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allegiance: rural healthcare provision in
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Institutions, local agency and allegiance: rural healthcare provision in colonial India

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Abstract

Despite the impact of colonial institutions on development has been widely studied, it has also been largely criticised for missing on the importance of local agency determining socio-economic outcomes in former colonies. In this context, local elite's role channeling the impact of colonial institutions on public goods provision remains mostly an open question. This paper uses a novel cross-section database with georeferenced hospitals and dispensaries from 1901 to explore the effect of land revenue systems on healthcare provision in colonial India considering the role of local agency driving this effect. The date of conquest is used as an instrument for the land revenue systems to identify causality. Results show that hospitals and dispensaries in districts with landlord based systems received significantly less total revenue and less revenue from local and district boards. However, they got significantly more revenue from native private subscriptions. I argue the former was due to less land revenue being collected in landlord districts. This was largely due to the important role of landlords in land revenue collection and assessment as well as the fixing of land revenue demand in some landlord areas. Finally, more native private subscriptions can be explained by the landlords' need to show allegiance to the colonial authorities and increase their prestige.

Keywords— Colonial history, Land revenue systems, Healthcare, Local agency, India. JEL Codes: N35, N45, N25

Declaration of interest: none.

1 Introduction

Institutions have been largely studied as drivers of long run development (Acemoglu et al., 2002; Banerjee and Iyer, 2005; Engerman and Sokoloff, 2000; Nunn, 2008). However, the effect of colonial institutions on development has been questioned for missing on the role of local agency driving the introduction and impact of such institutions (Austin, 2008; Bayly, 2008). Despite recent studies have emphasized the importance of local agencies in the administration and development of colonies in Africa, Asia and America (Chaudhary, 2009; Frankema, 2010; Grafe and Irigoien, 2012; Hong and Paik, 2018; Van Zanden, 2010), local elite's role channeling the impact of colonial institutions on public goods provision has rarely been straightforwardly studied. Moreover, most studies on the influence of local elites on public goods provision have focused on education (Chaudhary, 2009; Galor et al., 2009; Hong and Paik, 2018). Similarly, Lindert (2004) has pointed out how decentralization can play a positive or negative role -depending on the prevailing agency in each region- for the provision of public goods, particularly education. Consequently, I explore the impact of colonial land revenue systems on a rather unexplored public good in colonial India -and most colonies-: healthcare. I do so emphasizing how local agency -specially that of landlord elites- drove such relation, reducing the state's capacity to tax while providing private funding to show allegiance where most needed.

The remarkable death rates in colonial India during the late nineteenth and early twentieth centuries -until 1920s- have been partially attributed to the poor funding of public health institutions and policies (Arnold, 1993; Klein, 1973).¹ Relatedly, recent literature has shown that colonial health policies and healthcare provision have a persistent effect on health outcomes and trust on western medicine (Calvi and Mantovanelli, 2018; Lordemus, 2021; Lowes and Montero, 2021). In colonial India, 10% of the population was treated in hospitals and dispensaries partially or totally financed by public institutions during 1901 making them a major link between western medicine and the mass of the population (Harrison and Pati, 2009, p. 6).² However, the provision of hospitals and dispensaries and the resources devoted to them presented significant differences across regions.³

In this paper, I use a novel cross-section database with georeferenced hospitals and dispensaries from 1901 to explore how the introduction of different colonial land revenue systems can explain regional differences in healthcare provision through their interaction with local agency. Land revenue systems determined who owned the land and who was responsible for the payment of the most important revenue source of the colonial period -land revenue-. In some regions, cultivators were landowners themselves -non-landlord based systems- while in other, a landlord owned the land -landlord based systems-. Moreover, most non-landlord based regions were temporary settled, which meant that the land revenue demand was regularly updated, whilst landlord based regions tended to be permanently settled -land revenue demand being fixed-.

I focus on three revenue sources for hospitals and dispensaries as my outcome variables. First, revenue from local and district boards -local funds-. District and local boards were established from 1882 and were responsible for education, public works, medical services and public health (Tinker, 1967, p. 43-63). Second, revenue from native subscriptions -including donations-, representing revenue from native private individuals. Finally, I check the overall effect on total revenue for hospitals and dispensaries. To measure land revenue systems, I use the acreage proportion of non-landlord based systems. I correlate district and local boards, native subscriptions and total revenues with the non-landlord proportion, showing that in non-landlord districts, hospitals and dispensaries' revenue from local and district boards was 601.182 rupees larger -0.52 standard deviations- than that of hospitals and dispensaries in landlord districts. Conversely, revenue from native subscriptions was 214.975 rupees smaller -0.26 standard deviations-. Finally, hospitals and dispensaries' total revenue was 32.7% larger in districts with a large non-landlord proportion. These results show two opposing effects of land revenue systems on hospital and dispensary finances -a positive district and local boards effect and a negative native subscriptions effect-, although overall the district and local boards effect seems to prevail.

I argue that larger revenues from district and local boards result from the larger land revenue collected in non-landlord areas. This was due to the landlords' control on the election of village state officials and their low numbers in landlord areas. The fixing of the land revenue demand in most landlord areas was also determinant. Additionally, I argue that larger revenue from native subscriptions in landlord areas results from landlords investing on healthcare to show allegiance to the colonial authorities and increase their prestige. This also reflects the need of the British to formalize alliances with the landlords. To address concerns on omitted variable bias and present evidence on causality, I introduce a dummy for districts conquered between 1820 and 1856 as an IV following Banerjee and Iyer (2005). Finally, the results are robust to spatial correlation -Conley standard errors-, dropping hospitals and dispensaries from Bengal, dropping potential outliers, using distance to Plassey battle site as an alternative instrumental variable, using an alternative measure of non-landlord proportion suggested by Iversen et al. (2013) and using different transformations for the dependent variables.

This paper contributes to several literatures. First, this paper contributes to the literature pointing at colonial institutions explaining development (Acemoglu et al., 2002; Banerjee and Iyer, 2005; Engerman and Sokoloff, 2000; Nunn, 2008). This literature has been criticised for missing on the role of local agency. Austin (2008) and Bayly (2008) point at the need to consider local agency to understand the introduction and success of colonial institutions, policies and production in Africa and India, arguing that much of what happened under colonial rule was not solely determined by the colonial authorities. In fact, the importance of local elites on colonial administration and outcomes has recently been emphasized in other colonial contexts (Frankema, 2010; Grafe and Irigoin, 2012; Van Zanden, 2010). This paper echoes the previous literature providing evidence on how local agency -through its influence as well as their need to show allegiance and gain prestige- could drive the effect of a colonial institution on healthcare provision.

Results from this paper also complement the literature on the determinants of public goods provision. Caste diversity, the presence of elites and land revenue collection have been signalled as factors determining education provision (Chaudhary, 2009; Chaudhary, 2010a; Chaudhary, 2010b). Other factors such as land inequality have also been recently signalled as determinants of education provision. More specifically, it has been argued that large landowners opposed education as they got little to gain and larger taxes

¹Despite this general consensus for poor funding, other causes for high death rates have been emphatically signalled in the literature: poverty, overcrowding and canal and irrigation works (Klein, 1973).

²This attendance percentage is similar to that reported in settled colonies such as 1923 Western Australia (8.1%) and much above African settled colonies such as 1919 Southern Rhodesia (3.9%). Data from the *Reports of Public Health* for each region and year.

³See Figure 1 for an overview of hospitals and dispensaries revenues across districts. Also, see Figure 4 in Appendix 6.1 for an overview of the distribution of hospitals and dispensaries in 1901 colonial India.

to pay (Baten and Hippe, 2018; Galor et al., 2009; Goñi, 2021) although a positive effect of landowners and land inequality on the provision of education has also been observed, specially for conservative and religious-intensive education systems (Andersson and T. Berger, 2019; Cvrcek and Zajicek, 2019). Similarly, Lindert (2004) has signalled decentralization as a factor explaining education provision, although its effect depends on the prevailing local agency and setting. In this work I focus on the determinants explaining public healthcare, in contrast with most of this literature which looks at the determinants of education provision. This is done pointing at the importance of colonial institutions explaining the healthcare financial (re)resources through its interaction with local agency.

Additionally, this paper adds to the literature pointing at colonial healthcare as a significant factor explaining nowadays health outcomes. Lowes and Montero (2021) find a negative effect of exposure to colonial campaigns against sleeping sickness in French Equatorial Africa on present vaccination rates and trust in western medicine. For the Indian case, Calvi and Mantovanelli (2018) find a robust and positive association between proximity to former Protestant medical missions and current individuals' Body Mass Index among other measures of health outcomes. This work provides an explanation on what determined the provision of colonial healthcare, which helps to better understand the colonial origins of nowadays regional differences in health outcomes. Such differences show up on today's per capita government health expenditure, which is much lower in Indian states that presented lower government expenditure in colonial times -see [National Health Accounts Estimates for India 2017-18](#), Table A.6-. Similarly, this paper sheds light on the work from historians on western medicine in colonial India (Arnold, 1993; Harrison and Pati, 2009). The present paper provides quantitative evidence on the differences in the revenue (re)resources for hospitals and dispensaries provision, which help better understand the reasons for the lacking resources and regional differences in the provision of western medicine in colonial India.

