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ABSTRACT

The Colonial Legacy in India: How Persistent Are the Effects of Historical Institutions?*

Using updated data, we analyze the long-run effects of two British colonial institutions established in India. Iyer (2010) showed that areas under direct colonial rule had fewer schools, health centers, and roads than areas under indirect colonial rule. Two decades later, we find that these differences have been eliminated. Banerjee and Iyer (2005) found lower agricultural investments and productivity in areas with landlord-based colonial land tenure systems. Our updated data finds that only some of these differences have been eliminated. We conclude that the impact of colonial institutions can eventually fade away under the influence of targeted policies.

JEL Classification: P14, N45, O12, O13

Keywords: historical institutions, colonial rule, land tenure, agriculture, public goods, India

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1. Introduction

How persistent are the effects of historical institutions on societies? Can post-colonial policies overcome the legacies left behind by colonial institutions? This paper examines the long-run impact of two historical institutions in India, extending the datasets used in two previous papers. Iyer (2010) compared areas in India that were under indirect colonial rule to those that were under direct colonial rule. Using an instrumental variables strategy to account for the selectivity in British annexation policy, she finds that directly ruled areas have lower levels of access to schools, health centers, and roads. Banerjee and Iyer (2005) examine the effect of land tenure systems implemented in different parts of (directly ruled) British India. They find that areas that had landlord-based systems had lower agricultural investments and productivity in the post-colonial period. Interestingly, these differences arise during the Green Revolution of the late 1960s, when the Green Revolution brought new agricultural technologies to India: landlord areas, despite being more productive in the colonial period, fell behind in the adoption of these new technologies.

The data sets used in Iyer (2010) and Banerjee and Iyer (2005) end in 1991 and 1987, respectively. After this period, India experienced higher economic growth following structural reforms and liberalization in 1991, and the political landscape also became more competitive after 1988. Additionally, the post-colonial Indian state made investments in many types of infrastructure and public service delivery over several decades. Have these developments eliminated the differences caused by historical institutions?

Several theoretical models describe mechanisms of policy persistence that include considerations of uncertainty, information asymmetry, endogenous investments by agents or path dependence dynamics (Alesina & Drazen, 1991; Coate & Morris, 1999; Fernandez & Rodrik, 1991; Nunn, 2007). Some empirical studies have documented the persistence of historical advantages and patterns of economic activity (Bleakley & Lin, 2012; Castelló-Climent et al., 2018; Huillery, 2009; Jedwab & Moradi, 2016). Despite these studies of persistence, there are also instances of convergence in human development outcomes across the world (Kenny, 2005).

The vast majority of studies on colonial institutions are cross-sectional comparisons across places with different historical circumstances (see the review by Nunn (2009)). The institutions studied have included property rights, slavery, labor coercion, and the presence of large corporate interests (Acemoglu et al., 2001; Dell, 2010; Dell et al., 2018; Dell & Olken, 2020; Lowes &

Montero, 2021; Méndez & Van Patten, 2022; Michalopoulos & Papaioannou, 2016; Nunn, 2008; Sokoloff & Engerman, 2000).

Both Iyer (2010) and Banerjee and Iyer (2005) conduct such cross-sectional comparisons across different regions of India. The historical variation explored in these papers have influenced many future studies, usually examining different outcomes and some employing spatial regression discontinuity designs. Most follow-up studies confirm the Banerjee and Iyer (2005) result of non-landlord areas having better development and policy outcomes (Batra, 2024; Misra, 2019; Ratnoo, 2024; Verghese, 2019). The follow-up studies on indirect colonial rule have yielded mixed results. Jha & Talathi (2023) find higher economic growth in indirectly ruled areas (as measured by night light intensity), consistent with Iyer (2010)'s finding of better public goods provision. But other studies document that directly ruled areas have more private investment, higher citizen cooperation, greater empowerment of women, lower cross-caste and land inequality (Chaudhary et al., 2020; Colleoni, 2024; Nandwani & Roychowdhury, 2024; Varun K, 2024); studies differ on the relationship between indirect colonial rule and post-colonial left-wing violence (Mukherjee, 2018; Verghese & Teitelbaum, 2019).

In contrast to studies that use different outcome variables, we are the first to revisit these historical institutions using the same outcome variables as in the original papers. We extend the data in Banerjee and Iyer (2005) and Iyer (2010) by 24 and 20 years respectively, allowing for a direct comparison with the earlier results to examine the evolution of the legacy of these historical institutions. Relatively few studies examine such evolution over time in the post-colonial period. An exception is Agüero and Campanario (2023), who reexamine Dell (2010) and find that gaps in per capita consumption across areas with different historical institutions remain equally large 20 years later, though present-day policies are successful in reducing extreme poverty.

For the impact of direct British rule, we use the 2001 and 2011 Population Censuses in India, which is the same data source used in Iyer (2010). In 1991, directly ruled districts had lower access to middle schools, primary health centers, primary health subcenters, and paved roads. By 2001, the difference in access to these public goods was zero, and the gap remained closed in 2011 as well. This suggests that post-colonial policies that were targeted at equalizing access to infrastructure, such as the Minimum Needs Program of the 1970s and the National Rural Health Mission of 2005, were successful in erasing the legacy of direct colonial rule.

