log Banks Per Capita 1993					0.00400			0.00563
					(0.00356)			(0.00386)
Female Labor Part. Rate 1991					0.0199			0.0105
					(0.0139)			(0.0136)
R-squared	0.471	0.513	0.579	0.596	0.746	0.299	0.311	0.574
Observations	412	412	412	412	412	356	356	356

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010) in columns 2 - 8. We also control for geography in columns 5 and 8. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Institutions, Human Capital, Long-Run Development - OLS and IV Estimates with State Fixed-Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: OLS and Second-stage Regressions									
	Dependent variable: log lights per capita in 1993								
	Full Sample		Neighboring Districts		IV Sample		Full Sample	IV Sample	
	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS
Brit direct rule	-0.220***	-0.428***	-0.104	-0.238***	-0.632***	-0.689*	-0.633***	-0.576**	-0.618
	(0.0838)	(0.0995)	(0.0975)	(0.0844)	(0.238)	(0.379)	(0.164)	(0.294)	(0.489)
Literacy rate 1991		3.206***		1.820*	3.488***	3.526***	6.377***	2.559	2.641
		(0.704)		(0.949)	(1.200)	(1.144)	(1.987)	(2.594)	(2.824)
R-squared	0.628	0.673	0.759	0.776	0.646	0.646	0.629	0.642	0.643
Panel B: First-stage Regressions for Brit direct rule									
	Dependent variable: Brit direct rule indicator								
Lapse						0.526***			0.533***
						(0.182)			(0.192)
Literacy rate 1991						0.420			
						(0.349)			
Catholic missionary									0.077
									(0.058)
R-squared						0.660			0.657
Panel C: First-stage Regressions for Literacy rate									
	Dependent variable: Literacy rate in 1991								
Catholic missionary							0.045***	0.055***	0.058***
							(0.010)	(0.019)	(0.018)
Brit direct rule							0.054***	0.048	
							(0.014)	(0.033)	
Lapse									0.035
									(0.029)
R-squared							0.697	0.739	0.735
Panel D: IV statistics									
K-P LM stat (p-value) (Underidentif. test)						0.0579	0.0021	0.0099	0.0115
K-P F stat (Weak Identif. test)						9.393	20.591	9.474	4.339
Observations	412	412	151	151	181	181	412	181	181
Brit Instrumented	NO	NO	NO	NO	NO	YES	NO	NO	YES
Lit. rate Instrumented	NO	NO	NO	NO	NO	NO	YES	YES	YES

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls and state fixed-effects in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.

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

Table 5: Other Correlates of Development I - OLS and IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: OLS and Second-stage Regressions								
	Dependent variable: log lights per capita in 1993							
	Full Sample	Neighboring Districts	IV Sample		Full Sample	Neighboring Districts	IV Sample	
	OLS	OLS	OLS	2SLS	OLS	OLS	OLS	2SLS
Brit direct rule	-0.582***	-0.354***	-0.570***	-0.943***	-0.382***	-0.246**	-0.528***	-0.953**
	(0.163)	(0.119)	(0.141)	(0.311)	(0.113)	(0.0962)	(0.196)	(0.416)
Literacy rate 1991	3.391***	2.617***	2.596***	2.893***	1.557***	1.645**	2.881***	3.416***
	(0.702)	(0.539)	(0.503)	(0.529)	(0.556)	(0.773)	(0.709)	(0.761)
IMR 1991	-0.00273	-0.00610**	-0.00377*	-0.00181	-0.00654*	0.000938	-0.00742*	-0.00461
	(0.00293)	(0.00232)	(0.00224)	(0.00240)	(0.00336)	(0.00375)	(0.00396)	(0.00349)
Log Road Length PC 1992	0.314***	0.0692	0.235*	0.161	0.200*	-0.175	0.322**	0.283**
	(0.115)	(0.163)	(0.124)	(0.124)	(0.109)	(0.182)	(0.156)	(0.141)
Log Railroad Length PC 1992	0.0995***	0.0254	0.125***	0.128***	0.0878***	0.102***	0.0431	0.0480
	(0.0351)	(0.0453)	(0.0447)	(0.0424)	(0.0271)	(0.0338)	(0.0518)	(0.0483)
Log Banks Per Capita 1993	0.363**	0.0708	0.202	0.193	0.387**	0.0238	0.180	0.173
	(0.154)	(0.122)	(0.173)	(0.165)	(0.171)	(0.130)	(0.193)	(0.178)
Female Labor Part. Rate 1991	0.802**	0.531	1.157**	1.324***	-0.00165	0.235	0.619	0.863*
	(0.365)	(0.341)	(0.447)	(0.434)	(0.344)	(0.530)	(0.502)	(0.524)
R-squared	0.581	0.612	0.617	0.608	0.698	0.787	0.667	0.661
Panel B: First-stage Regressions for Brit direct rule								
				Dependent variable: Brit direct rule indicator				
Lapse				0.556***				0.495***
				(0.182)				(0.150)
Literacy rate 1991				0.419				0.770
				(0.466)				(0.464)
IMR 1991				0.00357*				0.00587***
				(0.00189)				(0.00196)
Log Road Length PC 1992				-0.225**				-0.124**
				(0.101)				(0.0497)
Log Railroad Length PC 1992				0.00676				0.0106
				(0.0168)				(0.0167)
Log Banks Per Capita 1993				-0.0107				-0.00571
				(0.0524)				(0.0463)
Female Labor Part. Rate 1991				0.126				0.240
				(0.316)				(0.308)
R-squared				0.472				0.713
Panel C: IV statistics								
K-P LM stat (p-value) (Underidentif. test)				0.0791				0.0320
K-P F stat (Weak Identif. test)				9.305				10.902
Observations	412	221	181	181	412	151	181	181
Brit Instrumented	NO	NO	NO	YES	NO	NO	NO	YES
Lit. rate Instrumented	NO	NO	NO	NO	NO	NO	NO	NO
State FE	NO	NO	NO	NO	YES	YES	YES	YES

