

British Colonial Institutions and Economic Development in India

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December 2007

We are indebted to Latika Chaudhary for her helpful ideas and suggestions. We thank seminar participants at the University of Toronto and Washington University for their comments. We also thank Washington University in St. Louis (Faculty Research Grant), the Bradley Foundation and the Weidenbaum Center for research support.

Abstract

To extract revenue from its colony, the British implemented two major land tax systems and fundamentally altered the nature of existing property rights in India. In some regions, property rights and taxes were assigned to zamindars or landlords whereas in others they were assigned to ryotwars or cultivators. Because a few elites were able to accumulate significant economic and political power in the zamindari as opposed to the ryotwari areas, there is strong *a priori* reasons to believe that the local political structures diverged across these two types of areas. Although the zamindari areas were historically more developed than ryotwari areas, it appears that the introduction of these British institutions reversed the fortunes of these regions over time.

I. Introduction

When the British colonized and annexed various parts of India between the eighteenth and the nineteenth centuries, it implemented two major land tax systems: zamindari (landlord) and ryotwari (non-landlord). In the zamindari areas of Bengal, Bihar, Orissa, Central Province, and some parts of Madras, land taxes and property rights were assigned to landlords. In these areas, non-resident landlords often owned rights to numerous villages and developed extensive bureaucratic organizations and policing forces to manage and employ local villagers to farm the land under sharecropping or wage contracts (Nakazato (1994)). By contrast, in the ryotwari areas, land taxes and property rights were assigned to individual villagers in most of Madras, Bombay, and Assam or to an entire village under the mahalwari system in the areas of Punjab. In these areas, local resident landowners either farmed their own land or employed low caste village laborers under sharecropping or wage contracts.

For scholars of Indian economic history, the study of the impact of the British land tax systems on the colonial Indian economy has been a subject of much debate (Roy (2000), Desai et. al (1984)). Ludden (1984) believes that the political and economic differences caused by the differing British land tax systems were relatively minimal although he suggests that zamindari areas were characterized by greater local elite political power as well as greater social conflicts. On the other hand, Chaudhuri (1984) argues that agricultural investments in the zamindari areas suffered over time due to an increasing uncertainty over property rights in these areas. Because the British gave proprietary rights to the zamindars, who were revenue agents and local sovereigns rather than proprietors under the Mughals, their land ownership rights came under increasing protest from the village peasants (Chatterjee (1984)).

More recently, Banerjee and Iyer (2005) argue that the impact of the British colonial land tax institutions extended beyond the colonial period into modern India. In fact, they argue that the origins of the divergence between zamindari and ryotwari regions began after 1965 with the advent of the Green Revolution. After 1965, the government of India increased its efforts to disseminate new high-yielding varieties of crops and to build public infrastructure in rural areas. Because the zamindari areas were unable to invest in public goods needed to effectively adopt the new technologies, agricultural productivity in these areas lagged compared to that of the ryotwari areas. According to Banerjee and Iyer, the class-based antagonism created by the historical inequity in land distribution in the zamindari areas led to significantly higher collective action costs and lower provision of investments in health, education and technologies.

In this paper, we examine the impact of the British land tax systems on colonial India between 1901 and 1941 as well as the period between 1941 and 1991. As far as we are aware, this is the first study to examine the impact of British land tax institutions on colonial India using census data from the British colonial government. For the colonial period, we construct measures of agricultural productivity at the district-level for 1901 and 1931 using *Agricultural Statistics of India* and the *Season and Crop Reports*.¹ We also construct other measures of development such as urbanization, employment in manufacturing and services, and population density from the *Censuses of India*. We also assemble similar data for the post-independence period. As for our independent variables, we borrow extensively from Banerjee and Iyer (2005). We use their measures of landlord and non-landlord variables, length of British control, and construct similar geographic control variables using data from Vanneman et. al (2000).

¹ There is extensive debate on the quality of agricultural data from the British colonial period. We address this issue in the data analysis section and in the appendix.

Because the zamindari system was initially implemented in Bengal where zamindars were already present, there is some concern that the geographic distribution of land tax schemes were endogenous to local conditions. However, if endogeneity bias exists, then there seems to be a general consensus that the zamindari system was more likely to be implemented in the more fertile, densely populated, rain-fed, rice-based areas such as Bengal, rather than in the more sparsely populated, drier, millet-based areas such as parts of Madras (Stokes (1978) and Ludden (1984)).² In addition, the existing local political structure may have also influenced the type of land tax institutions in some areas. The mahalwari (village-based) system may have been more likely to be implemented in regions such as Punjab where warrior caste lineage clans such as the Rajputs and the Jats jointly owned and controlled villages (Kolenda (1987)).

However, the ideology and influence of various individual British administrators may have played a far bigger role in the implementation of the two land tax systems (Stokes (1959), Stein (1989), Guha (1963), and Banerjee and Iyer (2005)). First, the economic and political philosophies of Phillip Francis and Lord Cornwallis were instrumental in the implementation of the zamindari system (Guha (1963)). Second, the utilitarian philosophy of Thomas Munro was instrumental in the development of the ryotwari system (Stokes (1989), Stein (1989) and Mukherjee (1962)). Third, because there was no centralized unified rule in the various parts of British India, many local decisions, such as those made by Holt Mackenzie in the North-West, further contributed to idiosyncrasies on why one area adopted the zamindari or the ryotwari system of land taxation.

Even more importantly, the British did not simply adopt the existing property rights

² Banerjee and Iyer (2005) provide some limited evidence that agricultural productivity was higher in the zamindari as compared to ryotwari areas in the early colonial period.

institutions of the Mughals.³ In all of British India, the British fundamentally altered the nature of property rights in land. In Hindu or Mughal India, the rights of land ownership were not proprietary but overlapping. While land was generally owned by high castes, the low castes held varying rights to occupancy and rights to shares of crops as defined by local custom and kinship rules. The introduction of sole proprietary ownership significantly altered the rights of property as many of the traditional rights were no longer formally recognized by the British courts. In addition, the alteration in the nature of property rights is believed to have been more significant in the zamindari areas where revenue collection rights were transformed into tenurial proprietary rights (Roy (2000)).

Because the British officials drastically altered the historical patterns of land ownership in zamindari areas but did so to a much lesser extent in the ryotwari areas, there are strong *a priori* reasons to believe that the introduction of these British land tax and property rights institutions significantly impacted these two regions differently during the British colonial period. In the zamindari areas, a small number of zamindari elites were able to acquire economic and political control over their local territories through the use of force, alliances with British

³ There were at least two important reasons for why the British did not just adopt the Mughal institutions as described in Habib (1999) and Saran (1973). First, the British possessed superior military strength than those of previous rulers. Frankel (1989, 1) writes that, unlike the British, “Neither the Moslem and Mughal imperia nor the great Hindu empires of ancient and medieval India exercised centralized bureaucratic control through ownership of land and revenue extraction, or wielded a monopoly of force within the territory defined as their dominion.” Second, the British were either ignorant of local institutions or could not help but alter the existing property rights institutions. The case of Punjab is illustrative. Under the Mughals, Punjab, a non-landlord province under British rule, was locally ruled by zamindars but its political landscape was altered significantly by the rise of the Sikhs in the last half of the eighteenth century. Even though the British policy under James Thomason, architect of the Ceded and Northwest Provinces, was conservative, Kessinger (1974, p.77-8) argues that “the goal of conserving rural society as the revenue officials found it proved difficult to attain because revenue officials were continually confronted by complexities which forced them to make series of decisions that resulted in innovation and change.” One of these innovations was to make the *bhaiachara* (the proprietary group in villages where all landowners are descended from a common ancestor and are treated as a corporate group by the government) collectively responsible for the collection and payment of revenue was new. Even in the British non-landlord areas such as Punjab, by establishing proprietary rights in land, the British fundamentally altered older social relationships based on traditional notions of property.

officials, and the use of courts. In the ryotwari areas, however, the land distribution was much more likely to be equal so the political power was likely to be more diffuse.⁴

While our evidence on the divergence of the zamindari and ryotwari regions in terms of total agricultural and productivities is somewhat mixed and varied, other measures of agricultural and economic development provide significant evidence for their divergence. We find that, after controlling for geographic factors, agricultural productivity between zamindari and ryotwari areas were similar in 1901 but that zamindari areas achieved higher productivity in 1931. Yet, in the early post-independence period, when the data quality is likely to be higher, agricultural productivities of these regions seem to have converged in the period 1958-1961. However, as found by Banerjee and Iyer (2005), agricultural productivities between these two regions diverged significantly between 1965 and 1991.

For all other measures of agricultural and economic development, the data suggest that zamindari and ryotwari areas diverged during the colonial period and continued to diverge after independence. The ryotwari areas were much more likely to shift its crop into the more productive non-food crops, were more likely to be urbanized, and had greater shares of employment in manufacturing and services.⁵ Interestingly, population density did not differ systematically between the zamindari and ryotwari areas.

4 For example, Cohn (1961) argues that, in the landlord region of Banaras, the eastern end of today's Uttar Pradesh, the British legal system was used by the elites to acquire valuable lands. Elites identified valuable land and then made sure that owners of these lands did not pay revenue. Failure of payment led to forced auctions where the land was subsequently purchased by elites. Cohn (1961, 622): "Under the regulations of 1793, it was assumed that by stabilizing landed relations, providing security of property, making peoples' rights explicit through the publication of the laws, and providing an impartial judge making decisions on the basis of evidence and arguments in open court, the happiness and security of the Indian population would be secured. In fact this did not occur. Charles Metcalf in 1815 expressed a view which was held by many English: 'Our Courts of Justice are generally spoken [of] with disgust, with ridicule, or with fear... They [the Indians] abuse the latter [the courts] as scenes of injustice and corruption where nothing is obtained but by bribery.'" Nakazato (1994) reaches a similar conclusion for Bengal.