To examine the effects of land tenure systems, we use updated agriculture data until 2011 from the Village Dynamics in South Asia (VDSA) dataset. These data show very similar results to those in Banerjee and Iyer (2005): Over the period 1966-1987, areas under landlord-based historical land tenure had lower agricultural investments and productivity. Extending the data until 2011 shows that the gaps in irrigation, as well as the use of high yielding varieties (HYV) of rice and wheat are much smaller and statistically insignificant. However, the gap in other investments such as fertilizer consumption and HYV of other cereals has grown. This is consistent with the nature of some post-colonial public policies. For instance, the Accelerated Irrigation Benefit Program prioritized the completion of last mile distribution networks in rural areas which had not previously been completed due to colonial budgetary constraints and local topography (Pant, 1981; Shah, 2011; Stone, 2002). Fertilizer subsidies comprised 0.26% of GDP over the period 2006-2007, but these were available for all farmers rather than being specifically targeted towards under-served areas (Iyer et al., 2010). Consistent with this partial closing of investment gaps, we find agricultural productivity (crop yield) differences continue to be statistically significant more than 60 years after the end of colonial rule. Overall, our findings suggest some gaps can be narrowed or completely eliminated by later policies; however, those policies have to be specifically targeted towards equalizing access.

The paper is structured as follows: Section 2 dives into the historical background and Section 3 explains the new datasets. Section 4 documents the results on indirect colonial rule from our updated dataset, while Section 5 does the same for historical land tenure systems. Section 6 concludes.

2. Historical Background

2.1. British Annexation Policy

The British Empire's influence and colonization of the Indian subcontinent lasted almost 200 years. Nearly all of modern-day India, Pakistan, Burma, and Bangladesh were under British political control. Beginning in 1757, and continuing through the Sikh wars of 1846 and 1849, the English East India Company waged several battles against Indian kings and successfully annexed many areas. Agreements for tribute or other payments were made with many rulers, with the East India Company acquiring territory when rulers failed in their payments. Further territorial annexations were made by accusing local rulers of "misrule" and by the controversial policy of

"lapse" whereby Lord Dalhousie (Governor-General from 1848 to 1856) annexed states where the Indian ruler died without a natural heir, in contrast to previous administrators who had frequently recognized adopted heirs.

In 1857, Indian soldiers in the British army mutinied against their officers. Many native states assisted the British by providing soldiers and equipment during the mutiny and protected British subjects within their territories. After the mutiny was suppressed at the end of 1858, the British Crown took over the administration of the East India Company's territories. Further annexation was halted, with Queen Victoria's 1858 proclamation stating that, "We desire no extension of our present territorial possessions." Further, all Indian rulers were guaranteed British recognition of adopted heirs. Thus, substantial parts of the Indian subcontinent (45% of area and 23% of population) continued to be ruled by Indian kings, being known as "native states" or "princely states."

2.2. Direct versus Indirect Colonial Rule

About 680 native states were recognized by the British Foreign Office in 1910. The British Crown controlled the foreign and defense policies of these states (e.g. setting limits on when and how they could communicate with each other or with other European power, or limiting the size of their armies), but they had considerable autonomy in matters of internal administration including the provision of public services and the building of infrastructure. Native states varied considerably in size, with some consisting of only a few villages, and others consisting of almost 100,000 square miles of land. As Iyer (2010) has documented, British policy was focused on annexing areas that were agriculturally superior: areas under direct British rule had significantly higher rainfall and a significantly lower proportion of barren or rocky areas, compared to areas that were part of native states.

Iyer (2010) compares districts that were part of native states to those that were under direct British rule. A simple OLS comparison shows that directly ruled areas have higher agricultural yields in the post-colonial period and similar access to public goods such as schools, health centers and roads. To overcome the bias caused by selective British annexation, she constructs an instrumental variables (IV) strategy based on Dalhousie's policy of "lapse." The instrument equals one if a native state ruler died without a natural heir during the period 1848-1856. This is a strong predictor of direct British rule during this specific period, but not during other periods. The IV

results are very different from the OLS results: directly ruled areas do not have any agricultural advantage, and have significantly lower access to middle schools, health centers and roads.

Iyer (2010) uses public goods availability data from the 1981 and 1991 population censuses. We examine whether the documented disadvantage of directly ruled areas continues to be present in later years using data from the 2001 and 2011 population censuses.

2.3. Colonial Land Tenure Systems

In 1765, the British were formally granted the right to collect revenue in modern-day Bengal and Bihar. Land tax constituted almost 60 percent of total tax revenue in 1841, and the collection of land revenue was a major policy decision. The British implemented one of three land revenue systems on approximately all of the cultivatable land in India. One of the systems was a landlord-based system, also called *zamindari* or *malguzari*, where a single landlord was responsible for paying taxes (to the British) for a village or a group of villages. In turn, the landlord was able to tax tenants or land cultivators within their jurisdiction. This system was mainly implemented in the colonial provinces of Bengal, Bihar, Central Provinces and parts of Madras.

The second system was an individual cultivator-based system, also known as *raiyatwari.* In this land tenure system, the government surveyed the land, and cultivators were given a record of rights which served as a legal title to the land. The individual cultivators were individually responsible for paying their tax liability to the government. This was implemented in the provinces of Bombay, Assam and much of Madras. The last land tenure system was the village-based system, also called *mahalwari,* prevalent in the provinces of Panjab and the North-West Provinces. Under this system, villages were jointly responsible for collecting tax revenue. The village bodies could be composed of a single person, family, or a large number of individuals.