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Other Correlates of Development II - Relationship with Brit direct rule and interaction of Brit direct rule and NLT (dummy)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Dependent variable													
	Literacy rate 1991	IMR 1991	Log Road Length PC 1992	Log Railroad Length PC 1992	Log Banks Per Capita 1993	Female Labor Part. Rate 1991	Log Mfg. Labor Prod. 1993-94	Literacy rate 1991	IMR 1991	Log Road Length PC 1992	Log Railroad Length PC 1992	Log Banks Per Capita 1993	Female Labor Part. Rate 1991	Log Mfg. Labor Prod. 1993-94
Brit direct rule	0.0191	1.112	-0.156**	0.113	0.242***	-0.0395	-0.0899	-0.0208	9.033	-0.245***	-0.0748	0.137	-0.0544	-0.234
	(0.0276)	(5.257)	(0.0654)	(0.175)	(0.0883)	(0.0257)	(0.124)	(0.0319)	(7.163)	(0.0913)	(0.185)	(0.0953)	(0.0358)	(0.190)
Brit direct rule × NLT (dummy)								0.105***	-19.97***	0.0930	0.0790	0.324***	0.0213	0.302
								(0.0321)	(5.997)	(0.0726)	(0.176)	(0.0982)	(0.0335)	(0.189)
R-squared	0.351	0.269	0.750	0.356	0.318	0.524	0.060	0.504	0.392	0.719	0.227	0.387	0.571	0.090
Observations	412	412	412	412	412	412	385	356	356	356	356	356	356	344

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.

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

Table 7: Effect of direct rule stemming from differences in land tenure institutions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Full Sample				Neighboring landlord and non-landlord districts		
	Dependent variable: log lights per capita in 1993						
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Brit direct rule	-0.513***	-1.044***	-0.975***	-0.923***	-0.637**	-0.716***	-0.665***
	(0.184)	(0.255)	(0.191)	(0.193)	(0.245)	(0.213)	(0.190)
Brit direct rule × NLT (dummy)		0.972***	0.622***	0.530***	0.379	0.124	0.142
		(0.281)	(0.166)	(0.167)	(0.232)	(0.194)	(0.180)
Literacy rate 1991			3.345***	2.935***		3.665***	2.892***
			(0.609)	(0.614)		(0.416)	(0.655)
IMR 1991				-0.000607			0.000194
				(0.00345)			(0.00369)
Log Road Length PC 1992				0.206*			0.280**
				(0.105)			(0.111)
Log Railroad Length PC 1992				0.0704*			0.0895*
				(0.0371)			(0.0468)
Log Banks Per Capita 1993				0.258**			0.292
				(0.120)			(0.184)
Female Labor Part. Rate 1991				0.634*			0.314
				(0.371)			(0.506)
R-squared	0.301	0.436	0.552	0.579	0.298	0.506	0.561
Observations	356	356	356	356	170	170	170

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Deeper Mechanisms I - Relationship with Brit direct rule and interaction of Brit direct rule and NLT (dummy)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full Sample	NLT Sample		Full Sample	NLT Sample		Full Sample	NLT Sample	
	Dependent variable								
	Government Responsiveness						Conflict and Trust		
	Avg. Voter Turnout (2008 - 2013)	Avg. Voter Turnout (2008 - 2013)	Avg. Voter Turnout (2008 - 2013)	Frac. HHs 'regular' newspaper (2012)	Frac. HHs 'regular' newspaper (2012)	Frac. HHs 'regular' newspaper (2012)	Frac. HHs 'not much' conflict (2012)	Frac. HHs 'not much' conflict (2012)	Frac. HHs 'not much' conflict (2012)
Brit direct rule	-0.0293	-0.0257	-0.0497**	-0.0382**	-0.0458**	-0.0509**	-0.0640	-0.0784*	-0.142**
	(0.0194)	(0.0190)	(0.0226)	(0.0174)	(0.0199)	(0.0230)	(0.0419)	(0.0450)	(0.0585)
Brit direct rule × NLT (dummy)			0.0439*			0.00845			0.105**
			(0.0246)			(0.0184)			(0.0465)
R-squared	0.125	0.138	0.174	0.204	0.217	0.217	0.053	0.080	0.103
Observations	412	356	356	280	248	248	280	248	248