5 We believe that the data on acreage are likely to be much more reliable than those on productivity or yields for the colonial period. There are also strong reasons to believe that non-food crops were much more productive than food crops. For the pre-independence period, Blyn's (1966) classic work shows that non-food crops were 2 to 3 times more productive than food crops and that these differences widened over time in most British provinces. We

While it is extremely difficult to establish the causes of divergence in the economic performances between the zamindari and ryotwari districts, we believe that the divergence was caused by differing institutional developments in these two regions. In the pre-independence period, agricultural investments and productivity in zamindari areas were more likely to suffer from agency costs and greater uncertainty in property rights. The ability of zamindars to extract effort and rents from tenants was likely to be functions of land tenancy reforms. When zamindars possessed considerable power, they were likely to extract a significant level of effort from tenants through threats of eviction or extra-legal coercion in order to maintain high levels of productivity. However, when tenancy reforms reduced the zamindar's bargaining power, agricultural productivity likely fell as the effort levels of tenants declined.

Because the bargaining power of zamindari elites increased when the economic alternatives of their tenants were more limited, zamindars had incentives to limit the economic and geographic mobility of tenants and laborers. Landed elites who controlled district boards were less likely to promote spending on public education. They were also less likely to promote infrastructural investments for urbanization. Even in the post-independence period, while other factors such as collective action costs may have become important over time, we believe that agency costs and property rights uncertainty continued to depress investments and productivity in the historically zamindari areas.

II. British Colonial Institutions in India

The British introduction of land taxes and proprietary property rights in India presents an interesting case study of colonial institutional development. In our view, the path of institutional

believe that our finding lends credence to the idea that non-landlord areas were more responsive to market opportunities and were more likely to shift into the more productive non-food crops.

development in India does not fall neatly into any of our current categories of understanding on the subject of colonial institutions and development.⁶ India is endowed with a tropical climate, fertile soil and possessed a large native population. Yet, in India, unlike in the other tropical colonies, the British did not develop extensive plantation economies.⁷ Due to its tropical disease environment and the pre-existing dense native population, British immigration to India was limited.⁸ Yet, despite the small number of British immigrants, the British government established institutions in India based on private property rights and an English-type judicial system for the native populations. In a land where property rights were informally defined by traditional Hindu law and enforced by local village leaders, the British attempted to introduce an impersonal, bureaucratic, modern form of property rights.⁹

6 There are three important views on the distribution of colonial institutions around the world. For North (1990) and La Porta et. al (1998a, 1998b), British colonies developed superior institutions as compared to the Spanish colonies as Britain possessed superior political and legal institutions than Spain. On the other hand, Engerman and Sokoloff (1997, 2000) and Acemoglu et. al (2001, 2002, 2004) argue that the distribution of colonial institutions was caused by local geographic conditions. For Engerman and Sokoloff, poor institutions arose in the New World colonies where geography and climate were well suited for plantation economies or where there were significant indigenous populations as land was granted to few elites. For Acemoglu et. al, the distribution is determined by initial conditions in settler mortality and native population density. In places where mortality rates were high or where there were dense native populations, the Europeans did not have an incentive to establish democratic institutions but rather simply took over the existing native institutions which favored local elites.

7 The British owned or leased plantations in tea, indigo, and coffee. Of the three crops, tea was the most important and it represented about 20% in value of the eight most important non-food grain crops in 1923-1947 (Blyn (1966)). In terms of acreage, however, these crops accounted for a miniscule amount of Indian agriculture (Tomlinson (1993)). British firms were also involved in a variety of manufacturing from the production of jute, cotton and machinery, but their most important presence was in their control of transportation networks, exports and imports (see Bagchi (1972, p. 183)).

8 British views of Indians and the Indian climate evolved over time with changes in theories of race and disease as well as with the new emerging information from European experiences in Asia (Harrison (1999)). But by the early nineteenth century, the British believed that India's climate was generally incompatible with the European constitution.

9 What type of property rights system emerged in India? Because of differing local political and cultural conditions, the nature of property rights in India varied greatly. Banerjee and Iyer (2005) write that a zamindar's property right was one of revenue-collecting, which could be bought and sold, rather than proprietary rights. However, this view seems to be based on southern India where property rights of zamindars were least secure (Kumar (1965)). Baker (1976) writes that in Madras a bizarre court judgment in 1870, followed by the Land Act of 1908, changed the legal relationship between zamindars and tenants where tenants' rights were restored to "status quo ante" – giving the tenant the right of land ownership and leaving only the right of revenue collection to zamindars. Because the landlords could not effectively use the courts to collect rents from tenants, Baker argues that they resorted to other means such as control of credit, water, and marketing to gain leverage over tenants. Scholars of southern India such as Baker (1984) and Frykenberg (1965) generally emphasize the limitations of British power and authority. However, in northern India, many scholars believe that the zamindars were able to attain proprietary rights to land.

While British India was not exempt from corruption, graft and arbitrary use of power, the introduction of private property rights for natives was rather unusual by the standards of colonial institutions. Why did the British attempt to introduce a system of private property rights in India? We believe that there were at least three important reasons. First, in India, unlike in the New World and elsewhere, the military costs of taking land from natives were prohibitive. As a consequence, the British, like the Mughals before them, focused their energies on extracting land rents from peasant farmers. Second, the focus on land taxes aligned the economic incentives of the British administrators with those of cultivators. A majority of the British administrators believed that private property rights in India would unleash economic development and raise tax revenue for the British government. Finally, Dirks (2006) argues that the highly visible corruption trials of Robert Clive and Warren Hastings for their actions in India set bounds on the level of corruption tolerated by the Parliament for future governors and officials of India.

Although British involvement in India expanded greatly under Clive's direction of the East India Company, the rise of the British State in India is associated with the rule of Hastings, the first Governor-General of India between 1773 and 1785. Hastings consolidated British control of India and established a more centralized British authority by implementing a system of criminal and civil courts under British control. Yet, despite establishing British sovereignty in major parts of India, Hastings' vision of the British role in India was conservative and limited. Because the practice of tax farming had long historical precedence and required minimal state

“Owing to the tightening alliance between the British and zamindars during and after the Indian Mutiny, even the Courts had begun to decree that the land itself had also belonged to Zamindars and peasants were only tenants-at-will. (Ranga and Saraswathi (1979, p.50))” Even in some areas of Madras, Reddy (1989, p.275) argues that “jagirdars, zamindars and desmukhs” were able to exploit the courts to turn cultivators to tenants-at-will. Nakazato (1994) provides a detailed examination of the operation of land markets in Bengal. He demonstrates that zamindars were able to use their political power in concert with the British to acquire proprietary rights in land and establish a zamindari-sharecropping system between 1870 and 1910. Similar views are held by Chatterjee (1984), Chaudhari (1984) and Shukla (1993). The emergence of a land market in India where property was bought and sold in high volume is *prima facie* evidence of a radical change in the conception of property rights in India (see Baker (1976), Chaudhari (1975), and Neale (1962)).

bureaucracy, Hastings instituted a land tax system which auctioned off estates and farmed them out to the highest bidders for short-term leases not extending beyond five years.

However, Hasting's tax farming system was quickly opposed by other British officials. Phillip Francis, a nemesis and a physiocrat, argued that tax-farming with short-term leases led to poor incentives for development as it subverted the property rights of landholders. Since tax-farmers owned revenue rights for limited number of years, Francis believed that they did not have the proper incentives to invest for the long-term. Influenced by Francis, Lord Cornwallis, who succeeded Hastings as Governor-General between 1786 and 1793, in the famous Permanent Settlement of Bengal in 1793, established the zamindari system of land taxes. Because Francis and Cornwallis both believed that only the zamindars had the knowledge, capital and the incentives to develop Indian agriculture, they assigned land taxes and property to the zamindars (Guha (1963)).

Yet, shortly after it was implemented, Cornwallis's zamindari system also came under attack. Arthur Wellesley, who ruled India from 1798 to 1805, inspired a new generation of Company servants who were instrumental in re-designing the colonial state. One of these men was Thomas Munro who advocated the ryotwari system. Stokes (1959) argues that Munro and the new leaders were paternalistic utilitarians whose vision for ruling India was much more imperial than those of Hastings and Cornwallis. For Munro, the ryotwari system served two purposes, economic and political. By giving the property rights to farmers rather than zamindars, Munro believed that agricultural productivity would increase significantly. Just as important, however, Munro argued that the assignment of taxes and property at the local village level administered by British district officers would significantly strengthen the level of British

political control in India. Although the zamindari system remained in place in many parts of India, the ryotwari system became the new dominant form of land taxes in the 1820s.

Thus, there is considerable evidence that the implementation of the zamindari and ryotwari systems in India was significantly influenced by the political and economic philosophies and objectives of the various British officials at different points in time. Yet, whether a British official advocated a zamindari or a ryotwari system, all of the British officials were in full agreement that the introduction of British type property rights would promote economic development and increase tax revenues (Stokes (1959), Guha (1963)).

Whether intended or not, however, these differing land tax schemes and property rights assignments led to a significantly different distribution of economic and political power among the native Indian populations in different regions of India. Moreover, many scholars suspect that these differing land tax and property rights institutions contributed to the political and economic divergence in Indian regional economies during and beyond the British colonial period.