The paper is structured as follows. In Section 2 I present a general overview of the history of healthcare provision and land revenue systems in colonial India. In Section 3, I introduce the data and methodology I am using in this paper while in Section 4 I present my main results (IV), some robustness checks and the mechanisms driving my results. Finally, in Section 5 I conclude.

2 Historical context

Hospitals and dispensaries were a relevant tool as centers for vaccination, sanitary education and contact with western medicine in colonial India (Harrison and Pati, 2009, p. 6). In Bengal, Punjab, Central Provinces and Assam, vaccination in hospitals and dispensaries was an important part of the vaccination systems. In these provinces, up to two native vaccinators were assigned per dispensary, being supervised by the officials in charge of each dispensary. Apart from vaccinating people attending dispensaries, these vaccinators traveled throughout the district to vaccinate (James, 1909, p. 26, 29–31). Hospitals and dispensaries also sold medicines -mostly quinine-, were linked to certain market centers for medical officers to visit and were used to train medical students.⁴ Curing the sick, realising surgical operations and reporting information on illness and mortality patterns were also functions of hospitals and dispensaries. Whilst there is a negative but rather weak link between hospitals' per capita revenue and infant mortality in the short-term,⁵ the most plausible effect of these institutions was on medium to long-term, through smallpox vaccination and changing of health habits of the population, as found in (Calvi and Mantovanelli, 2018) for Protestant missions. Lastly, the number of surgical operations in hospitals and dispensaries steadily rose throughout all of India⁶ as such operations were neglected by indigenous practitioners but highly demanded by the Indian population (Arnold, 1993, p. 251). The most common surgical operation -with just over 300,000 operations in 1901- was the evacuation of abscesses, although the removal of parasites, tumours and setting broken bones -among others- were also common in colonial hospitals and dispensaries.⁷

The provision of hospitals and dispensaries in colonial India started in the presidency cities -Calcutta, Madras and Bombay- during the late seventeenth and early eighteenth centuries (Arnold, 1993, p. 246–247). This enclavist approach was in line with the focus of the colonial government on the health of the army -specially of British troops- and prisons (Arnold, 1993; Harrison, 1994). Even within these privileged sectors healthcare was segregated, marginalizing the native population. For instance, hospitals for native troops in army cantonments were significantly less equipped than their European counterparts.⁸ This was the result of the British complacent view of Indian health and mortality -which is also linked to Indian's immunity resulting from exposure to multiple

⁴Notes on the Annual Settlements of the Government Charitable Dispensaries in the Central provinces (1901, p. 3), *Triennial Report on the Working of the Charitable dispensaries under the Government of Bengal* (1902, p. 13-14) and (Arnold, 1993, p. 247).

⁵Check Appendix 6.2 for more on this link.

⁶For instance, in Bengal surgical operations rose by almost 8% in one year -from 1907 to 1908- according to the *Annual Returns of the Charitable dispensaries under the Government of Bengal* (1909, p. 9).

⁷See the 1901 provincial *Reports on the civil hospitals and dispensaries*.

⁸*Report of the Commissioners appointed to inquire into the Sanitary State of the Army in India* (1864, p. 324-332).

pathogens⁹ and the need of British troops to control the colony combined with the constrained military manpower of Britain.

Nonetheless, the colonial government had one major constraint to expand the provision of health services to the natives in general: the Government was reluctant to commit many financial resources to provide health services to the native population. In fact, resource constraints forced the Government to interact with practitioners of native medicine systems -e.g. *Ayurveda*- to implement health policies (R. Berger, 2013, p. 67). This lack of financial commitment was mostly justified by official authorities by the apparently generalized prejudice of Indian population towards hospitals and western medicine. However, this prejudice appears not to have been so generalized and greatly overrated (Arnold, 1993; Ramasubban, 2008). In the end, before the second half of the nineteenth century, only the main hospitals in the presidency capitals and some dispensaries were mainly financed by the colonial state. Beyond these basic institutions, the finance of new hospitals and dispensaries was mostly left to individual philanthropy and subscriptions (Arnold, 1993, p. 247).

This enclavist approach slowly changed when the Crown gained control of India, as the link between Indians' health and the health of troops was clearer (Arnold, 1993; Harrison, 1994), as public health was considered part of the *civilising mission* of British rule (Arnold, 1993, p. 97) and relevant to the political and economic power of the Empire (R. Berger, 2013). The link between the health of civilian natives and that of the troops was largely stated already in the *Report of the Commissioners appointed to inquire into the Sanitary State of the Army in India (1864, p. 338)* as "[...] nobody [...] can fail to see that the sanitary improvement of the Indian army involves the sanitary improvement and the advancement of civilisation in India.". In line with that, R. Berger (2013, p. 52) argues that Government rising concern on public health was the direct consequence of its increasing worries on the security and position of British rule in the subcontinent. Overall, this slow expansion of western medicine to Indian civilians does not imply that the resource constraint faced by the Government disappeared. However, the Government was able to significantly improve the funding and the number of hospitals and dispensaries provided. To exemplify, by the 1850s there were less than 90 hospitals and dispensaries somehow financed by colonial administrations while by 1901 that number was more than 20 times larger, reaching almost 2000.¹⁰

Such expansion of hospitals and dispensaries was mainly financed by local funds -mostly composed of district and local boards funds- (35.2%), provincial governments (23.6%), municipalities (19.9%) and private subscriptions from natives (9.5%). It is important to point out that most resources from municipalities as well as provincial governments went to hospitals and dispensaries in important cities. For instance, hospitals and dispensaries in district headquarters received more than 56% of their revenue from municipal and provincial government funds. In the rest of hospitals and dispensaries, revenue from these sources barely represented 36% of total revenue.¹¹ On the other hand, funds from native subscriptions as well as district and local boards funds were more spread across hospitals and dispensaries throughout the whole territory.

Hence, district boards were the main revenue source for hospitals and dispensaries. These boards were the most important local government institutions in colonial India, being responsible for education, health provision and local infrastructures (Chand, 1947, p. 223). They came into existence after the decentralizing reforms that started in the 1870s. By 1877, a system of five-year contracts between the Government of India and the provincial governments were negotiated (Kumar, 1989, p. 908). This reform entrusted provincial governments with some responsibilities such as the administration of important departments -e.g. land revenue departments- and of some local public works. Further steps were taken with Lord Ripon's resolution of 1882. The main aim of this resolution was to provide political education, in order to train the growing Indian middle class in the administration of representative institutions (Tinker, 1967, p. 44). To do so, the resolution established the creation of district and local boards, which were to contain a two-thirds majority of non-officials -with chairmen not being officials whenever possible-. However, not all points of this reform were fully implemented. While district boards were introduced in all provinces -and local boards in some-, a significant presence of natives and the chairmanship by non-officials was not as common as intended. In fact, the boards met infrequently with district officers hardly considering native suggestions and zamindar members rarely attending the meetings due to the procedure being unfamiliar to them (Tinker, 1967, p. 54).¹²

District and local boards got most of their revenue from land revenue cesses and provincial grants. Land revenue cesses were additional surcharges on land revenue that district boards were able to charge, although provincial governments established a minimum and a maximum rate for the cesses.¹³ In practice, however, cesses were usually levied at 6.25% of the district land revenue and this rate was uniform within provinces (Chaudhary, 2010b, p. 281). This means that most variation on the cesses came from differences in land revenue assessment and collection. On the other hand, provincial grants were allocated on a per-capita

⁹Arnold (1993, p. 91) also signals the importance of the abstinence from alcohol and Indians' adaptation to the climate as factors explaining their lower mortality.

¹⁰Data from the 1901 provincial *Reports on the civil hospitals and dispensaries* and (Arnold, 1993).

¹¹Data from the 1901 provincial *Reports on the civil hospitals and dispensaries*.

¹²See (Tinker, 1967) for more on Lord Ripon's reform and its implementation.

¹³*Report of the Indian Taxation Enquiry Committee 1924-25. Volume I. Page 311.*

basis, and in some cases favoured the poorest districts or those with larger minorities (Chaudhary, 2010b). Overall, district and local boards in colonial India had extremely limited financial independence, as most of their revenue depended on land revenue assessment and on grants from the provincial governments (Chand, 1947). This clearly sets them apart from the British local boards, which were mostly able to effectively determine the tax rate of certain local taxes and which were more representative (Goñi, 2021).