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast. The data for fraction of households in which members 'regularly' read newspapers as well as fraction of households that believe there is 'not much' conflict among communities (*jatis*) is obtained from IHDS II (2012). Out of the full sample of 412 districts, this data is only available for 280 districts. Out of the 356 districts for which NLT data is available, the IHDS II (2012) data is only available for 248 districts.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Deeper Mechanisms II - OLS Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dependent variable: log lights per capita in 2013											
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Brit direct rule	-0.414**	-0.288**	-0.270**	-0.231*	-0.239*	-0.171	-0.752***	-0.554***	-0.648***	-0.587***	-0.592***	-0.475***
	(0.164)	(0.116)	(0.133)	(0.129)	(0.128)	(0.107)	(0.180)	(0.124)	(0.178)	(0.171)	(0.172)	(0.150)
Brit direct rule × NLT (dummy)							0.773***	0.598***	0.701***	0.691***	0.660***	0.589***
							(0.184)	(0.133)	(0.179)	(0.171)	(0.168)	(0.147)
Avg. Voter Turnout (2008 - 2013)		4.307***				3.917***		3.987***				3.412***
		(0.623)				(0.663)		(0.587)				(0.595)
Frac. HHs 'regular' newspaper (2012)				1.012**		0.714**				1.194***		0.867**
				(0.387)		(0.331)				(0.414)		(0.372)
Frac. HHs 'not much' conflict (2012)					0.476***	0.204					0.394***	0.137
					(0.124)	(0.151)					(0.128)	(0.154)
R-squared	0.277	0.446	0.277	0.294	0.301	0.463	0.419	0.555	0.409	0.434	0.425	0.558
Observations	412	412	280	280	280	280	356	356	248	248	248	248

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast. The data for fraction of households in which members 'regularly' read newspapers as well as fraction of households that believe there is 'not much' conflict among communities (jatis) is obtained from IHDS II (2012). Out of the full sample of 412 districts, this data is only available for 280 districts. Out of the 356 districts for which NLT data is available, the IHDS II (2012) data is only available for 248 districts.

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

Table 10: Robustness I - Effect of Direct British Rule (Measurement Issues, Duration of Colonial Rule)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full Sample		Neighboring Districts		Full Sample			
	Dependent variable: log lights per capita in 1993				Dependent variable: log lights per capita in 1993 BK		Dependent variable: log lights per capita in 1993	
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Brit direct rule	-0.561***	-0.352***	-0.362***	-0.237**	-0.576***	-0.365***		
	(0.137)	(0.0982)	(0.109)	(0.102)	(0.139)	(0.0984)		
Duration of Brit direct rule (x 1/100)							-0.441***	-0.227***
							(0.108)	(0.0681)
Literacy rate 1991	3.117***	1.626***	2.593***	1.693**	3.121***	1.662***	2.712***	1.486***
	(0.572)	(0.570)	(0.478)	(0.787)	(0.574)	(0.561)	(0.464)	(0.553)
IMR 1991	-0.00280	-0.00657*	-0.00474**	0.00103	-0.00245	-0.00652*	-0.00335	-0.00708**
	(0.00279)	(0.00354)	(0.00228)	(0.00373)	(0.00280)	(0.00352)	(0.00263)	(0.00352)
Log Road Length PC 1992	0.361***	0.224**	0.0885	-0.175	0.329***	0.197*	0.324***	0.216*
	(0.113)	(0.109)	(0.166)	(0.184)	(0.116)	(0.107)	(0.115)	(0.113)