III. Empirical Methodology and Data

Scholars have proposed numerous potential causes for why zamindari and ryotwari regions diverged during and beyond the British colonial period. First, the colonial government may have been more likely to invest in irrigation and railroads in ryotwari areas where land taxes could be adjusted rather than in zamindari areas where tax rates were set permanently.¹⁰ Second, zamindari areas faced greater agency problems in agriculture. In the zamindari areas, a great majority of farms were worked by sharecroppers whereas in the ryotwari areas, more land was

¹⁰ See Whitcombe (1983), Boyce (1987), Hurd (1983), Banerjee and Iyer (2005) and others.

farmed by owners and renters.¹¹ Third, in the zamindari districts, tenancy reforms increased the level of uncertainty of property rights.¹² Finally, local district spending in public goods such as education or roads may have differed between zamindari and ryotwari areas. The varying levels of expenditures may have reflected differences in the preferences of local elites or differences in the ability of local governments to solve collective action problems.¹³

In order to investigate whether the zamindari and ryotwari regions diverged, we estimate the following regression:

$$(1) \quad Y_i = \alpha + \beta \text{Ryotwari}_i + \gamma \text{BR}_i + \theta X_i + \varepsilon_i$$

where Y_i is the dependent variable in district i and the independent variables are Ryotwari_i - the share of the land under a ryotwari land tax system, BR_i - the length of British rule in district i , and, X_i - the geographic control variables. Since district level measures of output or income are unavailable, we use agricultural productivity, urbanization, shares of workforce in manufacturing and services, and population density as dependent variables. Ryotwari_i and BR_i are Banerjee and Iyer's (2005) 'proportion of non-landlords' variable and the 'length of British control' variable.¹⁴

Geographic controls include altitude, latitude, rainfall, and various soil types (alluvial, black, and

11 Banerjee et. al (2002) provide a useful model of agricultural tenancy in India. While the model is used to investigate tenancy reforms in the post-independence period, we believe that the model applies to the pre-independence period as well. In the base model where tenants cannot be evicted, the first best solution is a rental contract. If the wealth of tenants is too low for a rental contract, then the tenant's effort level is less than first-best and is a positive function of the tenant's outside options. The authors show that agency costs typically lead to less than first-best level of effort from tenants as well as investments from landlord and tenants. If the model allows the landlords to evict tenants, then the effort level of tenants is inversely correlated with landlords' bargaining power over tenants. Landlords can use the power of eviction threats to elicit more effort from poor tenants. In this model, tenancy reform lowers the effort level of tenants but increases the share received by tenants. Besley and Burgess (2000) present a different model of tenancy which has essentially the same predictions as those of Banerjee et. al (2002). Also see Bardhan (1984).

12 See Chatterjee (1984), Appu (1975), Besley and Burgess (2000), and Frankel and Rao (1989, 1990).

13 In the colonial period, Chaudhary (2005) finds that local district boards who determined local public expenditures were often controlled by high caste Brahmans. In the post-independence period, Banerjee and Iyer (2005) argue that local public developmental expenditures were determined by the ability of local governments to solve collective action problems.

14 For areas where information was available, Banerjee and Iyer (2005) define the 'proportion of non-landlord' as the proportion of villages, estates or land area which was not under the revenue liability of landlords or zamindars. For all other areas, they assign the non-landlord measure as either zero or one depending on the dominant form of land revenue system.

red) and whether a district was located on a coast. Although rainfall and soil conditions fluctuate with time, we assume that these geographic characteristics remained constant over time. Soil data are based on a visual inspection of maps from Raychaudhuri et. al. (1963); rainfall data are based on a 30-year norm between 1930 and 1961.

For our analysis, we use district level data from 9 provinces of British India.¹⁵ Data at the district level are constructed for the period between 1901 to 1991 using various *decadal censuses*, *District Gazetteers*, *National Sample Survey*, *World Bank Data*, and other census reports. The *Agricultural Statistics of India* and various provinces' *Season & Crops Reports* for different years were the major source of pre-independence period agriculture-related data. The India Database Project by Vanneman, Reeve and Barnes (2000) proved an important source of post-independence period census data. Some of the geographic control variables and post-independence period agricultural data are taken from the India Agriculture and Climate Data Set (compiled by the World Bank using official government publications) and the Maps of India website.¹⁶

We present descriptive statistics of our data in Tables 1-3.¹⁷ Table 1 indicates that landlord districts accounted for about 57% of total cultivated land area. Table 2 shows that India

15 A district in India is an administrative unit below the state level. These districts are also a part of present-day India with minor changes in district boundaries for some of them. Present day and older district boundaries have been matched to account for these changes. The Provinces of India were those portions of India that were ruled directly by officials of the British East India Company until the middle of the 19th century and were under the direct control of the British crown from 1858 until Indian Independence in 1947. During the years 1947-1950, Independent India was divided into 19 provinces and hundreds of princely states which were replaced with states and union territories in 1950 when the Indian Constitution came into effect. We have included districts from 9 provinces. The included provinces are Madras, Bombay, Ajmer, North-West Province, Punjab, Central Provinces, Berar, Oudh, and Bengal. Most of the excluded provinces are now a part of Pakistan, Burma, Bangladesh and Yemen and thus no longer belong to the Indian territory and for few others, there is major lack in availability of data. We have also included a few of the princely states in our data sample for some of the regressions. Since some districts of British India became parts of Pakistan and Bangladesh, data on these districts are omitted for the post-independence India.

16 The Indian district database combines district-level data from census and agricultural sources between 1961 and 1991 and also adjusts the district boundaries to create comparable units across the three decades.

17 For Tables 2 and 3, we define landlord districts as those districts with a greater proportion (> 0.5) of the area under landlordism. In our sample, this classification led to about 50% of districts falling under the category of landlord districts.

is a vast country with considerable variations in geographic characteristics in latitude, altitude, rainfall and soil conditions. In general, superior agricultural conditions exist in locations with lower altitudes, higher latitudes, greater rainfall, and soil in the form of alluvial and red soil rather than black soil. The data suggest that zamindari districts possessed better geographic conditions for agriculture than non-landlord districts.

Despite the fact that the ryotwari districts possessed inferior geographic conditions than zamindari districts, summary statistics of our dependent variables in Table 3 reveal that the ryotwari districts had higher agricultural productivity and higher shares of land allocated to the cultivation of non-food crops. Ryotwari districts were also more urbanized throughout and had greater shares of employment in manufacturing and services in the post-independence period. Population density, however, was higher in the zamindari districts for both the pre- and post-independence periods.

IV. Empirical Results

In this section, we present a series of empirical evidence. First, we report in Tables 4-11 the OLS and IV estimates for agricultural productivity, food grain productivity, non-food grain acreage share, urbanization, employment shares in manufacturing and services, and population densities for various years.¹⁸ The Durbin-Wu-Hausman test could not reject the hypothesis that our OLS estimates are consistent.¹⁹ Due to the potential presence of heteroskedasticity, we use t-statistics based on Hubert/White standard errors. Second, we report in Tables 12-13 panel

18 The IV estimates are based on Banerjee and Iyer's (2005) dummy variable instrument where the dummy takes on a value of 0 if the district was annexed prior to 1820 and 1 if the district came under British rule between 1820 and 1856. This IV strategy is based on the belief that the districts annexed after 1820 were predominantly designated as ryotwari due to Munroe's political victory over the Board of Revenue in Madras. However, because many districts were classified as ryotwari areas prior to 1820 for exogenous political reasons, we believe that this instrumental strategy is imperfect at best. The first stage regression is reported in Table 4.

19 See Davidson and MacKinnon (1993).

regressions where standard errors are clustered by district and by province. Finally, in Table 15, we report a panel regression for a sub-sample of districts which share borders.²⁰

A. Agricultural Productivity: Yield per Acre

Although comprehensive agricultural data exist for the British colonial period, there has been considerable debate on their quality. Scholars generally believe that data on acreage are likely to be more reliable than that on output; they also believe that the quality of data is superior in ryotwari than in zamindari areas, especially where tax rates were set on a permanent basis.²¹ Unfortunately, it is extremely difficult, if not impossible, to assess whether the colonial data are flawed and to what extent they are flawed. Guha's (1992) introduction provides an excellent summary of the debate.²²

Blyn's (1969) construction of the agricultural trends for the period 1891-1941 remains the most important work to date. Blyn finds that agricultural productivity in British India declined modestly between 1891 and 1941, but on closer examination, the data reveal that the overall decline is caused by a sharp decline in the productivity of food crops and that the

20 For a list of neighboring districts, see Table 5 of Banerjee and Iyer's (2005) web appendix. Due to data availability, our sample consists of 32 out of 35 districts in Banerjee and Iyer's sample.

21 In ryotwari areas, acreage data were collected by field-to-field inspections of villages by a trained village revenue officer (patwari). By contrast, in permanently settled zamindari areas, the returns were made by a village policeman (chowkidar) who is thought to have been ill-equipped and untrained for field-to-field inspection. From the acreage data, agricultural output was calculated using information on standard yield and seasonal factor. Standard yield was obtained from crop-cutting experiments to be updated every five years; seasonal factors were provided by village revenue officers or policemen but were subject to revision by district and provincial officials. Incentives for under-reporting yields and acreage were likely to have been higher in ryotwari rather than in zamindari areas, especially in places where tax rates were set on a permanent basis.