In the end, there were substantial differences in the revenue available for district and local boards, specially across different provinces. In 1903, district and local boards in Bombay and Madras had as much revenue per capita as twice that from boards in Bengal or the United Provinces.¹⁴ These differences translated into important differences in funds devoted to healthcare in colonial India. To exemplify, sanitation and hospitals expenditure represented from 4.92% (Bengal) to 16.7% (Madras) of district and local boards' total expenditure in 1903. Therefore, there were important differences in the provision of funds for hospitals and dispensaries as can be observed in Figure 1.

Total revenue per capita of hospitals and dispensaries

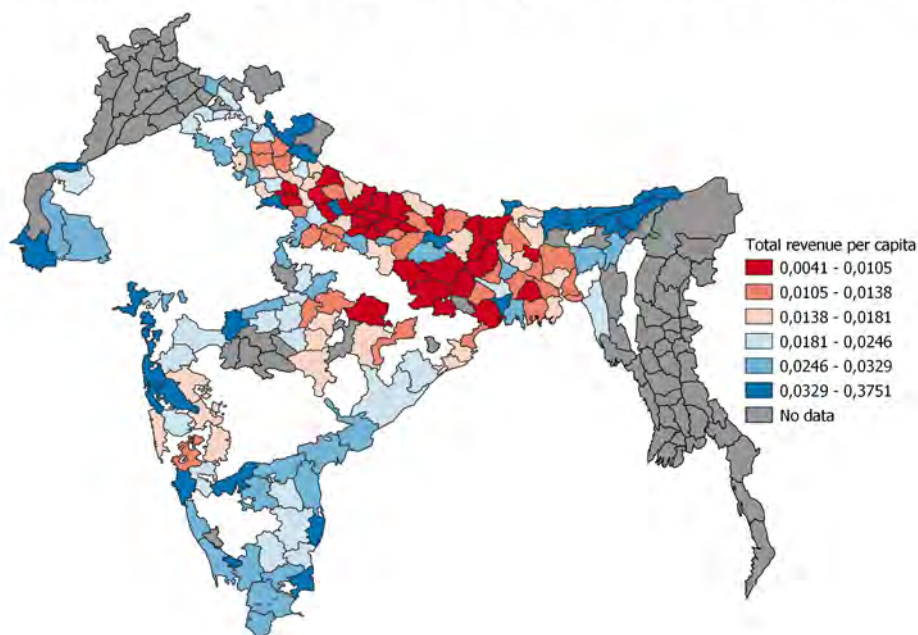


Figure 1: Total revenue per capita of hospitals and dispensaries at the district level. Data on revenue for hospitals and dispensaries from 1901 provincial *Reports on the civil hospitals and dispensaries*. Population data from *Census of India (1901)*.

These regional differences might be explained by the introduction of distinct land revenue systems. It may be the case that hospitals and dispensaries presented larger revenues in non-landlord areas. That would be because non-landlord land revenue systems tended to be temporary settled -which allowed for the update of the land revenue demand each 20-30 years- while most landlord areas were permanently settled -land revenue demand was fixed- (Chaudhary, 2010b). Additionally, land revenue assessment and collection was smaller in landlord areas due to the influence of landlords in the assessment and collection processes -see (Baden-Powell, 1892a; Baden-Powell, 1892b; Baden-Powell, 1892c)-. However, the presence of wealthy landowners in landlord areas could also have led to more private investment in public services -e.g. hospitals and dispensaries- to justify their social position or to show allegiance to the colonial government.

Land revenue systems determined who was the landowner. However, landownership was not given without a cost, as landowners were liable to pay the land revenue to the colonial state. The British introduced their first land revenue system in Bengal in 1789 (Baden-Powell, 1892a, p. 284, 391). Such system was the zamindari system, in which the zamindars -former revenue collectors of

¹⁴Data from *Statistical abstract relating to British India from 1894-95 to 1903-04* available [here](#).

the Nawabs of Bengal¹⁵ - became landowners. In this system, land was owned by an intermediary -zamindar- between the actual cultivator -tenant or agricultural labourer- and the state. Under the mainstream classification of land revenue tenures, such land revenue system is classified as landlord based (Banerjee and Iyer, 2005, p. 1193).

By contrast, in most of Madras and Assam and all of Bombay, Berar and Burma the ryotwari system was adopted. This land revenue system gave landownership to cultivators, dropping any intermediary -e.g. landlords and tenants- between the state and cultivators. The ryotwari system has been classified as a non-landlord based system. Finally, the mahalwari system was introduced in Punjab and the United Provinces. Such system established a village body as the responsible for land revenue payment and landownership. In this case, it is necessary to differentiate between villages where the share of the land revenue and representativity in the village body was distributed by ancestry -pattidari system- and those where the share was distributed by the actual possession of the land -bhaiachara system-. The former led to less representative village bodies -in those areas, the mahalwari system can be classified as landlord based while the latter has been classified as a non-landlord based system- (Banerjee and Iyer, 2005, p. 1194).

In a nutshell, despite the expansion of hospitals and dispensaries by the last half of the 19th century, there were important differences in their provision across colonial India. These differences might be explained by the introduction of certain colonial land revenue systems, which -through its interaction with local agency- could affect the (re)sources available for hospitals and dispensaries. I explore this hypothesis in the following sections.

3 Data and Empirical Framework

As stated in section 1, in this paper I study the effect of land revenue systems on the (re)sources of hospitals and dispensaries. To do that, I use a cross-section database with georeferenced hospitals and dispensaries from 1901. More precisely, I look at the link between land revenue systems and different revenue sources -district and local funds and private native subscriptions- as well as total revenue for hospitals and dispensaries. Finally, to tackle a potential omitted variable bias and present evidence on causality, I use a dummy for districts conquered between 1820 and 1856 as an IV following Banerjee and Iyer (2005).

3.1 Baseline regression (OLS)

I study the link between land revenue systems and total revenue as well as different revenue sources following equation (1):

$$Revenue_{\delta,i} = \beta_0 + \beta_1 NonLandlord_r + \beta_2 Population_r + \beta_3 X_i + \beta_4 \Gamma_r + \varepsilon_i \quad (1)$$

where the dependent variable - $Revenue_{\delta,i}$ - represents revenue source δ for hospital or dispensary i . Revenue source (δ) can either be revenue from local and district boards, revenue from private native subscriptions or total revenue. To measure the revenue from district and local boards as well as the revenue from private native subscriptions and total revenue, I use the 1901 provincial *Reports on the civil hospitals and dispensaries*. These reports provide information on all revenue sources for each hospital and dispensary totally or partially financed by colonial authorities.¹⁶

I use the revenue from local funds to estimate the revenue from district and local boards. Revenue from local funds included revenue from institutions which were vested in Local Boards and guaranteed or maintained by local funds.¹⁷ For the most part, this meant district and local boards although revenue from public institutions other than district or local boards -such as Port Commissioners or Improvement Funds- were also included. However, the contribution of these other local institutions seems to have been minimum. In fact, all but 4 hospitals and dispensaries managed and financed by local bodies were directly managed and financed by District Boards in Bengal.¹⁸ Hence, it would appear that most revenue classified as local funds came from district and local boards. This is in line with the responsibility of district and local boards to provide medical services and the introduction and generalization of these boards since the 1880s signalled in Section 2.

Nonetheless, to mitigate concerns on the impact of this potential measurement error on my results, I collected data on 1901 medical expenditure by district boards from *District Gazetteers*. District boards' medical expenditure was not only devoted to hospitals

¹⁵The Nawabs were the provincial rulers of Bengal under Mughal domination.

¹⁶These provincial *Reports on the civil hospitals and dispensaries* also provide information on the number of beds per hospital and dispensary, people attending and the expenditures of each institution among other things.

¹⁷*Annual returns (Triennial Report) on the Civil Hospitals and Dispensaries in The Madras Presidency (1901)*. Statement n°1. Note.

¹⁸*Triennial Report on the working of the Charitable Dispensaries under the Government of Bengal (1901)*. Page 16, Paragraph 33.

and dispensaries, but also to sanitation works and vaccination campaigns.¹⁹ However, hospitals and dispensaries was usually the main head of medical expenditure.²⁰ I test my results using the medical expenditure by district boards as an alternative measure of hospitals and dispensaries revenue from district boards. My IV coefficient is positive and significant in all specifications -see Table 11 in Appendix 6.3-. This is in line with my results when using local funds as funds from district and local boards in Table 3. Finally, Figure 2 graphically presents the relation between district boards medical expenditure and revenue from local funds clustered by district. The results show how the district boards medical expenditure is similar to local funds available for hospitals and dispensaries within each district, although systematically larger. This means that district and local boards could have provided most -if not all- of the local funds to hospitals and dispensaries.