Log Railroad Length PC 1992	0.107***	0.0914***	0.0309	0.102***	0.109***	0.0915***	0.115***	0.0933***
	(0.0313)	(0.0277)	(0.0393)	(0.0326)	(0.0310)	(0.0271)	(0.0308)	(0.0281)
Log Banks Per Capita 1993	0.393***	0.374**	0.109	0.00861	0.434***	0.409**	0.408***	0.367**
	(0.144)	(0.161)	(0.126)	(0.140)	(0.141)	(0.159)	(0.146)	(0.161)
Female Labor Part. Rate 1991	1.041***	0.153	0.445	0.251	1.068***	0.139	0.816***	0.0982
	(0.284)	(0.347)	(0.333)	(0.536)	(0.276)	(0.333)	(0.258)	(0.342)
Dist. to closest major city	-0.190***	-0.101*	-0.141**	-0.0336	-0.194***	-0.107**	-0.184***	-0.103*
	(0.0591)	(0.0534)	(0.0593)	(0.0654)	(0.0597)	(0.0541)	(0.0568)	(0.0555)
R-squared	0.619	0.703	0.629	0.787	0.624	0.711	0.626	0.702
Observations	412	412	221	151	412	412	412	412
State FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Robustness I and II - Direct British Rule and Land Tenure Institutions (Additional Controls, Measurement Issues, Duration of Colonial Rule)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NLT Sample	Neighboring landlord and non-landlord districts	NLT Sample		NLT Sample	Neighboring landlord and non-landlord districts	NLT Sample	
	Dependent variable: log lights per capita in 1993		Dependent variable: log lights per capita in 1993 BK	Dependent variable: log lights per capita in 1993	Dependent variable: log lights per capita in 1993		Dependent variable: log lights per capita in 1993 BK	Dependent variable: log lights per capita in 1993
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Brit direct rule	-0.853***	-0.611***	-0.875***		-0.872***	-0.585***	-0.890***	
	(0.156)	(0.141)	(0.160)		(0.165)	(0.133)	(0.168)	
Brit direct rule × NLT (dummy)	0.476***	0.116	0.479***		0.467***	0.105	0.468***	
	(0.125)	(0.145)	(0.128)		(0.152)	(0.144)	(0.154)	
Duration of Brit direct rule (x 1/100)				-0.612***				-0.637***
				(0.114)				(0.120)
Dur. of direct rule × NLT (dummy)				0.307***				0.303***
				(0.0842)				(0.0999)
Literacy rate 1991	2.878***	2.887***	2.875***	2.491***	2.782***	2.879***	2.783***	2.359***
	(0.557)	(0.649)	(0.562)	(0.487)	(0.602)	(0.706)	(0.614)	(0.525)
IMR 1991	-0.000405	0.000445	-6.38e-05	-0.00154	0.000113	0.000899	0.000408	-0.000984
	(0.00329)	(0.00368)	(0.00333)	(0.00313)	(0.00310)	(0.00370)	(0.00314)	(0.00296)
Log Road Length PC 1992	0.269**	0.335**	0.229**	0.247**	0.269**	0.320**	0.230**	0.244**
	(0.112)	(0.146)	(0.114)	(0.114)	(0.105)	(0.146)	(0.107)	(0.110)
Log Railroad Length PC 1992	0.0989***	0.101**	0.0998***	0.0944***	0.0859**	0.0928*	0.0885***	0.0798**
	(0.0306)	(0.0453)	(0.0300)	(0.0303)	(0.0328)	(0.0464)	(0.0318)	(0.0327)
Log Banks Per Capita 1993	0.290**	0.326	0.329***	0.301**	0.332***	0.327*	0.368***	0.350***
	(0.116)	(0.198)	(0.112)	(0.115)	(0.108)	(0.191)	(0.104)	(0.106)
Female Labor Part. Rate 1991	0.901***	0.182	0.941***	0.646**	1.309***	0.289	1.304***	1.084***
	(0.316)	(0.479)	(0.304)	(0.297)	(0.350)	(0.478)	(0.338)	(0.332)
Dist. to closest major city	-0.149**	-0.0913	-0.152**	-0.139**	-0.159***	-0.103	-0.162***	-0.148***
	(0.0660)	(0.1000)	(0.0664)	(0.0613)	(0.0586)	(0.101)	(0.0591)	(0.0536)
Sh_SC 1991					0.563	1.392	0.389	0.690
					(1.214)	(1.252)	(1.211)	(1.225)
Sh_ST 1991					-0.950	-0.193	-0.883	-1.041*
					(0.627)	(0.431)	(0.622)	(0.604)
R-squared	0.608	0.570	0.616	0.617	0.620	0.580	0.626	0.632
Observations	356	170	356	356	356	170	356	356