22 Heston (1973, 1979) questions the reliability of Blyn's (1966) estimates based on his work in Bombay. In that province, official standard yield estimates remained constant between 1897 and 1947 so that the only variation in overall yield came from changes in its seasonal factor. Heston argues that the decline in Bombay's seasonal factor over time is not correlated with that region's rainfall trends. On the other hand, Desai (1953), Mishra (1983), Dasgupta (1981), and Sivasubramonian (2000) generally find evidence in favor of Blyn's estimates. McAlpin (1983), based on her extensive research on Bombay Presidency, believes that agricultural statistics in this province are generally of high quality. Yanagisawa (1996) finds that yields reported in *Season and Crop Reports* for Tamil districts accord well with yield estimates derived from various crop-cutting experiments. Islam (1978) finds official yields reported in Bengal differed modestly from the plot-to-plot enumeration and survey estimates conducted in 1944/45. Unlike our study, however, none of these studies examines whether agricultural productivity at the district level correlates well with climate and geographic attributes.

productivity of non-food crops actually rose over this period. Yet, data indicate only a minor substitution in acreage from food to non-food crops. At the provincial level, Blyn finds that agricultural productivity declined in Greater Bengal, rose in places like Punjab, and remained constant in most other provinces.

We use the official statistics to construct similar data on agricultural productivity but at the district rather than at the provincial level for 1901 and 1931.²³ Because data reported at the district level are less systematic and comprehensive than at the provincial level, our district level productivity estimates are likely to be less accurate than Blyn's provincial estimates. District acreage data are most comprehensive; yield data on non-food crops are least comprehensive due to numerous missing data. In general, when we aggregate our district level productivity and acreage estimates to the provincial level, our estimates compare reasonably well with those of Blyn (see Appendix I).

The regression estimates for total agricultural productivity presented in Tables 5 and 6 indicate a fluctuating pattern. In 1901, the productivity between ryotwari and zamindari districts was relatively similar but it diverged in 1931 as agricultural productivity became 22% higher in ryotwari districts.²⁴ In the early post-independence period between 1958 and 1961, however, agricultural productivity between the two types of districts converged again. But since 1961, the annual regressions reported in Table 6 show that agricultural productivity in ryotwari districts diverged again and that the extent of the divergence seems to have accelerated after 1965 with

23 We construct data on agricultural productivity (yield per acre) using the following crops. For food grains, crops include rice, wheat, barley, jowar (sorghum), bajra (pearl millet), maize, ragi (finger millet), gram (chickpea), and other food grains including pulses; for non-food grains, they include linseed, sesamum, rape, mustard, groundnut, sugarcane, tea, coffee, tobacco, cotton, and jute. For the pre-independence period, we use 1924/25-1928/29 crop prices from Blyn (1966) to obtain the value of aggregate agricultural output; for the post-independence period, we use contemporaneous prices. See Appendix I for more detail.

24 Blyn (1966) discusses the various determinants of colonial agricultural productivity such as the composition of crops, water supply - irrigation and rainfall, double cropping, soil conditions, technology - improved seeds, education, implements, and labor.

the advent of the Green Revolution. In 1961, ryotwari districts had 13% higher agricultural productivity whereas, in 1981, the figure rose to 26%. When we examine food grain productivity in Table 7, the data exhibit similar patterns as the overall agricultural productivity.

Table 8 reports the regression estimates on the share of acreage devoted to non-food grain crops. In the pre-independence period, we find that ryotwari areas had about 33% higher proportion of their area cultivated under non-food grains in 1901-02 and that this difference increased to 57% in 1931-32.²⁵ Thus, there seems to be considerable evidence that ryotwari areas were responding faster to the commercialization of agriculture and shifting their production toward non-food cash crops which were generally more productive.²⁶ In the post-independence period, however, the differences in acreage devoted to non-food grain between zamindari and ryotwari districts seem to have narrowed over time.

Geography was very important for agricultural productivity in both the pre- and post-independence periods. We find that districts with alluvial or red soils were more productive than those with black soil; districts with higher rainfall were also more productive in food crops, especially in the pre-independence period. Latitude and altitude were negatively correlated, but statistically insignificant. Districts located near the coast were more productive perhaps because

25 Blyn (1966, p.180-181) addresses the impact of crop composition on overall productivity: "Since nonfoodgrain yield per acre is generally higher in value than that of food-grains, a progressive increase in the proportion of cropland in nonfoodgrains would tend to raise all-crop yield per acre."

26 Due to differing geographic conditions, the share of non-food crops grown in non-landlord and landlord regions may differ. If the composition of crops differs, then the variations in acreage devoted to non-food grain may be accounted for by differences in the prices of these crops. We believe that the price variations are unlikely to explain the concentration of food crops in landlord areas. Islam (1978) finds that in Bengal, where most districts were landlord based, the price elasticity of acreage under cultivation was extremely low. A more interesting case study is presented by Baker's (1984) study of Tamilnad. In this region, the valleys were controlled by mirasidars whereas the plains were inhabited by both zamindars and ryotwars. The expansion in acreage towards non-food cash crops was most extensive in the plains whereas the valleys continued to concentrate their cultivation in paddy rice. These trends persisted even when the price of rice fell and prices of non-food crops increased. Baker argues that the zamindars lost considerable power over their tenants with the shift in cultivation into cash crops as transactions moved from zamindar's estate office to cash-crop markets. Baker (1984, p. 219) writes: "Those large landholders who were excessively distanced from cultivation were unable to profit; 'estate mirasidars' in the valleys and zamindars in the plains actively resented the growth of commercial cropping because it loosened their remaining grip on their prospering subordinates and on the products of agriculture."

higher moisture levels in coastal districts facilitate the breakdown of organic soil matter into minerals that support plant growth.

Geographic factors also influenced the distribution of acreage between food and non-food crops. The share of non-grain acreage was higher in districts with lower rainfall and higher altitude throughout; it was also higher in districts with great black and red soils in the pre-independence period. Food grains rather than non-food grains are grown in high rainfall areas and non-food crops such as tea are grown in higher altitude locations. Moreover, important non-food crops like cotton are intensive in black soil.

B. Urbanization

The definition of an urban area changed markedly between the pre- and the post-independence periods.²⁷ But, unlike the agricultural data, there seems to be little controversy concerning the quality of the urban data. In the pre-independence period, urbanization levels were low but rose slightly over time; in the post-independence period, urbanization rates rose more significantly. In 1901 and 1941, the shares of urban population in India were 9.4% and 12.8% respectively; 1961 and 1991, using the revised urban definition, they were 14.0 and 22.1%, respectively.²⁸

²⁷ In the pre-independence period between 1901-1951, an urban area was defined as a town if it met one of the following criteria: (1) every municipality regardless of size, (2) a civil line not within municipal limits, (3) places 5,000 persons or more which the Provincial Superintendent decides to treat as a town, or (4) places under 5,000 persons which the Provincial Superintendent decides to treat as a town. However, Davis (1951) argues that towns with population less than 5,000 accounted for no more than 4-7% of the total urban population. In post-independence India, the definition of an urban area changed from decade to decade making comparisons of aggregate urban levels over time very difficult. However the new definition was more uniformly applied across the Indian provinces and conformed more closely to the definition of an urban area. In general, an area was considered a town if it met the following conditions: (1) a density of not less than 1000 per square mile, (2) population of at least 5000, (3) three-fourths of the occupations of the working population should be outside of agriculture, and (4) at the discretion of the Superintendent of the State, the place should have a few pronounced urban characteristics and amenities such as newly founded industrial areas, large housing settlements, or places of tourist importance, and other civic amenities. See Bose (1973).

²⁸ For all of India, urbanization rates for 1901, 1941, 1961, and 1991 were 10.8, 13.8, 18.0, and 25.7%, respectively (www.censusindia.net). In Tamilnad, Baker (1984) believes that urban data became more reliable after 1901. He finds four different patterns of urban development during the colonial period: in 1871-1891, the most important

We find that ryotwari districts were significantly more urbanized between 1901 and 1941 (Table 9). In 1921, ryotwari districts were 47% more urbanized than zamindari districts; in 1941, the figure was 40%. Despite the major changes in the definition of an urban area between the two periods, the regression estimates for the post-independence period are very similar to those of the pre-independence period. The OLS estimates indicate that the ryotwari districts have a 28% higher proportion of urban population in 1961 and 1981 and about 24% higher in 1991. We also find that districts with higher rainfall were less likely to be urban whereas districts with alluvial soil were more likely to be urban.²⁹ Districts in coastal locations were not significantly more urban since, despite possessing extensive miles of sea coasts, India is not endowed with good natural harbors.³⁰

The regression results presented in Tables 10 and 11 suggest that, at least for the post-independence period, ryotwari areas were more urbanized than zamindari areas because they have higher shares of employment in manufacturing and services than zamindari districts. In manufacturing employment, ryotwari districts had 57%, 45%, and 50% in 1961, 1971, and 1981 respectively, but the figure dropped to 9% in 1991. Also, ryotwari regions had 22-27% higher share of service employment than zamindari districts for the period between 1961-1991.

C. Population Density

For both the pre- and post-independence periods, the data exhibit little systematic relationship between population density and land tenures (Table 12). Even though ryotwari districts exhibited stronger economic outcomes, especially in the post-independence period,

factor for town development was the government; in 1891-1911, they were cash-cropping and marketing; in 1911-1931, commercial cropping; and in 1931-1951, industrial growth.

²⁹ The potential negative influence of rain on urbanization was mentioned in the 1931 census report (see Bose (1973, p.52)).