Banerjee and Iyer (2005) compared measures of agricultural investments (irrigation, fertilizer use, adoption of high-yielding varieties of seeds) and agricultural productivity (crop yields) across districts with higher and lower proportion of area under historical non-landlord tenure. They find that landlord areas lag behind non-landlord areas in these metrics during the post-colonial period, despite the facts that they were agriculturally more productive in the colonial period. Agriculture taxation was abolished after independence, and many land reform measures were enacted to reduce land inequality. In fact, Banerjee and Iyer (2005) document that the agricultural investment and productivity gaps arise in the late 1960s, the period of the Green

Revolution when HYV crops were introduced to India, suggesting that landlord areas are unable to successfully adopt the new technology.

2.4. Post-Independence Policies

After the end of colonial rule in 1947, the post-colonial Indian state enacted many policies towards improving infrastructure and human development. Some of these policies were explicitly targeted towards equalization of access to public facilities. For instance, the Minimum Needs program of the 1970s introduced a multi-tiered health system with primary health centers and sub-centers, and envisioned a primary school and a safe water source within a mile of every village and paved roads to all villages with populations over 1000. Banerjee and Somanathan (2007)'s empirical analysis provides strong evidence of convergence in the availability of public goods across the country. Many states also passed several land reforms in the post-independence period, including measures to abolish intermediaries (like landlords), land ceiling legislations and land distribution programs. Besley and Burgess (2000) find that such measures reduce poverty but do not accelerate economic growth rates.

There have been several subsequent investments in infrastructure. The Accelerated Irrigation Benefit Program was implemented in 1997 to complete last mile irrigation distribution networks, distribute water equitably, and complete maintenance (Shah, 2011). The Golden Quadrilateral project prioritized upgrading highways beginning in 1999, and the Pradhan Mantri Gram Sadak Yojana began building local roads in 2000. Ghani et al. (2016) show manufacturing activity increased near the Golden Quadrilateral project, while Asher and Novosad (2020) find no major economic changes as a result of increasing access to roads in rural areas. Fertilizer subsidies accounted for 0.60% of GDP (Mankunnummal, 2022), but since this was available to all rather than being targeted to poorer regions, it resulted in wealthier states actually receiving more fertilizer subsidies (Iyer et al., 2010). In 2005, the National Rural Health Mission (NRHM) was launched to address the health needs of states that had weak public health indicators. The program provided funds to upgrade community health centers and district hospitals to meet the Indian Public Health Standards while also improving sanitation, hygiene, nutrition, and clean drinking water at the district level (Nandan, 2010).

3. Data

We extend Iyer (2010) by examining the impact of direct British rule on access to public goods through 2011. The original paper uses the village directories from India's population censuses of 1961, 1981, and 1991 to compute the fraction of villages in each district that have the following public goods: primary school, middle school, high school, primary health center, primary health subcenter, canal, or a road. District level data is used because the direct British rule variable is assigned at that level rather than at the village level. We update these data using the village directory data from population census of 2001 and 2011, obtained from the SHRUG database in the Development Data Lab (Asher et al., 2021). Historical variables are obtained from the replication package for Iyer (2010).

The updated data show clear increases in the availability of most of these public goods (Appendix Table A.1), consistent with the post-independence policies described in Section 2.4. For instance, the share of villages that have a primary school increased from 51% in 1961 to 88% in 2011, and the share of villages with a road increased from 21% in 1961 to 70% in 2011. Two important caveats apply to interpreting changes over time. First, the recording of certain public goods changed across censuses. For censuses prior to 2001, we use the presence of canals only, while for 2001 and 2011 we use the presence of operational canals or rivers. For the 2011 census, we use the total of primary health centers and community health centers, since the NRHM advocated upgrading the former into the latter. Since we will be focused on the gap between directly and indirectly ruled areas for a given census year, such changes in definition may not be a major concern. The second caveat refers to missing data: the census was not conducted in the states of Assam in 1981 and Jammu & Kashmir in 1991 due to insurgencies, and the 1961 data is incomplete for many states.

The analysis in Banerjee and Iyer (2005) included district-level data on agricultural investments and productivity from 1956 through 1987 from the World Bank's India Agriculture and Climate Data Set. This database extracts data from five sources: Agricultural Situation in India; Area and Production of Principal Crops in India; Agricultural Prices in India; Fertilizer Statistics (published by the Fertilizer Association of India); and Statistical Abstracts of India. We update the analysis using the Village Dynamics in South Asia (VDSA) database to obtain

agricultural data from 1966 through 2011.[1] The VDSA data uses the same underlying data sources as the World Bank database, as well as season and crop reports, land utilization and use reports, and unpublished reports. Most of the reports and documents come from the national Directorate of Economics and Statistics; the state Directorates of Economics and Statistics; or the state Directorate or Commissionerate of Agriculture. Measures of historical land tenure institutions, as well as geographic variables (soil type, annual rainfall, coastal dummy, latitude, altitude) were obtained from the Banerjee and Iyer (2005) replication package. Henceforth, the data used in Banerjee and Iyer (2005) is referred to as BI data. We restrict our analysis to the 13 Indian states that were included in the original paper.[2] Analysis is conducted at the 1991 district level; data from split districts are aggregated to the original district boundaries.