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.

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

Table 12: Robustness II - Effect of Direct British Rule (Additional Controls)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full Sample		Neighboring Districts		Full Sample			
	Dependent variable: log lights per capita in 1993				Dependent variable: log lights per capita in 1993 BK		Dependent variable: log lights per capita in 1993	
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Brit direct rule	-0.567***	-0.268***	-0.374***	-0.180*	-0.582***	-0.287***		
	(0.130)	(0.0910)	(0.101)	(0.0971)	(0.132)	(0.0915)		
Duration of Brit direct rule (x 1/100)							-0.447***	-0.167**
							(0.102)	(0.0637)
Literacy rate 1991	2.907***	1.024*	2.037***	0.973	2.919***	1.101**	2.506***	0.901*
	(0.568)	(0.557)	(0.419)	(0.839)	(0.575)	(0.552)	(0.468)	(0.539)
IMR 1991	-0.00225	-0.00796**	-0.00472**	-0.000827	-0.00192	-0.00781**	-0.00284	-0.00840**
	(0.00249)	(0.00335)	(0.00231)	(0.00277)	(0.00252)	(0.00334)	(0.00237)	(0.00332)
Log Road Length PC 1992	0.365***	0.207*	0.119	-0.162	0.333***	0.181*	0.327***	0.201*
	(0.108)	(0.105)	(0.148)	(0.160)	(0.110)	(0.103)	(0.111)	(0.108)
Log Railroad Length PC 1992	0.104***	0.0873***	0.0412	0.112***	0.107***	0.0877***	0.111***	0.0887***
	(0.0335)	(0.0320)	(0.0384)	(0.0254)	(0.0330)	(0.0309)	(0.0333)	(0.0327)
Log Banks Per Capita 1993	0.443***	0.447***	0.173	0.0416	0.481***	0.477***	0.455***	0.442***
	(0.138)	(0.153)	(0.116)	(0.138)	(0.136)	(0.153)	(0.139)	(0.153)
Female Labor Part. Rate 1991	1.503***	0.639*	0.849**	0.477	1.493***	0.591*	1.281***	0.606*
	(0.323)	(0.339)	(0.369)	(0.527)	(0.316)	(0.327)	(0.286)	(0.343)
Dist. to closest major city	-0.194***	-0.124**	-0.120**	-0.0230	-0.198***	-0.129**	-0.186***	-0.126**
	(0.0560)	(0.0496)	(0.0539)	(0.0644)	(0.0565)	(0.0500)	(0.0530)	(0.0511)
Sh_SC 1991	0.593	1.501	-0.294	1.966*	0.480	1.400	0.699	1.505
	(0.680)	(1.012)	(0.725)	(1.091)	(0.679)	(1.004)	(0.695)	(1.031)
Sh_ST 1991	-1.225***	-1.156**	-1.494***	-0.864	-1.147***	-1.076**	-1.204***	-1.179**
	(0.389)	(0.472)	(0.367)	(0.519)	(0.383)	(0.466)	(0.382)	(0.474)
R-squared	0.635	0.722	0.662	0.809	0.639	0.726	0.643	0.720
Observations	412	412	221	151	412	412	412	412
State FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: Robust standard errors in parentheses. Standard errors are clustered at the level of the native state (Iyer, 2010). We include geographical controls in all the columns. Geographical controls include area in 1991, average annual temperature (1900-1993), average annual rainfall (1900-1993), average elevation, latitude, log river length per capita, and distance to nearest coast.
*** p<0.01, ** p<0.05, * p<0.1