³⁰ Davis (1951, 12) writes: "These coasts, lying mostly in the torrid zone, are practically devoid of natural harbors. For much of their distance they are blocked by coastal islands and mangrove swamps. 'The whole is storm-swept and scourged by fierce currents; there are hundreds of miles of bare rock-wall in the western half and of mangrove-swamp in the eastern; the river harbours are amongst the most dangerous and expensive in the world...'"

population density was no greater for ryotwari districts for the entire period between 1901 and 1991. On the other hand, the data indicate that geographic factors were very important determinants of population density. Population density was higher in districts with lower altitudes, higher latitudes, alluvial and black soil. However, rainfall and coastal locations were not correlated with population density.³¹

D. Length of British Rule

The length of the British rule is negatively correlated with all our dependent variables indicating that the longevity of British rule in a district had a negative impact on its economic performance. While the coefficient on the length of British rule is statistically insignificant in many specifications, it is significant for population density, employment shares in services, agricultural productivity and food grain productivity. Since institutional stability is likely to be correlated with longevity of rule, this negative correlation suggests that British institutions did not have their intended effects. Indeed, agricultural productivity and industrial development remained stagnant during the British colonial period (Blyn (1966), Gadgil (1972), Roy (2000)). Despite the introduction of private property rights and a formal judicial system in India, differences in the race and culture of government officials and their subjects may have created poor incentives for the implementation of policies favorable for long-run development.³²

31 It is interesting to note that many scholars such as Blyn (1966, p.134) attribute the geographic variation in population density to variations in rainfall. Surprisingly, at least by the twentieth century, we find little evidence that higher rainfall contributed to higher population density in India.

32 Iyer (2004) finds that the “native states” which were under the administration of Indian rulers during the British colonial period had significantly higher investments in public goods such as schools, roads, and health centers than those annexed by the British in the post-independence period. She attributes these differences to the differences in the incentives faced by British administrators and native rulers. British colonial public investments in India were very low as well. Davis and Huttenback (1988, p. 101) write: “When all is said and done, [British] India spent on public works at a lower rate than the underdeveloped countries, and at a level similar to the Princely States. Moreover, unlike the other sectors, where expenditures rose over time, in India they peaked in the early 1880s and declined thereafter. As a percentage of the government’s budget, the Indian average was one-quarter higher than the figure for the underdeveloped countries, but only two-thirds of the average of the Princely States. Inclusion of railroads raises the Indian levels substantially. The same adjustment, however, pushes the foreign underdeveloped indices upward as well, and India’s relative position changes but little.”

E. OLS Versus IV Estimates

In a majority of cases, the OLS and IV estimates generally give similar results. In a number of instances, however, the two estimates differ. The differences are most notable for pre-independence regressions of agricultural productivity, food-grain productivity, and urbanization. Why do these estimates differ? The main reason may be that the IV instrument is not a particularly good one. The Banerjee and Iyer's instrument assigns a value of 0 if the district came under British rule prior to 1820 and 1 if it came after. However, as shown in Appendix II, there were 49 districts which were annexed prior to 1820 that were designated as ryotwari rather than zamindari areas by British administrators. Most of these districts were in Madras and Bombay. On the other hand, only one district was classified as zamindari but were annexed after 1820. These differences may be the source of IV inefficiency.

Because of the early influence of Alexander Read and Thomas Munro in Madras, many districts in this region adopted the ryotwari system even before 1820. There is considerable evidence that the ryotwari system developed by Read in 1792 and extended by Munro was not indigenous. Under the native Tipu Sultan, the land revenue system was based on tax-farming. Tipu Sultan leased extensive tracts of land to amildars who employed patels or headman to collect revenue preferably in shares (half of the produce). Mukherjee (1962) believes that Read invented the ryotwari system to eliminate the abuses of amildars and patels. Tax-farming based on share-cropping was likely to have been highly inefficient and Read and Munro probably realized that direct assessment of taxes on cultivators would improve both the incentives and conditions of cultivators. However, the development of the ryotwari system faced great resistance from other administrators. Read's territory was converted to a zamindari system when he was forced to resign and return to England; Munro's territory was re-organized under a

village-lease system when he also returned to England. In the end, the decision to restore the ryotwari system in Madras came from the Court of Directors in England. The Directors, greatly impressed by Munro's opinion and knowledge, pressed local administrators to restore the ryotwari system over their objections between 1814 and 1827 (Mukherjee (1962)). In Bombay, Stokes (1959) and Kumar (1968) argue that the ryotwari system spread as a product of a change in official British ideology, but Charlesworth (1985) suggests that local conditions also played an important role.

F. Robustness

Table 13 presents OLS panel regressions with year fixed-effects and standard errors adjusted for within-district correlation. We find that the ryotwari coefficient is positively significant for every dependent variable except for population density. When we cluster the standard errors by province, however, the level of significance declines somewhat (Table 14). Finally, when we examine the restricted sample of districts which share borders, the non-landlord coefficient is no longer significant except for food grain productivity which is significant at the 13% level (Table 15). While the results of the restricted sample are troubling, we believe that the neighboring district sample is not randomly generated. Because tenants' bargaining power increases with greater outside options, tenants in landlord districts that border non-landlord districts are likely to have greater bargaining power. Thus, landlord districts that border non-landlord districts may exhibit less systematic variation in their economies.

IV. Conclusion

In this paper, we examine the impact of British colonial institutions on the regional economic development of India. In particular, we study the impact of two differing types of land

tax and property rights systems imposed in colonial British India. In the zamindari areas, property rights in land and taxes were assigned to zamindars who, in turn, set and collected taxes from cultivators; in the ryotwari areas, however, the property rights and taxes were assigned directly to those who cultivated the land. Whereas Banerjee and Iyer (2005) examine the impact of what they call “institutional overhang” for the post-independence period, we investigate the impact of these institutions for the pre- and post-independence periods using a variety of measures of development.

Except for agricultural productivity and population density, we find that non-landlord areas seem to have outperformed landlord areas between 1901 and 1991. Non-landlord areas were more specialized in non-food crops which were likely to be more productive; non-landlord areas were also more urbanized than landlord areas. For the post-independence period for which the data are available, we find that non-landlord areas had greater shares of employment in manufacturing and services. In agricultural productivity, the patterns fluctuated over time. In 1901, agricultural productivities of these areas were similar, but diverged in 1931. There is evidence of convergence between 1958-1961, but of divergence after 1961, and as shown in Banerjee and Iyer (2005), the divergence became more pronounced after 1965 with the advent of the Green Revolution. On the other hand, after controlling for geographic characteristics, land tenure systems had little impact on population density.

Due to the limitations of data, it is extremely difficult to determine the causes of divergence between zamindari and ryotwari districts. However, because the political and economic conditions differed considerably between the pre- and post-independence periods, the examination of these two periods is likely to shed additional insights on the causes of divergence between these regions. In particular, Banerjee and Iyer’s (2005) emphasis on the role of

collective action costs and the importance of investments caused by the Green Revolution are unlikely to be important for the pre-independence period.

Among the potential causes of divergence outlined in our introduction, we believe that the most likely cause of divergence in the economies of zamindari and ryotwari areas are likely to be related to agency costs and uncertainty in property rights. The fluctuations in agricultural productivities between zamindari and ryotwari regions may, in part, be explained by the changing bargaining power of zamindars and tenants. In the early years of the colonial period, when the British government typically intervened in favor of zamindars, agricultural productivity of zamindari areas may have been similar to ryotwari areas as zamindars extracted significant levels of effort and rents from tenants through close monitoring, threat of eviction and extra-legal physical coercion.³³ As reforms were implemented to protect the rights of tenants, however, agency costs may have risen toward the latter period of British colonial rule leading to a relative decline in agricultural productivity in zamindari areas.³⁴ Ironically, in the early years of the post-independence period, agricultural productivity of these regions may have converged as zamindars re-acquired significant bargaining power over tenants in the new national government.³⁵ But as land reforms became more binding over time, the agricultural productivity

33 See Chatterjee (1984), Chaudhari (1984), Bose (1987), Shukla (1993), and Nakazato (1994). For differing views, see Ray (1979) and Panda (1996). Also see Stokes (1978) and Ludden (1984).

34 Chaudhuri (1984) argues that rent reforms in Bengal, which restricted the ability of landlords to increase rents, contributed to lower levels of investments in the 1930s. Baker (1984) argues that landlords lost considerable bargaining power over their tenants during the first half of the twentieth century in Tamilnad. Yanagisawa (1996) also finds a gradual deterioration in the dominance of land ownership by members of higher castes in this region over time.

35 Appu (1975) examines the post-independence tenancy legislations in detail. The First Plan of the Indian National Congress proposed ceiling limits on ownership by landlords with the idea that surplus land be given to tenants. The enactment of these reforms, however, was left to state discretion and was voluntary. Subsequent Second and Third Five Year Plans attempted to improve on the first plan, but these reforms were generally seen as failures. During this period, it appears that landlords had great discretion in their ability to evict tenants at will. Insecurity of property rights, however, probably contributed to the failure to invest in new crop varieties. Fourth Five Year Plan reports: "It has been observed that under the present arrangement of informal tenancy and share-cropping, the landlord considers it unwise to invest in improving his land; likewise, the share-cropper or the tenant is either unable or reluctant to invest in inputs like fertilisers. The insecurity of tenancy has not only impeded the widespread adoption

of zamindari districts may have fallen relative to ryotwari districts as the increased bargaining position of tenants led to their reduced efforts.³⁶

We also believe that greater uncertainty in property rights in zamindari areas contributed to lower levels of agricultural investments and were likely factors responsible for the concentration of their agriculture in food crops, especially in paddy rice. Since a switch from food to non-food crops involves significant new investments in technology and a change in the organization of production, zamindars may have been less willing to take on such a venture when their property rights status was more uncertain. In addition, a switch from traditional paddy rice to non-food crops probably increased the monitoring costs of tenants.³⁷ While it is difficult to assess the importance of property rights uncertainty, peasant revolts and tenancy reforms are testaments to the perceived illegitimacy of zamindari property rights. Because the proprietary rights given to zamindars by the British colonial government differed markedly from tradition and history, these rights never attained full social legitimacy.