We use the same measures of agricultural investment as Banerjee and Iyer (2005): the proportion of gross cropped area irrigated; the quantity of nitrogen, phosphorus, and potash fertilizer used per hectare of gross cropped area; and the proportion of crop area sown with high-yielding varieties (HYV) of rice, wheat, and other cereals. We also examine agricultural productivity, measured by the (log) yield of rice, wheat and 13 major crops (crop output divided by total area of crop sown).[3,4]

The VDSA database is mostly consistent with the BI data, with some adjustments. When examining the common years that are covered in both databases (1966-1987), we see that the VDSA dataset has fewer observations than the BI data for several variables, but a larger number of observations for rice and wheat yields (Appendix Table A.2, columns 1 and 2). The gap is particularly pronounced for the proportion of area sown with HYV rice, wheat, and other cereal crops (VDSA has only 47%, 46%, and 34% of the district-year pairs in the BI data) and the yield of 13 major crops (64% of the district-year pairs are present in VDSA). To mitigate this issue, we "binned" the data in five-year increments i.e. computed the averages of our key variables over five-year periods (1956-1960, 1961-1965, …, 2006-2011). This greatly reduces the extent of

[1] The VDSA was funded by the Bill and Melinda Gates Foundation through a partnership with the International Crops Research Institute for the Semi-Arid Tropics in Andhra Pradesh, India.
[2] The 13 states include Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.
[3] Banerjee and Iyer (2005) examined the yield of 15 major crops. However, the VDSA data does not include tobacco or jute. We therefore use the 13 major crops common to both databases. These are rice, wheat, pearl millet, finger millet, maize, barley, groundnut, sesamum, rape seed, mustard seeds, sugarcane, cotton, sunflower and soybean.
[4] As in Banerjee and Iyer (2005), we drop observations where the proportion of irrigated area exceeds 1, or where the proportion of area sown with HYV rice, wheat, and other cereal crops exceeds 1.

missing data in the VDSA dataset compared to the original dataset (Appendix Table A.2, columns 3 and 4). Using the binned data, we find that the variables in the VDSA and BI data have over 90 percent correlation (column 5), except for area under HYV wheat (89 percent correlation) and HYV cereals (80 percent). Appendix Figure A.1 graphs the data over time from both datasets, and shows that the overlap between the two databases is extremely good, except that the VDSA systematically records a lower proportion of area under HYV wheat and HYV cereals, as well as slightly higher wheat yields, than the BI data.

4. Comparing Areas under Direct versus Indirect Colonial Rule

4.1. Empirical Strategy

To determine the effect of direct versus indirect British colonial rule, we use the following equation, which corresponds to equation (1) of Iyer (2010):

$$y_i = \delta_0 + \delta_1 Brit_i + \boldsymbol{X_i}\Gamma + \nu_i \qquad (1)$$

where y_i is an outcome for district i and $Brit_i$ is an indicator for whether a district was under direct British colonial rule. District characteristics are denoted $\boldsymbol{X_i}$. These controls mainly include the geographic characteristics of the area (latitude, altitude, rainfall, soil type, coastal dummy, and year of British annexation). The coefficient of interest is δ_1 which captures the average impact of direct British control on the outcome variable. Standard errors are clustered at the native state level to allow for potential correlation in outcomes across districts within the same native state.

The estimated coefficient δ_1 will be biased upwards if the British conquered areas with higher productivity. To account for this endogeneity, Iyer (2010) uses Lord Dalhousie's policy of "lapse" as a quasi-exogenous determinant of direct British rule. As described earlier, this policy allowed the British to annex a native state if the ruler died without a natural heir from 1848 through 1856. The instrumental variable is $Lapse_i$, a dummy that equals one if the ruler of the native state died between 1848 and 1856 without a natural heir. The $Lapse_i$ variable cannot be assigned to native states annexed prior to 1848 as these areas were already directly ruled by the British. The sample for IV estimation is therefore restricted to places that had not been conquered by 1847. Iyer (2010) shows that Lapse is a statistically significant predictor of direct British rule: 16 out of 20 districts with *Lapse = 1* were annexed to direct British rule.

4.2. Do Indirectly Ruled Areas Catch Up to Directly Ruled Areas?

The results from our extension of Iyer (2010) are shown in Table 1. We focus on the IV results that account for the potential endogeneity of British rule; OLS results are presented for completeness in Appendix Table A.3. Replicating the results in Iyer (2010), we see that directly ruled British areas are significantly less likely to have middle schools, high schools, primary health centers and subcenters and roads in the 1981 and 1991 censuses (Table 1, columns 2 and 3).[5] Importantly, we can also see that the gaps in access to schools have already become smaller (in percentage terms), when compared to the gaps estimated using data from the 1961 census (column 1); in particular, the gap in access to primary school is already closed by 1981.

Our updated data set shows that this narrowing of the gaps continues over time. By 2001, the differences in access to public goods between directly and indirectly ruled districts are not statistically significant, and the point estimates are close to zero, except for access to canals (Table 1, column 4). We interpret this with some caution since the definition of the canal variable has changed: it was measured as access to a canal (only) in 1991 but as access to a river or canal in 2001 (to be consistent with 2011 data). By 2011, we see no statistically significant differences in access to any type of infrastructure (column 5). Overall, our results suggest that post-colonial policies that are specifically aimed at equalization of infrastructure access can be successful in overcoming the long-run effects of historical institutions.