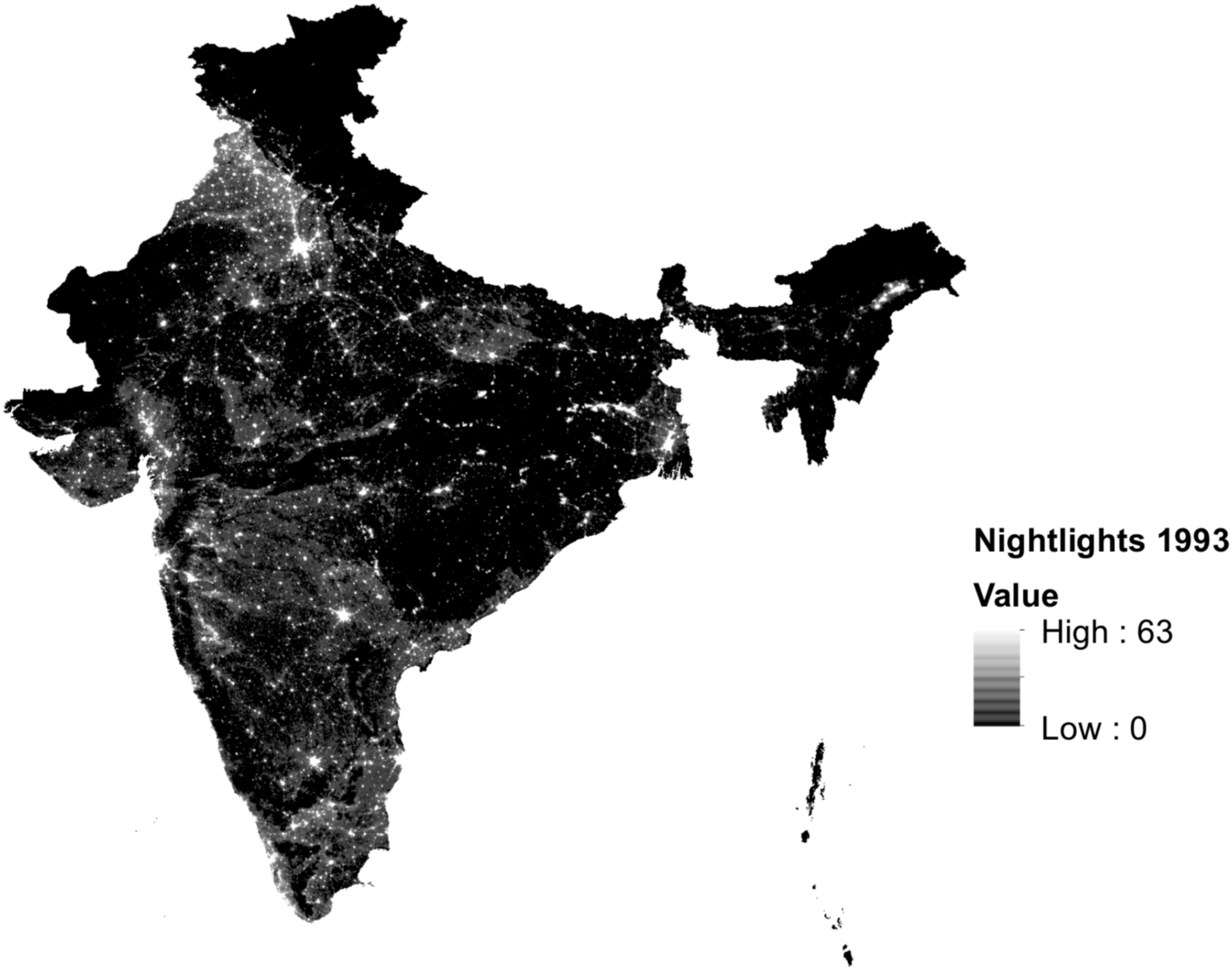

Figure 1: Raw Nightlights Image of India for year 1993

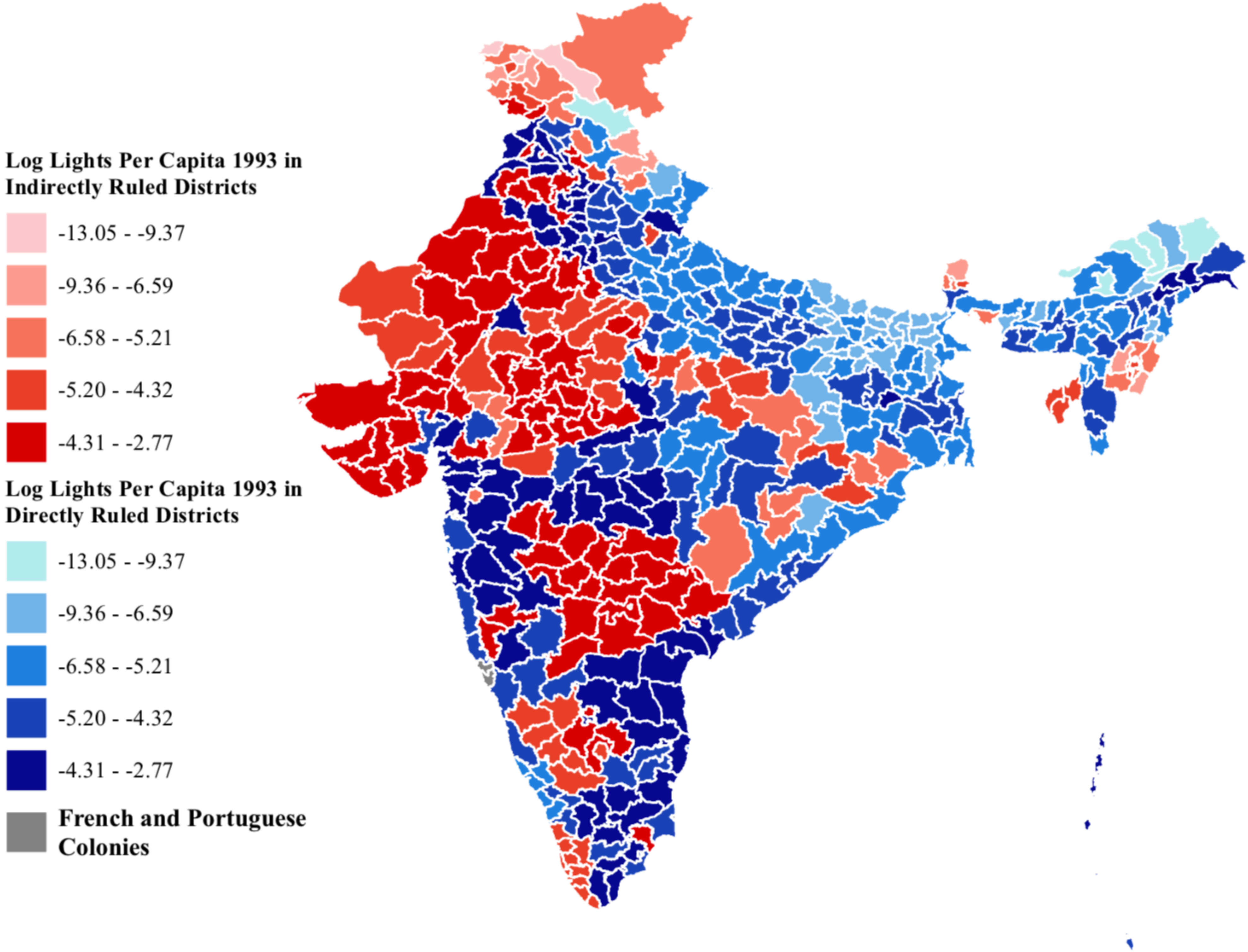

Figure 2: Distribution of Log Lights Per Capita in 1993 across Directly and Indirectly Ruled Districts