Economic development in landlord areas was likely to have been hindered as landlords had incentives to reduce the economic mobility of tenants and laborers in landlord regions. As shown in Banerjee et. al. (2002), a zamindar's bargaining power over tenants increased as

of the high-yielding varieties but in some cases led to social and agrarian tensions (Appu (1975, p. 1347))." Also see Frankel and Rao (1989, 1990), Brass (1994), Brown (1994) and Frankel (2005).

³⁶ Besley and Burgess (2000) find that tenancy reforms in post-independence India between 1958 and 1992 lowered poverty levels but did so at the expense of efficiency. They find that land reforms lowered agricultural productivity and they believe that this decline was likely caused by a fall in bargaining power of landlords over tenants due to tenancy reforms. Boyce (1987) argues that tenancy reforms also lowered landlord investments in irrigation. Because irrigation was an important complement to investments in new technology, he believes that tenancy reforms hindered the adoption of new agricultural technologies in the historically landlord areas. On the other hand, Banerjee et. al. (2002) find that tenancy reform implemented in West Bengal in the late 1970s were associated with an increase in rice yields between 1984 and 1993.

³⁷ The valleys in Tamilnad, according to Baker (1984, 170-172), were concentrated in paddy rice and were controlled by landlords who used sharecropping or a system of tied labor (indenture) arrangements to cultivate the land. Baker argues that the optimal scale of paddy rice under flush irrigation was about 1-4 acres involving one plough-team consisting of two men and two buffaloes or cattle. Landlords carefully controlled and monitored the growing of crops and restricted the cultivation of crops which depleted the soil. Because paddy rice involved the inundation of fields, it was difficult to complement paddy rice with other crops, especially those requiring good drainage conditions.

outside options of tenants declined. Given these incentives, it is not surprising that zamindari regions were much less urbanized than ryotwari regions as cities often provided alternative forms of employment for tenants. Landlords also had little incentives to foster the geographic mobility of tenants and laborers as their immobility lowered their bargaining position. While reasons as to why geographic mobility remained extremely low in India are complex, our findings on population density indicate little geographic movement from poorly performing zamindari districts to the more productive ryotwari districts.³⁸

The British colonial institutions imposed in India have had a profound impact on its development. In zamindari areas, where the British government gave proprietary rights to few landlords, political and legal institutions were used for the benefit of the few as compared to ryotwari areas where property rights were given to cultivators. These differences led to a significant divergence in their economies. Yet, the impact of British colonial institutions in India goes beyond the important issue of land tenures. Even in ryotwari areas, where property rights were granted to cultivators and were enforced by a formal judicial system, the record of economic progress remained bleak for centuries. Why the introduction of western institutions in India, which eventually led to the adoption of democratic institutions after its independence, did not contribute to economic development for such a long time remains a puzzle to be explored.³⁹

38 Collins (1999) finds little evidence of labor mobility in late nineteenth century India. Despite the fact that transportation improvements may have led to regional convergence in prices, Collins finds little evidence of corresponding regional wage convergence at the district level. Also see Munshi and Rosenzweig (2005).

39 It is beyond the scope of this paper to review the enormous literature on the impact of British colonialism on Indian economic development. We refer the reader to Roy (2000, 2002) for references and perspectives on this subject.

Appendix I: Pre-independence Agricultural Productivity and Acreage Estimates

We construct data on agricultural productivity and acreage at the district level for the pre-independence period (1901-1902, 1931-1932) using official published government documents: *Agricultural Statistics of India* and *Season & Crop Reports*.

We consider a major subset of crops produced in India. This subset currently occupies more than two thirds of the total output value from the crop sector and more than a half of the total output from agriculture. In terms of acreage, these crops account for almost 80-90% of total cultivation. As in Blyn (1966), the crops are divided into two categories: *food grains and non-food grains*. The food grain crops include rice wheat, barley, jowar (sorghum), bajra (pearl millet), maize, ragi (finger millet), gram (chickpea), other food grains including pulses; non-food grains include linseed, sesamum, rape and mustard, groundnut, sugarcane, tea, coffee, tobacco, cotton, and jute. For most of these crops, sufficient and continuous data are available for our period of study.

Prices in pounds per acre for various crops were derived from prices per ton figures from Blyn (1966). These prices are weighted averages of the provincial harvest prices during 1924/25-28/29 for different crops with weights proportional to the area under the crop in the individual provinces. Prices during this period were fairly stable and free from unusual influence of wars or foreign trade conditions. District level crop prices are difficult to construct due to numerous missing and unreported data.

A *Agricultural Productivity*

Agricultural productivity (rupees per acre) is measured as total output in rupees divided by total cultivated area in acres. The calculation for a given district of aggregate agricultural productivity is based on the following formula: $Agricultural\ Productivity = \sum_j (\text{Yield in pounds per acre of crop } j) * (\text{Price in pounds per acre of crop } j) * (\text{Area sown under the crop } j / \text{Total area sown in the district aggregated over all crops in the district})$.

Although yield information is available for most crops, we encountered many challenges in constructing district level agricultural productivity. We refer the reader to Blyn (1966) who faced similar challenges for the construction of output and productivity data at the provincial level. We outline some of the problems: (1) In aggregating the yield of irrigated and un-irrigated areas, the corresponding proportion of irrigated and un-irrigated acreage data for some of the crops were not reported. In these cases, we used the proportion of the total irrigated and un-irrigated sown area in the district as weights. (2) In aggregating the yield of broadcast and transplanted rice, the corresponding acreage shares under the two kinds of rice were not reported. We used a simple arithmetic average of the two kinds of rice yields to get an average yield of rice. (3) In aggregating the yield for crops classified as Bhadoi, Kharif and Rabi crops (autumn, winter and summer crops), we used the acreage share under each category from the *Season and Crop Report*; (4) For some of the crops such as tea, coffee, tobacco and groundnut, where many yield figures at the district level were missing, we used the respective national averages calculated by Sivasubramonian (1960); (5) In a small number of cases, the yield values were approximated using information from neighboring years and districts.

For 1931, we provide a comparison of our agricultural productivity estimates with those of Blyn. To make the comparison comparable, we aggregated our values from the district to the provincial level. It is important to note, however, that our province definition does not match completely with those of Blyn. For Bengal, Blyn's definition also includes present day Bangladesh; for Bombay, Blyn's definition includes Sind; for Punjab, Blyn includes Delhi and the Northwest Frontier province. For Madras, Central Province, and Bombay, our definition overlaps closely with those of Blyn's. In addition, there are a few differences in our coverage of crops from that of Blyn. Unlike Blyn, we include coffee and other food-grains but exclude indigo. Data are in rupees per acre.

Agricultural Productivity, 1931

Province	Our's	Blyn's
Bengal	73.1	64.5
Bombay	37.2	50.0
Central Provinces	32.2	32.8
Madras	66.2	65.3
Punjab	39.3	51.7
United Province	50.9	59.5

B. Agricultural Acreage

Whereas agricultural productivity estimates are based on 18 major crops, data on acreage are based on all crops and are much more comprehensive and reliable. We compare our acreage data with those of Blyn in the table below. Data are in million acres.

Acreage, 1901 Province	All Crops		Food Crops		Non-Food Crops	
	Our's	Blyn's	Our's	Blyn's	Our's	Blyn's
Bengal	41.1	49.0	34.6	41.9	6.5	7.1
Bombay	19.7	22.8	18.4	18.7	1.2	4.1
Central Provinces	20.0	19.0	15.0	13.6	5.0	5.4
Madras	28.2	26.1	23.3	22.5	4.9	3.6
Punjab	7.1	17.2	4.1	14.8	3.1	2.4
United Province	41.8	36.2	30.2	36.5	5.3	5.8

Acreage, 1931 Province	All Crops		Food Crops		Non-Food Crops	
	Our's	Blyn's	Our's	Blyn's	Our's	Blyn's
Bengal	36.5	48.9	32.0	43.3	4.5	5.6
Bombay	29.1	26.5	19.9	20.4	9.2	6.1
Central Provinces	24.2	21.2	17.8	14.9	6.4	6.3
Madras	32.0	27.6	24.6	21.6	7.4	6.0
Punjab	10.5	26.9	7.6	22.7	2.9	4.2
United Province	42.0	38.7	37.2	31.2	4.9	7.5

Appendix II: Differences in Land Tenure Status Between the OLS and IV Specifications

A. List of districts that were assigned as ryotwari prior to 1820

Bombay Province

Ahmadabad, Ahmadnagar, Belgaum, Bijapur, Broach, Dharwar, Kaira, Kanara, Khandesh, Kolaba, Nasik, Pancha Mahals, Poona, Ratnagiri, Satara, Sholapur, Surat, Thana

Madras Province

Anantapur, Bellary, Chingleput, Coimbatore, Cuddapah, Godavari, Kistna, Nellore, Nilgiris, North Arcot, Pudukottai, Salem, South Arcot, South Kanara, Tanjore, Tinnevely, Trichinopoly

Northwest Province

Agra, Azamgarh, Ballia, Basti, Farukhabad, Gorakhpur, Hamirpur, Kumaon, Mainpuri, Mathura, Muzaffarnagar, Saharanpur

Punjab Province

Hisar

B. List of districts that were assigned zamindari after 1820

Punjab Province

Ferozpur

Note: For this table, a district was defined as a ryotwari district if more than half of the district came ryotwari organization. Banerjee and Iyer's (2005) instrument takes on a value of 1 (ryotwari) if the area came under British rule between 1820 and 1856 and zero (zamindari) otherwise.