[Insert Table 1 here]

5. Do the Effects of Colonial Land Tenure Attenuate Over Time?

5.1. Empirical Strategy

We examine the long run effects of colonial land tenure systems by comparing outcomes across districts that have more versus less area under non-landlord systems. The regression specification is similar to equation (1) of Banerjee and Iyer (2005):

[5] Iyer (2010) analyzes the mean of 1981 and 1991 data, to account for missing data. These results are reproduced in Appendix Table A.3, column 1.

$$y_{it} = \alpha_t + \beta NL_i + Z_{it}\gamma + \varepsilon_{it} \qquad (2)$$

where the dependent variable y_{it} includes measures of agricultural investment and productivity in district i in (five-year) period t. NL_i denotes the extent of non-landlord land tenure systems in district *i*, measured by the fraction of area or fraction of villages in the district that were not under *zamindari* land tenure.[6] The coefficient of interest is β, which measures the average difference in the outcome variable between non-landlord and landlord districts post-independence. Period fixed effects are denoted α_t, and Z_{it} are control variables, including altitude, latitude, mean annual rainfall, indicators for soil type, and dummies for coastal regions, and a date of British land revenue control. The sample is restricted to districts where the British authorities determined the land tenure systems.[7] Standard errors are clustered at the 1991 district level to account for within-district correlation since the data contains observations for each district from 1966 through 2011.

To deal with possible threats to exogeneity, we follow Banerjee and Iyer's instrumental variables identification strategy. The instrument is a dummy variable that equals one if the British assumed land revenue control of the district between 1820 and 1856, and zero otherwise. Policymakers in this period were significantly more likely to choose non-landlord systems, owing to a series of historical events that set important precedents. The most important of these were a 1920 switch to individual cultivator systems in previously conquered Madras province, and a 1919 letter from the Secretary of the Board of Revenue stating that every village historically was led by a village body. However, the mutiny of 1857 led to a rethinking of this policy stance, with the British wanting to retain support from large landlords. We focus on the OLS estimates in the next section; the results from the IV regressions are shown as a robustness check in the Appendix.

5.2. Do Landlord Areas Catch Up to Individual Cultivator Areas?

We first verify that the VDSA data are able to closely replicate the results from Banerjee and Iyer (2005). We show that using five-year bins yields very similar results to using annual data for the BI data time frame of 1956-1987 (Table 2, columns 1 and 2). We see that areas with non-landlord

[6] This classification is based upon several historical sources, including district-level land settlement reports. See Banerjee and Iyer (2005) for details. *Mahalwari* systems were classified as "landlord" if the village body consisted of only one person.

[7] This is the same as districts that were under direct British rule, with the exception of the princely state of Mysore where the British regent chose the land tenure system during a period where the king was a minor.

land tenure systems have significantly higher levels of irrigation and fertilizer usage, higher proportions of land sown with high-yielding varieties (HYV) crops (marginally significant) and significantly higher crop yields. The coefficients are somewhat higher in magnitude when we use the period 1966-1987 (column 3), which overlaps with the VDSA data. Column 4 displays the estimates of equation (1) using the VDSA data for the overlapping time period of 1966-1987. All the coefficients are of similar magnitude and significance as in the BI data; in fact, the VDSA data shows larger differences between landlord and non-landlord areas for some of these outcomes, particularly the area under HYV cereals. Since a few districts are missing data for all years from the VDSA data, we replicate the results by dropping these from the BI data as well.[8] The results remain similar to those of columns 3 and 4 (Appendix Table A.4, columns 1 and 2).

[Insert Table 2 here]

We now use the VDSA data to examine whether the gap is higher or lower in the later years 1988-2011. We see that there is no longer a statistically significant difference in the proportion of irrigated area between landlord and non-landlord districts in the later period; the gaps in the proportion of area under HYV of rice and wheat have also narrowed, though the gap in the proportion of area under HYV of cereals other than rice and wheat has increased over time (Table 2, column 5). Additionally, the non-landlord advantage in fertilizer consumption per hectare has more than doubled since the 1980's despite the government of India providing fertilizer subsidies.

Consistent with the fact that only some of the agricultural investment gaps have narrowed, while others have widened, we see that the agricultural yield differences remain large and statistically significant in the 1987-2011 period. The combined yield of 13 major crops remains approximately 20 percent higher in non-landlord districts (Table 2, column 5); the rice yield is 20.9% higher and the wheat yield is 18.5% higher. The difference in the overall yield and rice yield has remained constant over time, whereas the gap in the wheat yield has almost been cut in half over time.

Figure 1 depicts the gaps between landlord and non-landlord districts for each of the agricultural productivity and investment variables, in each of the five-year bins, using the VDSA data. Each point represents the regression estimate of the impact of colonial land tenure in the five-

[8] VDSA data on HYV cereals is missing for the state of Karnataka and the districts of Kendujhar, Madurai, and Thanjavur. VDSA data on HYV wheat and wheat yields is missing for Kendujhar district.

year period. Figure 1 shows the irrigation gap closing in the early 1990s, and the gap in HYV rice and wheat becoming insignificant in the early 1980s. The figure also shows that the fertilizer consumption gap has consistently increased over time, as has the gap in HYV of cereals other than rice and wheat. Consequently, the gaps in the yield of 13 major crops and rice have remained constant over time. For wheat yields, the gap has been decreasing with time, but has not converged to zero yet.