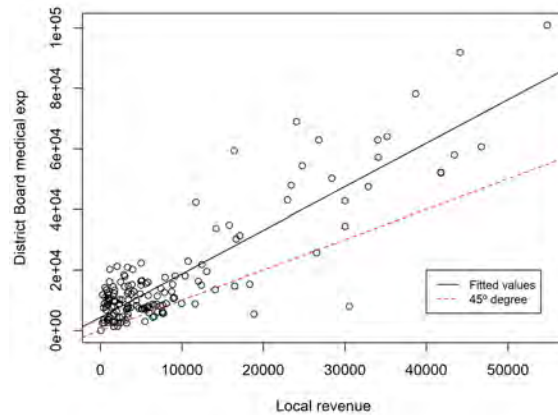


Figure 2: District Board Medical Expenditure vs local funds for hospitals and dispensaries clustered at the district level. Data from *District Gazetteers* and provincial *Reports on the civil hospitals and dispensaries*.

NonLandlord_r -my variable of interest- represents the non-landlord proportion -share of acreage under a non-landlord land revenue system- in district r . Data for the non-landlord proportion comes from Banerjee and Iyer (2005). For those districts not included in their work, I use the *Agricultural Statistics of India* to estimate the non-landlord proportion. Alternatively, I introduce the changes suggested by Iversen et al. (2013) in the non-landlord proportion. These changes are constrained to the Central Provinces, for which they argue that the land revenue system implemented there was not truly a landlord system in lands under a right of absolute occupancy. According to the authors, this is the case because in these lands, rents were established by the revenue officials instead of the landlord. There is still debate on whether or not land leased to tenants with absolute occupancy rights in the Central Provinces should be considered under a landlord system (Banerjee and Iyer, 2013); however, I use Iversen et al. (2013) corrections as a robustness check -see column (3) in Table 4-.

Population_r is the total population in district r . This is included to control for the population that can benefit from hospitals and dispensaries in each district. District population can work as a rough proxy for hospitals and dispensary demand. Population data comes from the different provincial volumes of the *Census of India (1901)*.

X_i is a matrix including all controls for hospital or dispensary (i) characteristics. This includes a dummy showing whether i is a hospital (1) or a dispensary (0), another dummy showing whether i is a hospital or dispensary for females (1) or not (0), the distance of i to the nearest railway line,²¹ the hospital or dispensary longitude and latitude, its altitude and the type of soil around the area. Data on being a hospital or dispensary and on being a hospital or dispensary for females comes from the 1901 provincial *Reports on the civil hospitals and dispensaries*. In some provincial reports -Bombay and Madras-, it was stated whether the institution was a hospital or a dispensary. For those reports where this was not stated and based on Bombay and Madras reports, I define hospitals as all institutions with in-door beds. However, if "dispensary" or "hospital" are included in the institutions' name, I classify them as so. For the distance to railway, latitude, longitude, altitude and type of soil, I had to georeference hospitals and dispensaries. Luckily, in the provincial *Reports on the civil hospitals and dispensaries* the name of the district and city, town or village where the hospital or dispensary was located is stated. With that information, I used [Google Maps](#) as well as [India Place Finder](#) to locate 1675 hospitals and dispensaries -representing almost 84% of all hospitals and dispensaries reported-. To measure hospitals and

¹⁹ *Madras District Gazetteers. Statistical Appendix (1915)*.

²⁰ *Agra: A Gazetteer, being Volume VIII of the District Gazetteers of the United Provinces of Agra and Oudh (1905)*. Pages 129-30. *Madras District Gazetteers. Statistical Appendix (1915)*.

²¹ Closeness to railroads has recently been signalled as a factor positively affecting the introduction of missions and public goods -including health services- (Jedwab et al., 2022).

dispensaries distance to the nearest railway, I use shapefiles from Fenske et al. (2021).²² To measure the type of soil, I use dummy variables for the 4 most common soils in the subcontinent following FAOs soil classification from the legend of the soil map of the world (1974).

Alternatively, Γ_r is a matrix including all controls for district (r) characteristics. This includes the urbanization rate, a caste and religious fragmentation index (CRFI), the share of Hindus as well as the share of Muslims, the average rainfall and a dummy showing whether the hospital or dispensary is located in a coastal district (1) or not (0). The urbanization rate is included to control for urban population and development. Richer districts tend to be more urbanized, which directly affects the funds available for hospitals and dispensaries. Additionally, caste and religious fragmentation has been pointed out as a factor affecting public goods provision (Banerjee and Somanathan, 2007) as well as the presence of large religious groups -Hindus- or minorities -Muslims- (Chaudhary, 2009). Data for the urbanization rate, the CRFI as well as the shares of Hindus and Muslims come from the various volumes of the *Census of India (1901)*. Rainfall data comes from the *Imperial Gazetteer of India (1909)* while for the coastal dummy I used colonial maps from the *Atlas of the Imperial Gazetteer of India (1909)*.

Notice how my baseline estimation does not include provincial fixed effects. This is because land revenue systems were introduced into large territories and there is very low -in some cases non-existent- within province variability in land revenue systems. Therefore, including provincial fixed effects would capture most of the effect of my variable of interest. Alternatively, I test the robustness of my results by clustering standard errors at the provincial level and including Conley standard errors among alternative ways to control for spatial correlation -see Section 4.1-.

Last but definitely not least, all standard errors are clustered at the district level (r). This is the case since the level at which I have data for my variable of interest -non-landlord proportion- is the district level (r).

3.2 IV: Date of conquest

Provision of hospitals and dispensaries could be affected by the demand for such services. Despite using the total population in each district as a way to account for demand, this is not a perfect proxy. It could be that in certain caste groups, regions or villages, the acceptance -and demand- of western medicine and services was lower than in others with similar population levels. This could be due to a larger presence of traditional medicine such as *Ayurveda*, pre-colonial patterns of medical consumption (R. Berger, 2013, p. 50) or due to the link between western medicine and foreign rule. The latter could lead to suspicions and fears unrelated to its effectiveness (Arnold, 1993, p. 156). Therefore, my OLS estimates could be affected by an omitted variable bias.

To tackle a potential omitted variable bias and to provide some evidence on the causality, I introduce a dummy variable identifying those districts that were conquered between 1820 and 1856 as an instrument for the non-landlord proportion. In fact, a dummy for districts conquered between 1820 and 1856 has already been used in the literature as an IV (Banerjee and Iyer, 2005). The date of conquest relates to the land revenue system introduced in a territory through different channels.

First, a later conquest meant that the East India Company (EIC) had a more effective and developed administrative body of tax collectors at the time of the occupation (Baden-Powell, 1892a, p. 394-398, 401-407). While in landlord systems tax responsibilities were clustered among a small group of landlords, in non-landlord systems tax collection and assessment had to be done for every individual field (Lee, 2018, p. 12-13). Hence, the introduction of more bureaucratic-intensive land revenue systems -i.e. non-landlord systems- was done later, as the position of the EIC was more secure and the EIC administrative body more developed. To exemplify, after the conquest of Bengal, the EIC stopped being simply a trade company and became the ruler of a large region in India.²³ This obliged the EIC to enforce law and collect taxes. Since the EIC had no large and trustworthy administrative body (Swamy, 2011, p. 140-142) which could afford to assess and survey the land for the land revenue, a landlord permanent settlement was introduced without any survey of the land (Baden-Powell, 1892a, p. 407-408).

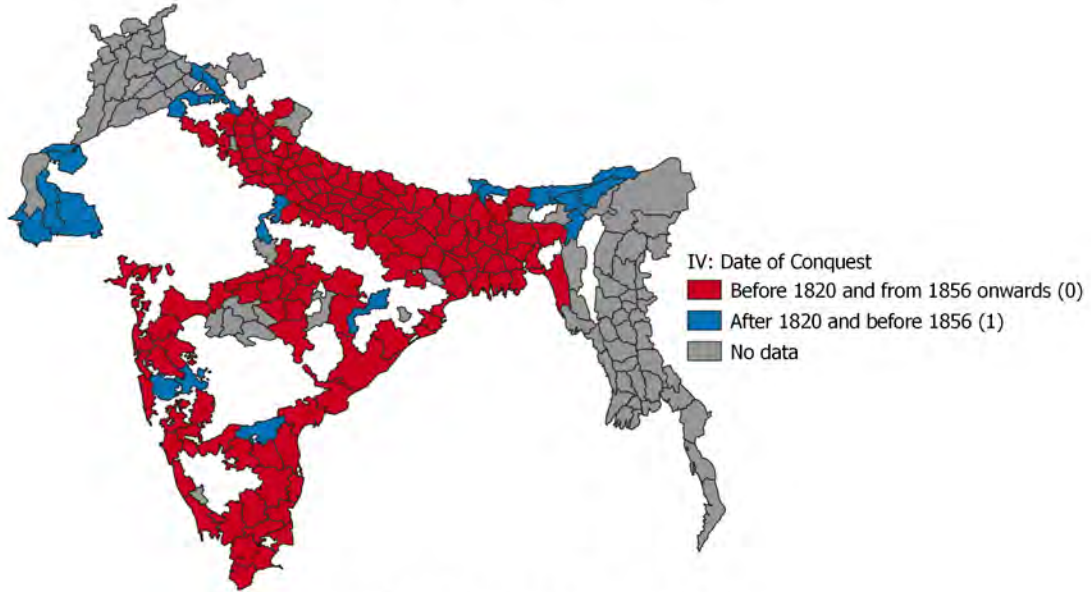
Second, territories that were conquered later had some non-landlord precedent. As pointed out by Banerjee and Iyer (2005), a ryotwari system -non-landlord based system- was introduced in Berar as it was the system of neighbouring Bombay. Punjab presented the village-based system that was already introduced in the United Provinces. Similarly, Sindh adopted the ryotwari system following the rest of the Bombay presidency.