Table 1**Geographic Distribution of Land-Tenure Systems in Colonial India**

Type of Tenure	Percentage	Province where it was prevalent
Zamindari (landlord)	57%	Bengal, Bihar & Orissa, parts of Madras and United Province
Ryotwari (cultivator)		
ryotwari	38%	Madras, Bombay & Assam, parts of Central Province
mahalwari	5%	Punjab, parts of Central Province and Orissa

Sources: Banerjee and Iyer (2005); Baden-Powell (1892).

Table 2**Summary Statistics of Geographic Variables: Mean values (standard deviation)**

	All Districts	Zamindari	Ryotwari	Differences
Latitude	21.99 (5.9)	23.80	20.44	3.28*
Altitude	433.77 (522.3)	327.7	523.58	-161.37*
Rainfall (mm)	1225.35 (436.8)	1346.0	1123.1	191.42*
Coastal dummy	0.18 (0.39)	0.13	0.24	-0.17*
Black soil dummy	0.21 (0.41)	0.13	0.27	-0.16*
Alluvial soil dummy	0.57 (0.50)	0.58	0.56	0.05
Red soil dummy	0.17 (0.38)	0.24	0.12	0.08

Note: *Difference in means between zamindari and ryotwari districts significant at 5% level. Latitude is degrees North; altitude is meters above sea level; rainfall is the 30 year average of mean annual rainfall between 1930 and 1961. For this table, a district is considered as zamindari if the percentage of land tenures in the district organized as zamindari was greater than 50%.

Table 3

Summary Statistics of Dependent Variables: Mean values

	1901	1911	1921	1931	1941	1961	1971	1981	1991
Agricultural Productivity									
All Districts	54.76	-	-	56.57	-	147.44	-	844.72	-
Zamindari	51.97	-	-	54.35	-	146.97	-	831.48	-
Ryotwari	57.12	-	-	58.37	-	147.57	-	848.29	-
<i>Difference</i>	-5.13	-	-	-4.02	-	-19.47	-	160.44*	-
Non-Food Acreage (%)									
All Districts	18.7	-	-	19.7	-	19.0	-	20.0	-
Zamindari	15.0	-	-	14.0	-	14.0	-	15.0	-
Ryotwari	22.0	-	-	24.0	-	22.0	-	24.0	-
<i>Difference</i>	-7.0*	-	-	-10.5*	-	-8.0*	-	9.0*	-
Urbanization (%)									
All Districts	9.7	11.5	11.2	13.6	14.0	16.0	17.4	20.3	22.1
Zamindari	5.0	9.0	8.0	9.0	13.0	13.0	14.0	20.0	19.0
Ryotwari	13.3	14.0	13.8	14.0	17.0	19.0	17.0	23.0	25.0
<i>Difference</i>	-8.0*	-5.0*	-5.8*	-5.0*	-4.0*	-6.0*	-6.0*	-5.8*	-6.0*
Manufacturing Empl. (%)									
All Districts	-	-	-	-	-	3.5	4.4	6.0	10.7
Zamindari	-	-	-	-	-	3.0	3.0	4.0	9.0
Ryotwari	-	-	-	-	-	4.0	5.0	7.0	11.0
<i>Difference</i>	-	-	-	-	-	-1.4*	-2.3*	-2.3*	-2.3*
Services Empl. (%)									
All Districts	-	-	-	-	-	15.6	14.5	14.8	18.6
Zamindari	-	-	-	-	-	15.0	13.0	13.0	17.0
Ryotwari	-	-	-	-	-	17.0	16.0	16.0	20.0
<i>Difference</i>	-	-	-	-	-	-1.9	-2.7*	-2.7*	-3.4*
Population Density									
All Districts	402.7	351.8	343.5	385.4	441.3	569.1	693.1	858.0	1141.1
Zamindari	407.2	404.0	387.2	409.9	491.4	627.8	765.6	950.7	1296.9
Ryotwari	395.3	304.1	302.5	357.3	394.3	507.5	617.0	760.7	968.3
<i>Difference</i>	11.6*	100.0*	84.7	52.6	97.1	120.2*	148.5*	189.0*	328.6*

Note: *Difference in means between zamindari and ryotwari districts significant at 5% level. Agricultural productivity is measured in rupees per acre. Population density is persons per square miles. The number of observations generally ranged from 124 to 141 districts, except for the 1901 urbanization data which contain only 32 observations.

Table 4**First Stage Results of Instrumental Variable (IV) Estimation**Dependent Variable: *Ryotwari*

Instrument (=1 if district conquered between 1820 and 1856)	0.477*** (4.70)	0.476*** (3.95)	0.521*** (4.67)
Length of British Rule	No	Yes	Yes
Geographic Controls	No	No	No
Observations	125	125	125
R-squared	0.1524	0.1525	0.3640

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 5**Agricultural Productivity, 1901-1981**

	1901 (OLS)	1901 (IV)	1931 (OLS)	1931 (IV)	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)
Ryotwari	8.42 (1.44)	-10.82 (0.55)	12.81** (2.40)	-7.92 (0.93)	12.14 (1.08)	50.54 (1.55)	69.50* (2.06)	242.9** (2.10)	223.2** (2.45)	495.47* (1.89)
Length of British Rule	-0.15 (1.78)	-0.12 (1.57)	-0.11 (1.69)	-0.06 (0.89)	-0.60** (2.86)	-0.71*** (2.68)	-1.70*** (2.80)	-2.19*** (2.82)	-3.16** (2.12)	-3.93** (2.33)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	115	118	118	105	105	105	105	105	105
R-squared	0.224	0.190	0.278	0.178	0.477	0.437	0.388	0.262	0.392	0.337

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses. Agricultural productivity is in rupees per acre. For 1901-1931, we use 1924-25 and 1928-1929 prices from Blyn (1966); for 1961-1981, we use contemporaneous prices.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 6

Annual Post-Independence Agricultural Productivity, 1958-1965

	1958 (OLS)	1958 (IV)	1959 (OLS)	1959 (IV)	1960 (OLS)	1960 (IV)	1961 (OLS)	1961 (IV)	1962 (OLS)	1962 (IV)
Ryotwari	4.30 (0.45)	32.69 (1.17)	11.04 (1.05)	62.19* (2.26)	15.65 (1.28)	44.12 (1.34)	12.15 (1.08)	50.54 (1.55)	17.40 (1.38)	77.75* (2.11)
Length of British Rule	-0.55*** (-2.90)	-0.63*** (-2.97)	-0.71*** (-3.54)	-0.85*** (-3.61)	-0.68*** (-2.75)	-0.76*** (-2.78)	0.60** (2.86)	-0.71*** (2.68)	-0.92*** (-3.65)	-1.09*** (-3.39)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	105	105	105	105	105	105	105	105	105	105
R-squared	0.393	0.356	0.488	0.393	0.401	0.378	0.477	0.437	0.438	0.347

	1963 (OLS)	1963 (IV)	1964 (OLS)	1964 (IV)	1965 (OLS)	1965 (IV)
Ryotwari	33.61* (1.94)	114.75** (2.22)	33.98 (1.63)	31.11 (0.55)	49.63** (2.43)	87.26 (1.29)
Length of British Rule	-1.21*** (-3.69)	-1.44*** (-3.49)	-1.13*** (-2.87)	-1.13*** (-2.63)	-1.52*** (-4.13)	-1.62*** (-3.87)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes
Observations	105	105	105	105	105	105
R-squared	0.419	0.319	0.334	0.334	0.485	0.471

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses. These regressions contain the same set of independent variables as Table 4.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 7**Food Grain Productivity, 1901-1981**

	1901 (OLS)	1901 (IV)	1931 (OLS)	1931 (IV)	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)
Ryotwari	0.48 (0.14)	0.96 (0.09)	4.34 (1.74)	-6.22 (1.11)	9.07 (0.94)	111.53* (2.81)	39.49 (1.27)	340.72** (2.47)	131.7 (1.83)	777.62*** (2.61)
Length of British Rule	-0.12** (1.74)	-0.12* (1.86)	-0.01 (0.25)	0.02 (0.31)	-0.30 (1.66)	-0.59* (2.32)	-0.90 (1.61)	-1.76*** (2.28)	-1.07 (0.82)	-2.91 (1.65)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116	116	118	118	105	105	105	105	105	105
R-squared	0.436	0.435	0.521	0.456	0.508	0.212	0.342	-	0.370	0.004

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses. Food grain productivity is in rupees per acre. For 1901-1931, we use 1924-25 and 1928-1929 prices from Blyn (1966); for 1961-1981, we use contemporaneous prices.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 8**Non-Food Grain Acreage Share, 1901-1981**