[Insert Figure 1 here]

As in Banerjee and Iyer (2005), we also compute IV estimates of the impact of non-landlord tenure, using the fact of being conquered between 1820 and 1856 as an instrument. We show that the VDSA data yields IV estimates that are similar to those from the BI data set for the common years of 1966-1987 (Appendix Table A.4, columns 3 and 4). For the updated years 1988-2011, the IV estimates confirm our conclusions from the OLS estimates: non-landlord areas continue to have higher fertilizer usage and a higher share of area under HYV of cereals, resulting in significantly higher wheat yields even in the later period (column 5). In contrast to the OLS, the IV results do not show significantly higher rice or total yields in the later period.

6. Conclusion

Extending the data sets used in Banerjee and Iyer (2005) and Iyer (2010), we document two important facts about the persistent effects of historical institutions. Comparing areas that were under direct versus indirect colonial rule, we find that, by 2001, there were no significant differences in access to middle schools, primary health centers, primary health subcenters and paved roadways between historically directly and indirectly ruled districts. We attribute these results to post-colonial policies that were specifically targeted towards places with initially lower levels of infrastructure. However, when extending the analysis on land tenure systems, we find that some of the agricultural investment gaps have dissipated while others have persisted and even widened. Consequently, non-landlord districts still experience higher crop yields more than 60 years after the end of colonial rule and the official dismantling of colonial land tenure institutions. We conclude that colonial institutions can have lasting impacts on populations long after the independence of a nation. However, it is possible to mitigate these long-run effects through targeted public policy and infrastructure investment.

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Table 1: How Long Do the Effects of Direct Colonial Rule Persist?

	(1) 1961 IV	(2) 1981 IV	(3) 1991 IV	(4) 2001 IV	(5) 2011 IV
Primary School	-0.127*	-0.007	-0.000	0.033	0.054
	(0.067)	(0.046)	(0.037)	(0.033)	(0.034)
Middle School	-0.068*	-0.087**	-0.088**	-0.080	-0.006
	(0.035)	(0.040)	(0.038)	(0.048)	(0.054)
High School	-0.037	-0.064	-0.068	-0.042	-0.081
	(0.022)	(0.045)	(0.041)	(0.059)	(0.063)
Primary Health Center		-0.024**	-0.039**	-0.007	-0.032
		(0.012)	(0.015)	(0.053)	(0.060)
Primary Health Subcenter		-0.041**	-0.063*	-0.050	-0.029
		(0.017)	(0.033)	(0.058)	(0.059)
Canals	-0.000	-0.047	-0.042	-0.306***	0.166
	(0.000)	(0.031)	(0.027)	(0.109)	(0.148)
Roads	-0.077	-0.189***	-0.204***	-0.104	0.006
	(0.092)	(0.070)	(0.068)	(0.084)	(0.058)

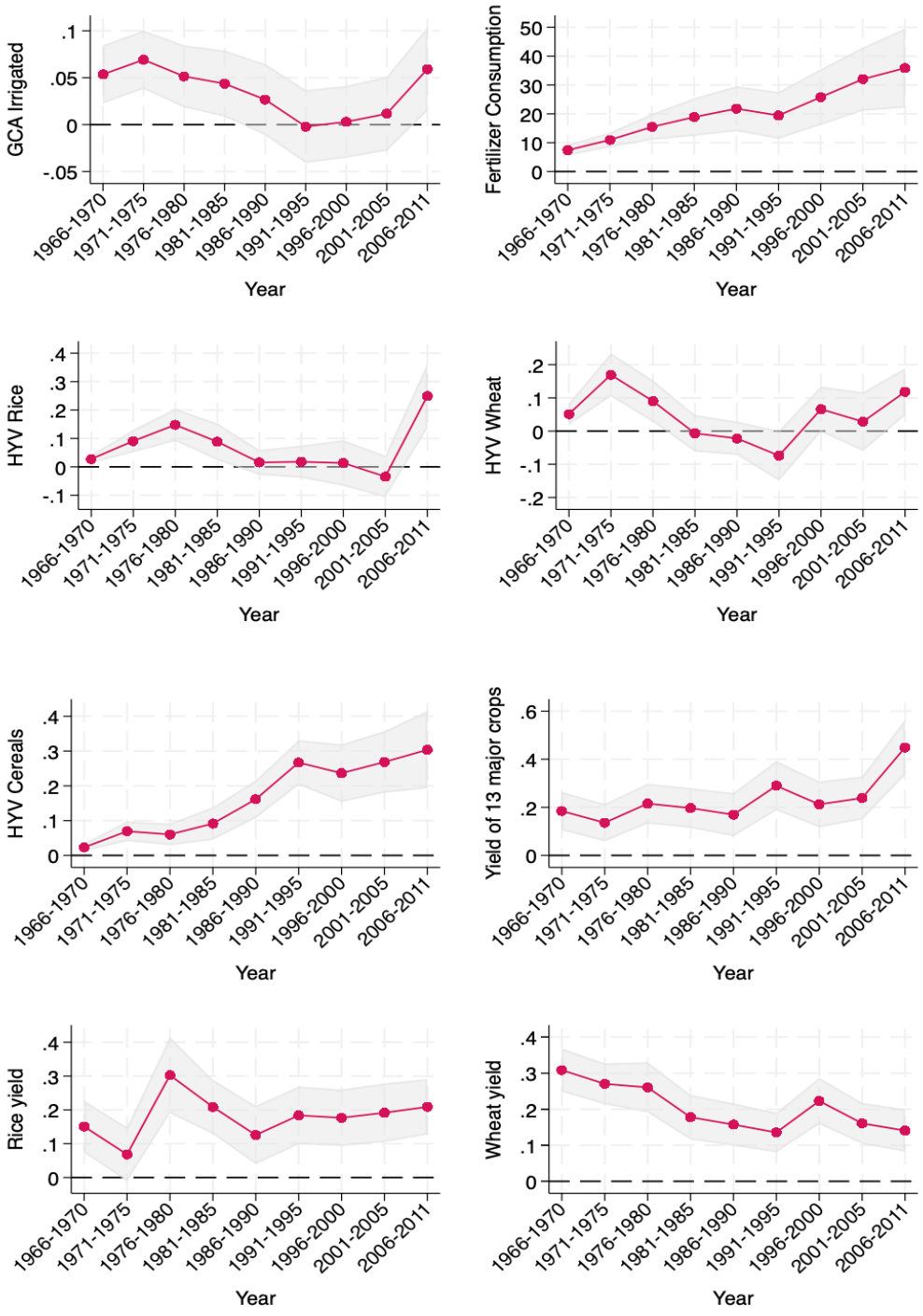
Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the native state level are reported in parentheses. Each cell represents the coefficient from a IV regression of the dependent variable on the measure of direct British rule, using the *Lapse* indicator as an instrument. *Lapse* = 1 if the ruler of a native state died without a natural heir between 1848 and 1856. Post-1847 sample refers to areas that were not annexed in or before 1847. The 1961 Population Census has the following missing data: canals for UP, Tamil Nadu, Rajasthan, Orissa, and Maharashtra; primary and middle schools for Uttar Pradesh; Middle schools, roads, and canals for West Bengal; and roads for Punjab and Rajasthan. The 1981 and 1991 have the following missing data: middle schools in Gujarat, high schools in Madhya Pradesh, and primary health subcenters in Karnataka. Assam is missing in the 1981 data, and Jammu and Kashmir are missing in 1991. Primary health centers includes community health centers in 2011. Canals refers to access to canal or river in 2001 and 2011.