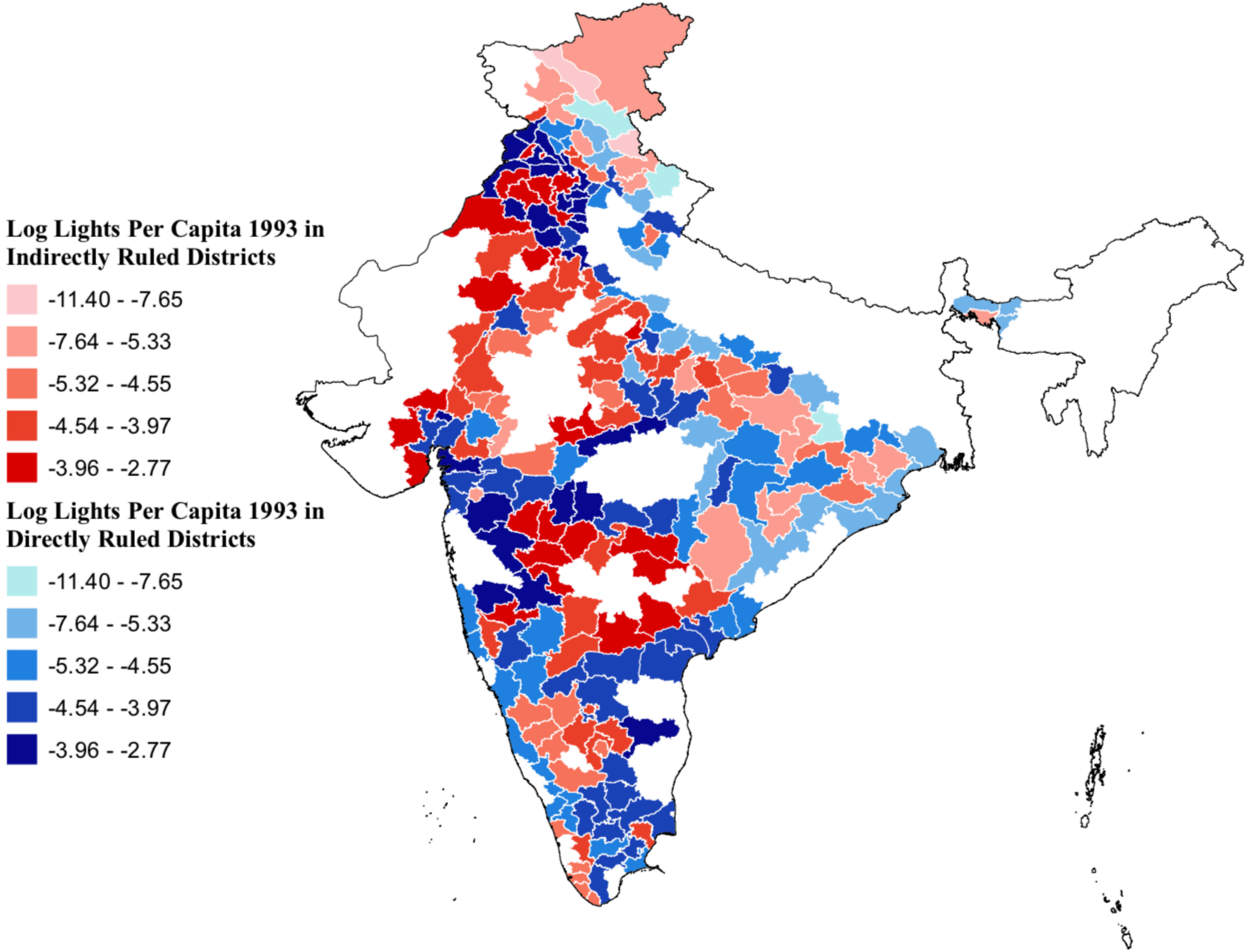

Figure 3: Distribution of Log Lights Per Capita in 1993 across Neighboring Directly and Indirectly Ruled Districts