Finally, the timing of conquest influenced the introduction of land revenue systems through the dominant ideology among prominent officers at the time. Before 1820, most policies introduced by the British administration had a clear Whig bias, which benefited

²²This data is available online in James Fenske's [website](#).

²³Bengal was the first large region conquered by the EIC and its conquest is usually stated as the beginning of British rule in India.

IV: Date of Conquest



Non-landlord proportion

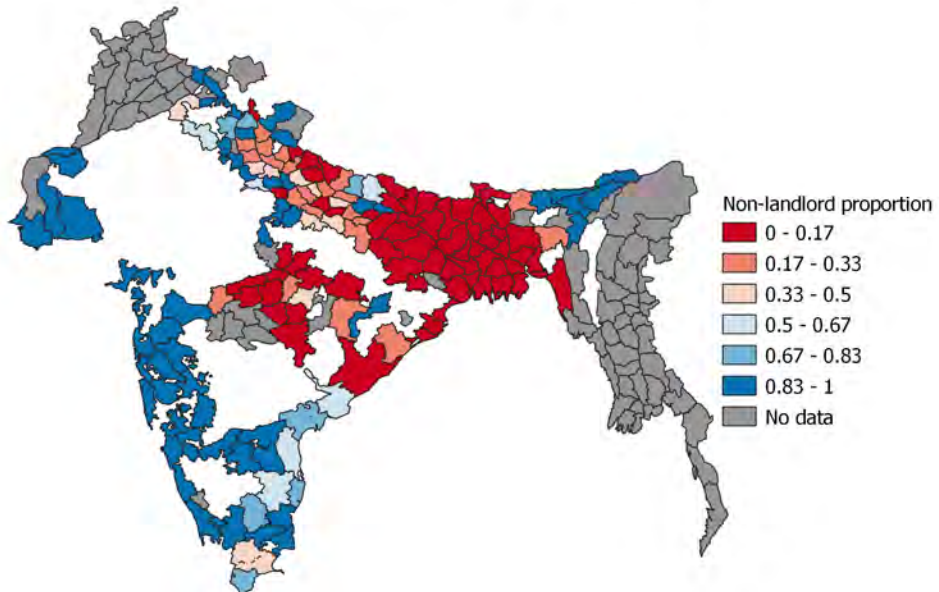


Figure 3: Maps showing the dummy for the date of conquest (IV) and the non-landlord proportion

large landowners who provided a natural elite and social order (Stokes, 1959, p. 5). For instance, the Permanent Settlement in Bengal -introduced by Lord Cornwallis- clearly sought to reduce the functions of government to guaranteeing property rights and security while providing landownership to large landlords -zamindars-. After 1820, utilitarian ideas gained momentum in India -as they did in England- (Banerjee and Iyer, 2005; Stokes, 1959). Utilitarians²⁴ saw the protection of the cultivator and their way of life as a function of government (Stokes, 1959). They aimed to do so by providing cultivators with private landownership rights and abolishing all intermediaries with the introduction of non-landlord systems. Finally, after the revolt of 1857, the Government of India acknowledged landlords as key allies for stability and social order in Oudh -a former princely state which was annexed in 1856 through the Doctrine of lapse²⁵- (Metcalf, 1962, p. 156-157). Consequently, the British favoured again the landlords, giving landownership in Oudh to taluqdars.²⁶

For the 1820 to 1856 annexed territories dummy to be a good instrument, it has not only to relate to my variable of interest -land revenue systems- but it also has to be exogenous. In line with that, I argue that the date of British conquest resulted from a mixture of the EIC fearing potential threats, idiosyncratic conflicts within and outside India as well as arbitrary policies unrelated to the provision of health services. Alternatively, it could be argued that the date of British conquest was endogenous and that the British started annexing the most fertile lands in India, allowing for a larger provision of hospitals and dispensaries in these regions. In fact, it has been stated that landlord areas tended to be more fertile than non-landlord areas, since they had to support a landlord intermediary (Roy, 2006). However, this selection bias -and endogeneity source- seems unlikely for several reasons: first, at least during the initial years of conquest, the EIC employees had very limited data and knowledge on the productivity of land and on the land revenue they could demand (Baden-Powell, 1892a, p. 395). This lack of real knowledge makes it rather improbable that the EIC selected its initial conquests by their productivity. Second, British conquest tended to unfold as a reaction -at least initially- to idiosyncratic political shocks (Wilson, 2016). This makes it improbable that the EIC was able to precisely select their annexations based on the economic conditions of the territory.

To illustrate this, the provoking acts of the petty Raja of Travancore -an EIC official ally- led the King of Mysore to attack him in 1789. That was the case, despite the British actively persuaded the Raja to stop provoking the King, even threatening the former with breaking their defensive alliance (Kunju, 1960). In the end, the EIC was forced to enter on a defensive war which ended with the EIC's acquisition of four districts. These conflicts resulted mostly of subjective factors such as perceived threats and old rivalries, which were unrelated to the British future capacity to provide hospitals and dispensaries. Further showing the exogeneity of the date of British annexation, the conquest of Bengal started with the outbreak of the Austrian Succession War (1740) in Europe, which led to a series of French conquests in South India -including Madras-. That, together with the EIC distrust on the Nawab -the provincial Mughal ruler of Bengal- to protect them from French attacks, led to a clash in Bengal (Bandyopadhyay, 2004, p. 42-43). The EIC updated their fortifications in Calcutta without the Nawab's consent and offered refuge to fugitives from the Nawab's court. In response, Siraj-ud-Daulah, the young Nawab of Bengal, threatened the EIC trade in Bengal and eventually besieged Calcutta. Such retaliations resulted in the Battle of Plassey (1757) and British dominion over the region. Finally, another example showing the exogeneity of British conquest is the Doctrine of lapse. This was an annexation policy implemented by the Governor-General Lord Dalhousie between 1848 to 1856 which made the British annex all Princely states for which there was no natural heir, disallowing the adoption of heirs (Iyer, 2010, p. 700-701). Four former princely states were annexed by the British through this rather arbitrary policy.

Last but definitely not least, even in the case that the British selected some rich areas to conquer first, then we would expect earlier acquired territories to have hospitals and dispensaries with larger revenues as they would have more resources available. This is against my hypothesis that in landlord areas -usually conquered first- hospital and dispensaries received less funding.

Another threat to the exogeneity of the instrument would be that the presence of powerful pre-colonial elites and states with large state capacity influenced both the date of conquest and the provision of healthcare. Earlier British conquests could have been on pre-colonial states with large state capacity and powerful elites that later received landownership from the EIC and who seized the opportunity to limit the capacity of the new colonial state to tax them. To mitigate this concern, I use the number of cities and towns for each district presenting forts, palaces, temples and other places of religious or cultural importance during the Mughal period from Schwartzberg (1978).²⁷ This source and its report of religious and cultural places has also been used by Dincecco et al. (2021) to measure pre-colonial state capacity. In my case, the presence of palaces, forts or temples estimates pre-colonial state capacity and the presence of powerful elites. Table 1 shows how districts conquered between 1820 and 1856 do not relate to the presence of religious and cultural sites -i.e. the presence of powerful pre-colonial states and elites- during Mughal times (1526-1707). In fact, once all controls are considered, the coefficient of the instrument is virtually 0 -see column (4) in Table 1-.

²⁴Such as Thomas Munro (1761-1827), who came to be Governor of Madras and the inventor of the ryotwari system.

²⁵For more on the Doctrine of lapse see below or Iyer (2010).

²⁶Taluqdars were former land revenue collectors in Oudh.

²⁷This data and all maps from Schwartzberg (1978) are available [online](#).