	1901 (OLS)	1901 (IV)	1931 (OLS)	1931 (IV)	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)
Ryotwari	6.06** (2.21)	34.0*** (3.21)	11.26*** (3.58)	23.47*** (3.28)	7.13* (2.47)	15.76 (1.73)	5.88* (1.94)	15.22 (1.66)	4.99 (1.61)	7.08 (0.74)
Length of British Rule	-0.02 (0.61)	-0.09 (1.75)	-0.02 (0.48)	-0.15 (1.20)	-0.02 (0.53)	-0.05 (1.04)	-0.02 (0.56)	-0.05 (1.11)	-0.05 (1.24)	-0.06 (1.51)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	117	117	116	116	105	105	105	105	105	105
R-squared	0.331	-	0.487	0.392	0.385	0.329	0.378	0.316	0.293	0.290

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 9**Urbanization, 1901-1991**

	1901 (OLS)	1901 (IV)	1911 (OLS)	1911 (IV)	1921 (OLS)	1921 (IV)	1931 (OLS)	1931 (IV)	1941 (OLS)	1941 (IV)
Ryotwari	10.64* (2.28)	105.8 (0.66)	8.00* (2.98)	-9.13 (0.82)	5.31*** (2.96)	-0.98 (0.22)	3.02 (1.21)	-1.50 (0.31)	5.53** (2.26)	1.60 (0.28)
Length of British Rule	-0.03 (0.59)	-0.40 (0.65)	0.007 (0.12)	0.05 (0.55)	-0.04 (1.46)	-0.03 (0.74)	-0.02 (0.67)	-0.01 (0.23)	-0.03 (0.95)	-0.03 (0.69)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31	31	122	122	121	121	121	121	113	113
R-squared	0.581	-	0.141	-	0.235	0.153	0.198	0.164	0.223	0.201

	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)	1991 (OLS)	1991 (IV)
Ryotwari	4.46* (1.56)	6.86 (1.14)	4.87* (1.61)	7.51 (1.22)	5.46* (1.74)	7.20 (1.11)	5.54* (1.66)	7.20 (0.98)
Length of British Rule	-0.02 (0.51)	-0.03 (0.63)	-0.03 (0.75)	-0.04 (0.85)	-0.04 (0.99)	-0.05 (0.99)	-0.03 (0.58)	-0.04 (0.60)
Geographic Controls ⁺	Yes							
Observations	124	124	124	124	124	124	125	125
R-squared	0.188	0.182	0.201	0.194	0.183	0.180	0.162	0.160

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 10**Manufacturing Employment Share, 1961-1991**

	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)	1991 (OLS)	1991 (IV)
Ryotwari	1.76* (2.05)	4.15* (2.10)	2.47* (2.57)	4.54 (1.94)	3.03* (2.76)	5.29* (2.05)	2.06 (1.24)	5.31 (1.55)
Length of British Rule	-0.02 (1.07)	-0.02 (1.30)	-0.01 (0.92)	-0.02 (1.17)	-0.03 (1.52)	-0.03 (1.73)	-0.03 (1.26)	-0.04 (1.55)
Geographic Controls ⁺	Yes							
Observations	125	125	125	125	125	125	125	125
R-squared	0.157	0.104	0.188	0.155	0.185	0.154	0.141	0.110

Note: * *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 11**Service Employment Share, 1961-1991**

	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)	1991 (OLS)	1991 (IV)
Ryotwari	4.17** (2.33)	11.00** (2.48)	3.63** (2.10)	8.93*** (1.98)	3.93** (2.42)	9.74** (2.26)	4.40** (2.33)	11.09** (2.24)
Length of British Rule	-0.05 (1.61)	-0.07** (2.23)	-0.03 (0.97)	-0.05 (1.39)	-0.02 (0.82)	-0.04 (1.28)	-0.02 (0.59)	-0.04 (1.11)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	125	125	125	125
R-squared	0.185	0.078	0.136	0.065	0.159	0.064	0.174	0.077

Note: * *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 12

Population Density, 1901-1991

	1901 (OLS)	1901 (IV)	1911 (OLS)	1911 (IV)	1921 (OLS)	1921 (IV)	1931 (OLS)	1931 (IV)	1941 (OLS)	1941 (IV)
Ryotwari	87.35 (1.70)	80.77 (0.78)	-10.71 (0.26)	-46.54 (0.57)	8.50 (0.20)	-25.35 (0.34)	61.73 (1.40)	47.63 (0.58)	26.34 (0.50)	30.94 (0.28)
Length of British Rule	-0.28 (0.40)	-0.28 (0.39)	-0.67 (0.93)	-0.60 (0.76)	-0.45 (0.62)	-0.39 (0.50)	-0.16 (0.24)	-0.15 (0.21)	-0.83 (0.97)	-0.83 (0.91)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	93	93	120	120	115	115	106	106	113	113
R-squared	0.457	0.457	0.398	0.394	0.388	0.384	0.443	0.443	0.434	0.434

	1961 (OLS)	1961 (IV)	1971 (OLS)	1971 (IV)	1981 (OLS)	1981 (IV)	1991 (OLS)	1991 (IV)
Ryotwari	28.38 (0.47)	18.43 (0.16)	34.92 (0.49)	49.12 (0.34)	50.98 (0.58)	36.03 (0.20)	61.47 (0.51)	189.77 (0.76)
Length of British Rule	-2.12 (1.84)	-2.08 (1.51)	-2.97* (2.14)	-3.02 (1.78)	-3.77* (2.19)	-3.72 (1.79)	-7.17* (2.53)	-7.58* (2.17)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	125	125	116	116
R-squared	0.454	0.454	0.470	0.470	0.484	0.484	0.490	0.486

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

Heteroskedasticity-robust t-statistics are in parentheses.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 13

OLS Panel Data Regression with Standard Errors Clustered by District, 1901-1991

	Agri Prod. 1901-1981	Food-Grain Prod. 1901-1981	NFG Acreage Share 1901-1981	Urbanization 1901-1991	Mfg. Emp. Share 1961-1991	Service Emp. Share 1961-1991	Population Density 1901-1991
Ryotwari	65.61*** (2.65)	39.06** (1.97)	7.41*** (3.04)	4.43** (1.95)	2.33** (2.24)	4.03** (2.42)	22.53 (0.38)
Length of British Rule	-0.86** (2.14)	-0.29 (0.83)	-0.03 (0.93)	-0.02 (0.65)	-0.02 (1.30)	-0.03 (1.03)	-2.12* (1.88)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	443	444	443	987	500	500	1038
R-squared	0.785	0.762	0.373	0.246	0.342	0.191	0.563

Note: *** significant at 1%, ** significant at 5%, *significant at 10%

The regressions include year fixed-effects and standard errors are clustered by districts. Heteroskedasticity-robust t-statistics are in parentheses. Agricultural productivity is in rupees per acre. For 1901-1931, we use 1924-25 and 1928-1929 prices from Blyn (1966); for 1961-1981, we use contemporaneous prices.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 14

OLS Panel Data Regression with Standard Errors Clustered by Province, 1901-1991

	Agri Prod. 1901-1981	Food-Grain Prod. 1901-1981	NFG Acreage Share 1901-1981	Urbanization 1901-1991	Mfg. Emp. Share 1961-1991	Service Emp. Share 1961-1991	Population Density 1901-1991
Ryotwari	65.61 (1.68)	39.1 (1.52)	7.41** (2.98)	4.43* (1.74)	2.33 (1.47)	4.03 (1.66)	22.53 (0.17)
Length of British Rule	-0.86 (1.86)	-0.29 (0.47)	-0.03 (0.69)	-0.02 (0.61)	-0.02 (0.82)	-0.03 (0.81)	-2.12 (1.15)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	443	444	443	987	500	500	1038
R-squared	0.785	0.762	0.373	0.246	0.342	0.191	0.563

Note: *** significant at 1%, ** significant at 5%, *significant at 10%

The regressions include year fixed-effects and standard errors are clustered by provinces. Heteroskedasticity-robust t-statistics are in parentheses. Agricultural productivity is in rupees per acre. For 1901-1931, we use 1924-25 and 1928-1929 prices from Blyn (1966); for 1961-1981, we use contemporaneous prices.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

Table 15

OLS Panel Data Regression for Neighboring Districts, 1901-1991

	Agri Prod. 1901-1981	Food-Grain Prod. 1901-1981	NFG Acreage Share 1901-1981	Urbanization 1901-1991	Mfg Emp. Share 1961-1991	Service Emp. Share 1961-1991	Population Density 1901-1991
Rytowari	35.62 (0.81)	45.87 (1.57)	-4.74 (0.93)	-2.52 (0.98)	-0.26 (0.29)	-1.00 (0.67)	55.29 (0.74)
Length of British Rule	0.48 (1.13)	0.43 (1.54)	-0.03 (0.76)	-0.06* (2.18)	-0.02** (2.88)	-0.04** (3.01)	-0.68 (0.53)
Geographic Controls ⁺	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	109	110	110	210	120	120	255
R-squared	0.864	0.831	0.399	0.733	0.759	0.759	0.815

Note: *** significant at 1%, ** significant at 5%, *significant at 10%.

The regressions include year fixed-effects and standard errors are clustered by districts. This sample of neighboring districts consists of 32 districts out of our sample of 148 districts.

Heteroskedasticity-robust t-statistics are in parentheses. Agricultural productivity is in rupees per acre. For 1901-1931, we use 1924-25 and 1928-1929 prices from Blyn (1966); for 1961-1981, we use contemporaneous prices.

+ Geographic controls include altitude and latitude of the district, coastal dummy, average rainfall in the district and soil dummies (alluvial soil, red soil, black soil). Detailed results for coefficient estimates of geographic controls are available on request.

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