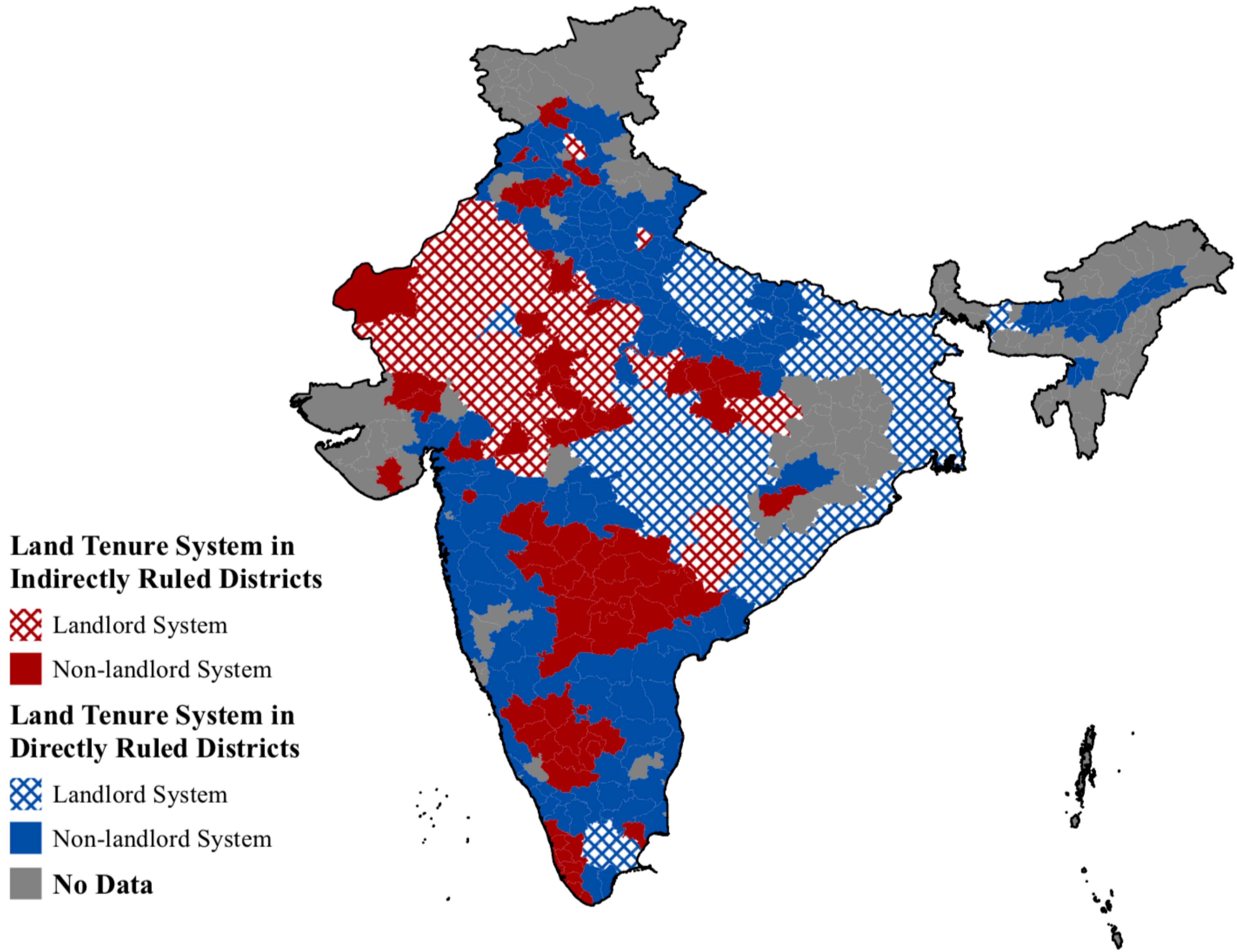

Figure 4: Distribution of Land Tenure Institutions across Directly and Indirectly Ruled Districts

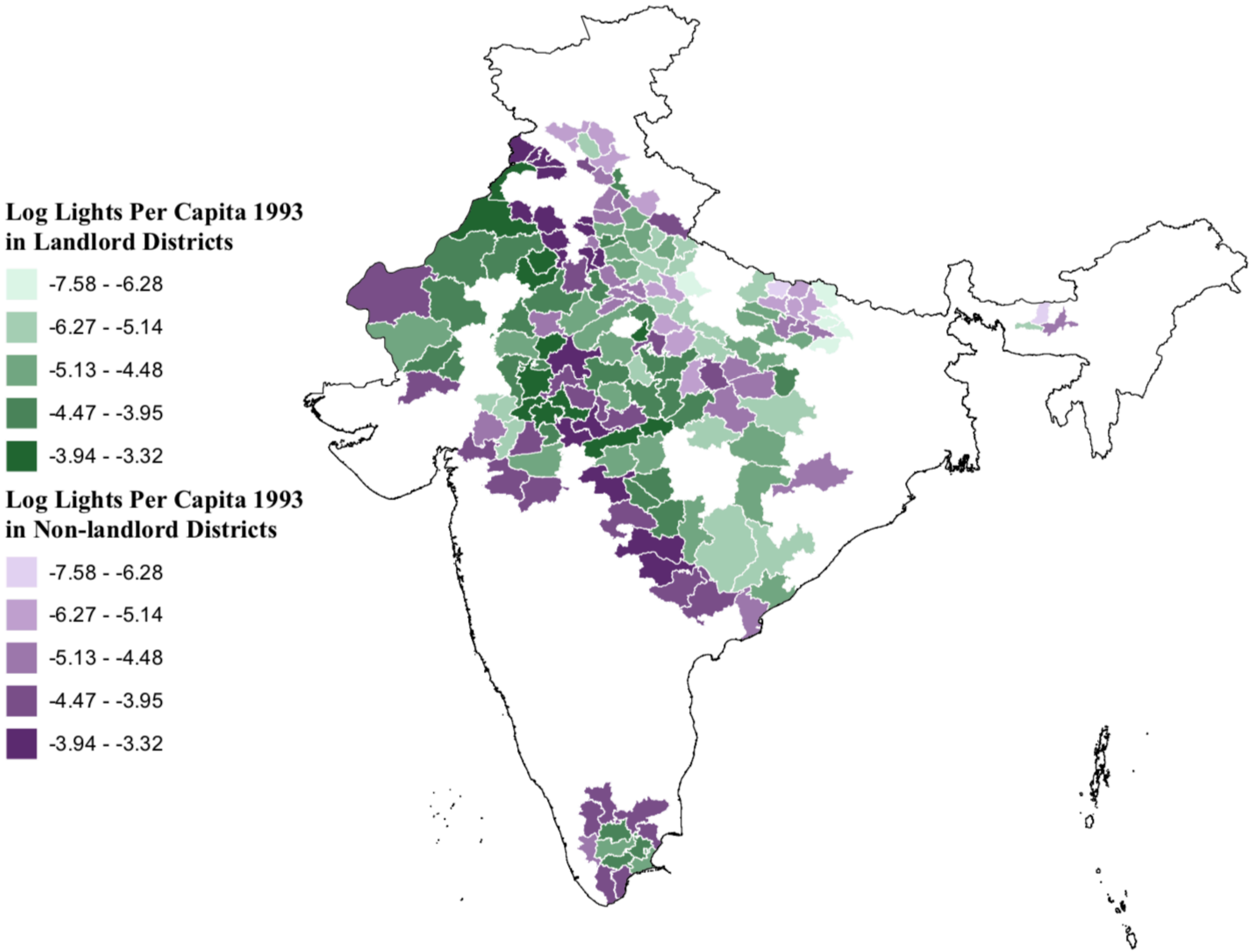

Figure 5: Distribution of Log Lights Per Capita in 1993 across Neighboring Landlord and Non-landlord Districts