Table 1: Conquest between 1820 and 1856 is unrelated to pre-colonial state capacity and the power of pre-colonial elites

	Religious and cultural sites of the Mughal Period			
	(1)	(2)	(3)	(4)
Districts conquered between 1820 and 1856	-0.131 (0.123)	-0.120 (0.167)	-0.079 (0.230)	-0.005 (0.209)
Constant	0.451*** (0.057)	0.940 (0.733)	-0.994 (1.440)	-1.588 (2.138)
Observations	169	169	159	159
R-Squared	0.005	0.074	0.163	0.200
Geographic controls	NO	YES	YES	YES
Economic controls	NO	NO	YES	YES
Caste and religious controls	NO	NO	NO	YES

Note: OLS estimates showing no link between the instrument and pre-colonial state capacity and elites. The dependent variable represents the number of cities and towns for each district presenting forts, palaces, temples and other places of religious or cultural importance during the Mughal period (1526-1707). Geographic controls include district longitude, latitude, mean altitude, maximum altitude, rainfall and a coastal dummy. Economic controls include the 1911 land/labour ratio, railway miles in the district and the urbanization rate. Finally, caste and religious controls include the CRFI, the share of Hindus and the share of Muslims. Data sources are pointed out in Section 3.1 and 3.2.

In a nutshell, the date of British annexation was exogenous to factors potentially affecting the funding of hospitals and dispensaries -e.g. land productivity, pre-colonial state capacity and elites-. In fact, British conquest was a process driven by idiosyncratic conflicts, British perceived threats and arbitrary annexation policies. On the other hand, the date of conquest is linked to my variable of interest -non-landlord proportion-. In later annexed territories, the British could introduce more bureaucratic-intensive land revenue systems -non-landlord systems- which created a precedent for their future introduction used by officers depending on the dominant ideology of the period.

4 Results

Table 2 shows the OLS estimates for each revenue source including estimations with controls from section 3.1. Accounting for all controls defined in section 3.1 -see column (3) from top to bottom-, a hospital or dispensary in a non-landlord district had a revenue from district and local boards significantly larger -0.52 standard deviations- than an institution in a landlord district. On the other hand, a hospital or dispensary in a non-landlord district received a revenue from native subscriptions significantly lower -0.26 standard deviations-. Finally, a hospital or dispensary in a non-landlord district had a total revenue 32.7% larger than that of a hospital or dispensary in a landlord district.

Therefore, there was a positive and significant relation between hospitals and dispensaries' revenues from district and local boards and the non-landlord proportion. Conversely, this relation becomes negative when looking at revenue from native subscriptions. Overall, total revenue of hospitals and dispensaries was significantly larger in non-landlord districts, meaning that the positive link with revenues from district and local boards prevailed.

However, the OLS results might be driven by omitted variables -such as the demand for hospitals and dispensaries-. To mitigate this concern and provide some evidence on the causality of these relations, I provide the IV estimates in Table 3. After including all controls from Section 3.1 -see column (3) from top to bottom-, a hospital or dispensary in a non-landlord district received 0.90 standard deviations more from district and local boards than the same institution in a landlord district. This coefficient is significant in all specifications. Conversely, revenue from native subscriptions in hospitals and dispensaries in non-landlord districts was 0.32 standard deviations lower than that in landlord districts. Finally, total revenue for a hospital or dispensary in non-landlord districts was 73.7% larger than that of a hospital or dispensary in a landlord district. In all cases, the IV coefficients are larger than those in the OLS -see 2nd IV Stage columns (1), (2) and (3) in Table 2-.

Table 2: OLS estimates for each revenue source

	District and local boards revenue		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	591.930*** (95.334)	557.889*** (89.469)	601.182*** (89.314)
Constant	71.086 (116.710)	-198.189 (547.611)	-1622.413** (728.061)
	Native subscriptions revenue		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	-346.652*** (54.453)	-214.247*** (44.508)	-214.975*** (43.782)
Constant	361.035*** (49.864)	-277.407 (250.912)	174.167 (332.477)
	Total revenue in ln		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	0.304*** (0.065)	0.329*** (0.072)	0.283*** (0.071)
Constant	7.157*** (0.068)	7.122*** (0.516)	7.669*** (0.652)
Observations	1675	1675	1675
District Population	YES	YES	YES
Hospital and dispensary controls	NO	YES	YES
District controls	NO	NO	YES
SE Clustered at district level	YES	YES	YES

Note: OLS estimates for each revenue source. (1) shows the effect of non-landlord proportion on revenues from district and local boards, native subscriptions and total revenue -in natural logarithms- controlling for district population. (2) shows the same estimates but controlling also for hospital and dispensary features. Finally, (3) shows the different estimates including all controls as defined in Section 3.1.

Table 3: IV first and second stage estimates

1st IV Stage			
Non-landlord proportion (B&I)			
	(1)	(2)	(3)
Districts conquered between 1820 and 1856	0.365*** (0.073)	0.446*** (0.081)	0.443*** (0.089)
Constant	0.581*** (0.073)	3.887*** (0.344)	4.173*** (0.494)
2nd IV Stage			
District and local boards revenue			
	(1)	(2)	(3)
Non-landlord proportion (B&I)	612.472** (275.723)	994.546*** (236.296)	1037.235*** (253.990)
Constant	56.411 (252.525)	-1977.708 (1207.744)	-3796.732** (1626.838)
Native subscriptions revenue			
	(1)	(2)	(3)
Non-landlord proportion (B&I)	-287.098*** (109.153)	-260.447*** (99.210)	-259.518** (116.225)
Constant	318.491*** (109.296)	-89.129 (463.540)	396.278 (639.053)
Total revenue in ln			
	(1)	(2)	(3)
Non-landlord proportion (B&I)	0.384* (0.225)	0.596*** (0.191)	0.552*** (0.196)
Constant	7.101*** (0.169)	6.035*** (0.827)	6.325*** (1.072)
Observations	1675	1675	1675
Kleibergen-Paap rk Wald F statistic	24.981	30.132	24.963
District Population	YES	YES	YES
Hospital and dispensary controls	NO	YES	YES
District controls	NO	NO	YES
SE Clustered at district level	YES	YES	YES

Note: IV estimates for each revenue source. (1) shows the effect of non-landlord proportion on revenues from district and local boards, native subscriptions and total revenue -in natural logarithms- controlling for district population. (2) shows the same estimates but controlling also for hospital and dispensary features. Finally, (3) shows the different estimates including all controls as defined in Section 3.1.

In a nutshell, the IV estimates confirm the positive effect of non-landlord proportion on revenue from districts and local boards and the opposite effect on revenue from private native subscriptions. It also shows how the overall effect leans towards the district and local boards effect providing some evidence on the causal effect of the land revenue systems.

4.1 Robustness checks

In order to test the robustness of my IV results, I include several changes to the IV baseline estimation in Table 4.

First, I drop all hospitals and dispensaries in Bengal from my sample -see column (1)-. Bengal was the first large province conquered by the EIC and the paradigmatic province -specially its western part- of the zamindari land revenue system -landlord based system-. Therefore, it could be that my results are only driven by hospitals and dispensaries in this important region. Coefficients in (1) remain significant for district and local board funding, native subscriptions and total revenue. Moreover, the magnitudes of the coefficients are similar to those in the IV baseline estimates -see column (3) in Table 3-, although a bit smaller.

Second, I cluster standard errors at the provincial level instead of the district level. This is done to account for correlation within provinces. We could expect such correlation, specially in revenue from district and local boards. Such correlation could be driven by the importance of provincial grants in the finance of district and local boards. For all revenue sources, the IV coefficient remains significant after clustering standard errors at the provincial level -see column (2)-.

Third, I present the IV results including the changes suggested by Iversen et al. (2013). These authors argue that in the Central Provinces, land that was leased by landlords under a right of absolute occupancy was not truly under a landlord based system. If this estimation of the non-landlord proportion is considered valid,²⁸ it would mean that there is a measurement error in my non-landlord estimate. However, using Iversen et al. (2013) non-landlord estimate does not affect my IV results. The IV coefficients remain significant when estimating any of the revenue sources analysed and with a similar magnitude -a bit larger in absolute value for all cases- to that in Table 3.