Table 2: How Long Do the Effects of Colonial Land Tenure Persist?

	(1) B&I 2005 Annual, 1956-1987	(2) B&I 2005 Binned, 1956-1987	(3) B&I 2005 Binned, 1966-1987	(4) VDSA Binned, 1966-1987	(5) VDSA Binned, 1988-2011
Irrigated Land	0.065*	0.063*	0.077**	0.074**	0.009
	(0.034)	(0.034)	(0.036)	(0.037)	(0.043)
Fertilizer Consumption	10.708***	11.778***	16.053***	17.067***	26.692**
	(3.345)	(3.874)	(5.303)	(4.932)	(11.172)
HYV Rice	0.079*	0.072	0.072	0.067	0.064
	(0.044)	(0.049)	(0.049)	(0.045)	(0.059)
HYV Wheat	0.092**	0.085*	0.085*	0.070	0.039
	(0.046)	(0.049)	(0.049)	(0.047)	(0.056)
HYV Cereals	0.057*	0.056	0.056	0.096**	0.253***
	(0.031)	(0.037)	(0.037)	(0.037)	(0.065)
Yield of 13 major crops	0.202**	0.203**	0.242**	0.214**	0.188*
	(0.092)	(0.092)	(0.095)	(0.088)	(0.098)
Rice yield	0.171**	0.173**	0.197**	0.181**	0.189**
	(0.081)	(0.082)	(0.091)	(0.091)	(0.091)
Wheat yield	0.229***	0.229***	0.259***	0.279***	0.171***
	(0.067)	(0.068)	(0.080)	(0.065)	(0.063)

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the 1991 district level are reported in parentheses. Each cell represents the coefficient from a regression of the dependent variable on the measure of non-landlord tenure, controlling for period fixed effects, geographic controls, and the date of British land revenue control. The geographic controls include altitude, latitude, mean annual rainfall, dummies for soil type, and dummies for coastal regions.

Figure 1: Impact of Colonial Land Tenure Systems Over Time



Note: Each point on the graph represents the coefficient from a regression of the outcome variable (listed on the y-axis) on the measure of non-landlord land tenure. The shaded area is the 95 percent confidence interval for the regression coefficient. The black, dashed, horizontal line is at zero. GCA stands for "gross cropped area." HYV stands for "high yielding varieties." All regressions use data from the VDSA data set.

Table A.1: Trends in Public Good Availability

	(1) 1961	(2) 1981	(3) 1991	(4) 2001	(5) 2011
Primary School	0.513	0.747	0.794	0.870	0.879
Middle School	0.097	0.225	0.267	0.411	0.510
High School	0.030	0.112	0.141	0.239	0.272
Primary Health Center		0.030	0.052	0.146	0.280
Primary Health Subcenter		0.039	0.101	0.248	0.275
Canals	0.002	0.053	0.042	0.498	0.575
Roads	0.212	0.406	0.461	0.665	0.703

Note: Data from village directories of population censuses. The 1961 Population Census has the following missing data: canals for UP, Tamil Nadu, Rajasthan, Orissa, and Maharashtra; primary and middle schools for Uttar Pradesh; Middle schools, roads, and canals for West Bengal; and roads for Punjab and Rajasthan. The 1981 and 1991 have the following missing data: middle schools in Gujarat, high schools in Madhya Pradesh, and primary health subcenters in Karnataka. Assam is missing in the 1981 data, and Jammu and Kashmir are missing in 1991. Primary health centers includes community health centers in 2011. Canals refers to access to canal or river in 2001 and 2011.