Fourth, I use the distance to the Plassey battle site as an alternative instrument for the non-landlord proportion. The battle of Plassey is generally considered as the beginning of British dominion in the subcontinent as it represented the first conquest of a large region -Bengal- of India by the EIC. From Bengal, the EIC expanded its dominions to the east through the Benares region (1775) and to the south, through the Carantic districts (1801). As argued previously, in its initial conquests, the EIC introduced landlord land revenue systems, which means that the distance to the Plassey battle site and the non-landlord proportion are correlated. In fact, the F-statistic shown in column (4) of Table 4 is large enough to consider it a strong instrument. As pointed out for the dummy for districts conquered between 1820 and 1856 instrument, the conquest of Bengal as well as the acquisition of most territories -specially initially- by the EIC was mostly exogenous. Also, the battle of Plassey (1757) occurred in a crossing of the Hooghly river more than 100km away from Calcutta. This means that the distance to the Plassey battle site could be a good alternative instrument to test my results. Using distance from the Plassey battle site as an alternative instrument, the district and local boards as well as the native subscriptions coefficients remain significant at 1%. However, the IV coefficient for total revenue becomes insignificant, despite remaining positive.

I also present my IV estimates dropping all observations within the highest decile of each revenue source -district and local boards, native subscriptions and total revenue-. This is to show the robustness of my results to dropping potential outliers. For all revenue sources, the IV coefficient drops -in absolute value-, although it does not lose its significance level in any case -see column (5)-. However, since determining which observations are actually outliers is extremely subjective, I repeat my IV estimates using different thresholds to drop observations -see Table 12 in Section 6.4 in the Appendix- and the results remain significant.

Apart from these general robustness checks, I also test whether my results are driven by spatial correlation as it could be the case that the standard error is correlated beyond the level of treatment -in my case, the district level- (Barrios et al., 2012; Kelly, 2020). To do so, I repeat my IV estimates including Conley standard errors in Table 5. This table shows how all my results hold when using Conley standard errors with different cutoff levels. Additionally, I test my results using spatial autocorrelation models -Table 13 in Section 6.5 of the Appendix- and alternative structures of the error covariance matrix -Table 14 in Section 6.5 of the Appendix-, and the results hold in most specifications.

Finally, I test the robustness of my results using different transformations of my dependent variables. For revenue from district and local boards as well as for native subscriptions, I estimate my IV using their inverse hyperbolic sine and the natural logarithm of

²⁸There is still an ongoing debate on whether lands under absolute occupancy rights in the Central Provinces should be considered to be under a landlord based system or not (Banerjee and Iyer, 2013).

Table 4: General robustness checks

	District and local boards revenue				
	(1)	(2)	(3)	(4)	(5)
Non-landlord proportion (B&I)	668.864*** (166.396)	1037.235*** (367.439)		829.183*** (159.564)	477.801*** (154.913)
Non-landlord proportion (IPS)			1206.040*** (312.031)		
Constant	-1917.892** (865.842)	-3796.732 (2477.460)	-4732.066** (1937.743)	-2759.309*** (956.384)	-1023.335 (884.586)
	Native subscriptions revenue				
	(1)	(2)	(3)	(4)	(5)
Non-landlord proportion (B&I)	-171.048* (95.263)	-259.518** (120.290)		-449.751*** (99.223)	-142.142** (55.939)
Non-landlord proportion (IPS)			-301.754** (136.428)		
Constant	-38.771 (388.207)	396.278 (851.385)	630.301 (735.898)	1344.847*** (483.076)	122.277 (299.664)
	Total revenue in ln				
	(1)	(2)	(3)	(4)	(5)
Non-landlord proportion (B&I)	0.360** (0.156)	0.552** (0.249)		0.189 (0.132)	0.382** (0.166)
Non-landlord proportion (IPS)			0.642*** (0.234)		
Constant	6.651*** (0.841)	6.325*** (0.880)	5.827*** (1.266)	8.134*** (0.852)	7.122*** (0.958)
Observations	1200	1675	1675	1675	1507
Kleibergen-Paap rk Wald F statistic	32.156	5.815	21.231	77.987	24.942
District Population	YES	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES	YES
District controls	YES	YES	YES	YES	YES
SE Clustered at district level	YES	NO	YES	YES	YES
SE Clustered at provincial level	NO	YES	NO	NO	NO

Note: IV estimates for each revenue source introducing some changes to the baseline estimation. (1) shows the IV estimates dropping all hospitals and dispensaries from Bengal. (2) shows the IV estimates clustering standard errors at the provincial level. (3) shows the IV estimates using Iversen et al. (2013) as an alternative to estimate the non-landlord proportion. (4) uses the distance to Plassey as an alternative instrument. Finally, (5) shows the IV estimates dropping the highest decile observations for each revenue source. For more on controls and data sources see Section 3.1.

Table 5: Conley standard errors with different cutoffs

	District and local boards revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	819.727*** (159.096)	819.727*** (167.038)	819.727*** (173.853)	819.727*** (166.482)
	Native subscriptions revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	-236.816*** (85.566)	-236.816*** (85.464)	-236.816*** (89.427)	-236.816* (124.206)
	Total revenue in ln			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	0.915*** (0.214)	0.915*** (0.214)	0.915*** (0.233)	0.915*** (0.303)
Observations	1675	1675	1675	1675
District Population	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES
SE Clustered at district level	NO	NO	NO	NO

Note: Conley standard errors with different cutoffs. (1) shows the results for each revenue source using Conley standard errors with a 25km cutoff. (2) shows the results for each revenue source using Conley standard errors with a 50km cutoff. (3) shows the results for each revenue source using Conley standard errors with a 100km cutoff. Finally, (4) shows the results for each revenue source using Conley standard errors with a 200km cutoff. Data sources are pointed out in Section 3.1.

Table 6: IV with different transformations of the dependent variables

	D & L revenue		Native subs revenue		Total
	(1)	(2)	(3)	(4)	(5)
Non-landlord proportion (B&I)	2.705*** (0.729)	2.542*** (0.672)	-3.283*** (1.013)	-2.960*** (0.910)	0.552*** (0.196)
Constant	-6.117 (4.588)	-5.820 (4.217)	-0.526 (5.770)	-0.130 (5.172)	7.018*** (1.072)
Observations	1675	1675	1675	1675	1675
District Population	YES	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES	YES
District controls	YES	YES	YES	YES	YES
SE Clustered at district level	YES	YES	YES	YES	YES

Note: IV estimates with alternative transformations of the dependent variables. (1) and (2) show the IV estimates for the district and local boards revenue using the asinh and $\ln(1+Revenue_{\delta,i})$ transformations respectively. (3) and (4) present the same changes as in (1) and (2) but for the native subscriptions revenue. Finally, (5) introduces the IV estimates for total revenue using the asinh transformation. Data sources are pointed out in Section 3.1.

the revenue plus one $-\ln(1+Revenue_{\delta,i})$. I use the natural logarithm of the revenue plus one to avoid losing all 0 observations. For the total revenue, instead of using the natural logarithm -as done in all my other regressions- I use its inverse hyperbolic sine. Table 6 shows all these alternative estimations, and the coefficient of interest remains significant at 1% for all transformations of the dependent variables.

4.2 Mechanisms

There are various mechanisms that can explain the effect of land revenue systems on revenues from district and local boards as well as native subscriptions. In the following paragraphs, I provide evidence on two mechanisms potentially driving the link between land revenue systems and the revenue (re)sources of hospitals and dispensaries in colonial India. Most importantly, both mechanisms are linked to the agency of local landlords, which influenced how the land revenue systems affected the (re)sources available to hospitals and dispensaries.

4.2.1 Land revenue collection

Larger collections of land revenue may explain the larger revenue of hospitals and dispensaries in non-landlord districts from district and local boards. In fact, as argued in section 2, district and local boards had limited capacity to increase their revenues as they were mainly financed by provincial grants -the extent of which could change depending on the land revenue collected- and land revenue cesses -an additional surcharge on land revenue, whose variability depended mostly on the land revenue assessed and collected-. Land revenue cesses represented 60% of district boards income in the 19th century, while provincial grants started gaining ground in the 1900s and by 1929-30 represented 43% of district boards revenue, compared to the 36% of cesses (Chaudhary, 2010b, p. 281). Provinces allocated grants on a per capita basis and, although initially larger grants were provided to districts rising more revenue, over time poorer districts and those populated by minorities received more money (Chand, 1947; Chaudhary, 2010b). Overall, provinces -through grants- and districts -through cesses- collecting more land revenue could provide district and local boards with more resources, which they could spend on hospitals and dispensaries.

In this context, land revenue systems were closely related to the land revenue assessment and collection, and that to the funds available for district and local boards. Landlord (non-landlord) districts tended to collect less (more) land revenue due to two main reasons.