Table A.2: Comparing the Banerjee & Iyer (BI) and VDSA datasets

	(1) BI Annual	(2) VDSA Annual	(3) BI Binned	(4) VDSA Binned	(5) Correlation
Irrigation	2,805	2,574	496	488	0.996
Fertilizer	3,634	3,594	826	828	0.919
HYV Rice	3,542	1,667	793	808	0.976
HYV Wheat	3,375	1,556	755	749	0.893
HYV Cereals	3,453	1,179	785	710	0.799
Yield of 13 Major Crops	3,652	2,354	830	830	0.979
Rice Yield	3,642	3,652	828	830	0.991
Wheat Yield	3,124	3,652	744	785	0.911

Note: Each entry of Columns 1 through 4 is the number of observations. "Binned" refers to five-year averages of outcome variables. Correlation coefficients are computed for the binned data from 1966 through 1987.

Table A.3: Long-run Effects of Indirect Colonial Rule

	1981 and 1991 Population Census			2001 Population Census		2011 Population Census	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Post-1847 Sample	Full Sample	Post-1847 Sample	Full Sample	Post-1847 Sample	Full Sample	Post-1847 Sample
	IV	OLS	OLS	OLS	OLS	OLS	OLS
Primary School	-0.011	-0.016	-0.007	-0.049**	-0.030	-0.021	-0.008
	(0.041)	(0.032)	(0.039)	(0.024)	(0.038)	(0.023)	(0.034)
Middle School	-0.091**	-0.046	-0.047	-0.041	-0.095*	-0.020	-0.062
	(0.037)	(0.034)	(0.031)	(0.040)	(0.050)	(0.042)	(0.038)
High School	-0.065	-0.068*	-0.061*	-0.035	-0.068	-0.055	-0.071*
	(0.042)	(0.040)	(0.033)	(0.034)	(0.047)	(0.043)	(0.036)
Primary Health Center	-0.031**	-0.024*	-0.015*	-0.029	-0.044	-0.027	-0.081*
	(0.013)	(0.014)	(0.008)	(0.029)	(0.037)	(0.034)	(0.044)
Primary Health Subcenter	-0.053**	-0.002	-0.007	-0.005	-0.108**	-0.022	-0.080*
	(0.021)	(0.017)	(0.017)	(0.032)	(0.043)	(0.033)	(0.044)
Canals	-0.043	-0.010	-0.024*	-0.149**	-0.277***	-0.011	0.143
	(0.028)	(0.014)	(0.014)	(0.067)	(0.073)	(0.061)	(0.101)
Roads	-0.198***	0.043	-0.010	0.039	0.042	0.091**	0.137**
	(0.066)	(0.065)	(0.067)	(0.058)	(0.060)	(0.046)	(0.054)

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the native state level are reported in parentheses. Each cell represents the coefficient from a regression of the dependent variable on the measure of direct British rule. IV estimate computed using the *Lapse* indicator as an instrument for British rule. *Lapse* = 1 if the ruler of a native state died without a natural heir between 1848 and 1856. Post-1847 sample refers to areas that were not annexed in or before 1847. Columns 1 through 3 use the mean from 1981 and 1991 Population Censuses, as in Iyer (2010).

Table A.4: Long-run Effects of Land Tenure Systems: Additional Results

Dependent Variable:	(1) B&I 2005 Binned, 1966-1987 Same districts, OLS	(2) VDSA Binned, 1966-1987 Same districts, OLS	(3) B&I 2005 Binned, 1966-1987 IV	(4) VDSA Binned, 1966-1987 IV	(5) VDSA Binned, 1988-2011 IV
Irrigated Land	0.080**	0.079**	0.189	0.186	-0.056
	(0.037)	(0.037)	(0.135)	(0.139)	(0.122)
Fertilizer Consumption	12.464***	12.640***	41.807**	31.878*	66.903*
	(3.256)	(3.251)	(20.374)	(16.541)	(34.923)
HYV Rice	0.075**	0.072**	0.478***	0.461***	0.627*
	(0.037)	(0.034)	(0.174)	(0.171)	(0.323)
HYV Wheat	0.125***	0.118**	0.630***	0.979***	0.597
	(0.047)	(0.048)	(0.188)	(0.247)	(0.392)
HYV Cereals	0.044**	0.071***	0.637***	0.321***	2.358*
	(0.021)	(0.023)	(0.159)	(0.092)	(1.241)
Yield of 13 major crops	0.246**	0.208**	0.148	-0.078	-0.172
	(0.097)	(0.086)	(0.413)	(0.383)	(0.384)
Rice yield	0.185**	0.184**	0.673**	0.573*	0.391
	(0.093)	(0.091)	(0.337)	(0.313)	(0.342)
Wheat yield	0.300***	0.330***	1.047***	0.988***	0.366**
	(0.074)	(0.068)	(0.314)	(0.285)	(0.184)

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the 1991 district level are reported in parentheses. Each cell represents the coefficient from a regression of the dependent variable on the measure of non-landlord control. Each regression includes year fixed effects, geographic controls, and a data of British land revenue control. The geographic controls include altitude, latitude, mean annual rainfall, dummies for soil type, and dummies for coastal regions.

Figure A.1: Trends in Agricultural Investments and Productivty, VDSA and BI data