First, the British state maintained a lower number of village officials in landlord areas. These village officials were vital for the assessment and collection of land revenue. Village accountants were responsible for the compilation of each landed estate's statistics required for the assessment of the land revenue while the village headman was responsible for the collection of the land revenue among village landowners and its delivery to the British collector. These village officials were considered as civil servants and were paid by the colonial state -see (Baden-Powell, 1892a; Baden-Powell, 1892b; Baden-Powell, 1892c)-. The low number of village officials in landlord areas was fuelled by the concentration of landed estates into only a few landowners, specially when compared with non-landlord areas (Banerjee and Iyer, 2005, p. 1197). Such land concentration substantially reduced government's incentives to sustain a large number of village officials in landlord areas, as land revenue demand was clustered in a few landlords (Lee, 2018, p. 13). Overall, the introduction of landlord land revenue systems led to large land concentration levels which disincentivized the presence of state officials. This is in line with the mechanism signalled in Galor et al. (2009) through which land inequality may affect the provision of education.

Furthermore, landlords' central role on land revenue assessment and collection was not only enhanced by the lower presence of village officials but also by their appointment. In fact, landlords were deeply involved in the selection of these village offices. In the North-Western provinces, landlords nominated all village accountants -subject to final approval by the British collector- while in Oudh landlords directly appointed them (Baden-Powell, 1892b, p. 268-283). Even more explicitly, the village headman was a notable landlord in the Central Provinces (Baden-Powell, 1892b, p. 504-505). Finally, in Bengal the accountants -if existed- were directly employed by the landlord (Baden-Powell, 1892a, p. 673-680). By contrast, in the non-landlord province of Madras, the village headman and accountants were directly appointed by the British collector (Baden-Powell, 1892c, p. 87-89). Moreover, most accountants and village headmen in non-landlord areas were Brahmans, which were usually not landowners (Suryanarayan, 2021, p. 12-13). Overall, landlords were in a far better position to hold their case for a low assessment of land revenue than landowners in non-landlord areas, who had no control over the appointment of village officials. This, combined with the larger land concentration, allowed for systematically less land revenue collected in districts with landlord-based land revenue systems.

Last but not least, landlord districts tended to have a land revenue demand fixed in perpetuity -permanent settlement- for some lands

while non-landlord districts were usually temporary settled, meaning that land revenue demand was updated every 20-30 years.²⁹ Therefore, non-landlord districts tended to collect more land revenue simply because its demand could be updated.

Table 7: OLS estimates showing how the share of village officials and the presence of permanent settlement relate to the non-landlord proportion and the land revenue collection

	Non-landlord proportion		Land revenue collection PC			
	(1)	(2)	(3)	(4)	(5)	(6)
Share of village officials	66.717*** (13.890)	38.865** (17.341)	156.468*** (17.829)	116.161*** (18.851)		
Presence of permanent settlement	-0.342*** (0.052)	-0.300*** (0.087)	-0.313*** (0.091)	-0.512*** (0.147)		
Non-landlord proportion (B&I)					0.940*** (0.118)	0.708*** (0.164)
Constant	0.446*** (0.054)	2.417*** (0.682)	0.961*** (0.077)	0.093 (1.453)	0.769*** (0.052)	0.377 (1.450)
Observations	169	169	164	164	164	164
R-Squared	0.382	0.549	0.393	0.581	0.303	0.528
Geographic controls	NO	YES	NO	YES	NO	YES
Economic controls	NO	YES	NO	YES	NO	YES
Caste and religious controls	NO	YES	NO	YES	NO	YES

Note: OLS estimates showing how the share of village officials and the presence of permanent settlement relate to the non-landlord proportion and the per capita land revenue collection. (3) and (4) show the correlation between per capita land revenue collected and the share of village officials and the presence of permanently settled lands. Finally, (5) and (6) show the link between the per capita land revenue collected and the non-landlord proportion. Geographic controls include district longitude, latitude, mean altitude, maximum altitude, rainfall and a coastal dummy. Economic controls include railway miles in the district and the urbanization rate. Finally, caste and religious controls include the CRFI, the share of Hindus and the share of Muslims. Data sources are pointed out in Section 3.1 and Section 4.2.

In Table 7 I provide evidence that in landlord areas, local landlords -through their control of the appointment of village officials and the small number of the latter- received lower land revenue demands. More precisely, the 1911 share of male village officials over total male agricultural workers relates positively and significantly with the non-landlord proportion, even after controlling for the presence of permanent settlements and an array of geographic, economic and caste and religious controls -see columns (1) and (2)-.³⁰ Additionally, I test if the presence of permanent settlements can explain the differences in land revenue collection. To do so, I use a dummy with value 0 for those districts that had some land permanently settled and with value 1 for those only temporarily settled.³¹ Columns (1) and (2) show a negative and significant link between landlord districts and the introduction of the permanent settlement. In line with these results, the non-landlord proportion relates positively with the land revenue collection per capita -see columns (5) and (6)-.³² More specifically, non-landlord districts collected 1.31 standard deviations more land revenue per capita than a landlord district -see column (5)-.

Finally, Table 8 shows how the collection of land revenue was positively and significantly linked with the hospitals and dispensaries' revenue received from district and local boards. Overall, this evidence shows that hospitals and dispensaries in landlord districts had less revenue from district and local boards due to less land revenue being collected in these districts. This was mostly due to the small presence of village officials and landlords' influence in their appointment as well as to the permanent settlement introduced in landlord areas.

²⁹For more on the type of settlement see Baden-Powell (1892a).

³⁰See Note in Table 7 for a complete list of controls included. Data for the share of village officials is obtained from *Census of India (1911)*.

³¹Data on the type of settlement available at the *Agricultural Statistics of India*.

³²Data on the land revenue collected comes from the provincial *Reports on the (land) revenue administration*.

Table 8: OLS estimates testing the land revenue collection mechanism

	District and local boards revenue		
	(1)	(2)	(3)
Land revenue collection in ln (1901)	277.837*** (49.802)	198.238*** (46.884)	200.069*** (51.762)
Constant	-3173.760*** (634.122)	-2288.002** (1086.937)	-1891.471* (1109.306)
Observations	1630	1630	1630
R-Squared	0.059	0.155	0.163
District Population	YES	YES	YES
Hospital and dispensary controls	NO	YES	YES
District controls	NO	NO	YES
SE Clustered at district level	YES	YES	YES

Note: OLS estimates testing the land revenue collection mechanism. (1) is a district level estimate showing the link between land revenue collection and the non-landlord proportion. (2), (3) and (4) present hospital and dispensary level estimates for the link between district and local boards revenue and land revenue collection. Data sources are pointed out in Section 3.1 and Section 4.2.

4.2.2 Allegiance and prestige

Larger land revenue collection in non-landlord districts can explain the link between the non-landlord proportion and district and local boards revenue, but it is hard to imagine how it could explain the larger revenue from native subscriptions in landlord areas. In fact, I argue that showing allegiance to the British and increasing prestige motivated these larger native subscriptions and donations in landlord areas.

Medical patronage -mostly done by landlords, merchants and native officials- was sometimes the result of pressure from colonial authorities (Arnold, 1993, p. 269). However, it was also part of an accommodation strategy, where Indian elites made donations to hospitals and dispensaries in exchange of greater influence, prestige and even political recognition. These abstract compensations could materialize in the form of a personal message from Queen Victoria, some title, state gift or *simply* the good will of the local Collector or Resident (Arnold, 1993, p. 270-271). Moreover, the names and amounts from the largest donations and subscriptions were mentioned in official reports such as the *Reports on the civil hospitals and dispensaries*. To exemplify, in the *Triennial Report on the working of the Charitable Dispensaries under the Government of Bengal (1901)* it is stated how the Maharani Sarat Sundari Barmin of Tajhat donated 12,000 rupees to the Rangpur Hospital or how two Muhammadan noblemen -Syed Muhammad Mehdi Khan and Syed Shah Mahammad Kamal- paid donations of 5,000 and 2,000 rupees to the Bankipore Hospital.³³ The *Annual Report of the Dispensaries and Charitable Institutions of the Punjab (1901)*, states the names of subscribers paying over 50 rupees.³⁴ These acknowledgements in official reports show how large donors and subscribers were identified by the British and possibly by those living close or interacting with hospitals or dispensaries.

Additionally, landlords used this recognition to show their allegiance to the British. This was specially useful for landlords in areas where there had been more insurrectional activity during the revolt of 1857 -also known as the Mutiny or First War of Independence-. The revolt started on May the 10th of 1857, with the mutiny of the sepoys stationed in Meerut and ended by late 1858. Such a rebellion was fueled by a diversity of fears, grievances and social groups such as the Indian soldiers in the EIC's army, Hindus, Muslims, Rajas, landlords and even peasants (Chakravarty, 2005, p. 23). The revolt did not only mark the transfer of India from the EIC to the Crown, but it had lasting and significant effects on the British administration and policies. In fact, prior to the revolt, the EIC administration had embarked in a process to anglicize India's administration, society and tradition. However, these goals were partly abandoned with the resistance met during the revolt, after which the British administration swiftly switched to a much more conservative approach.³⁵ To exemplify, social reform and capitalist transformations of the Indian countryside were mostly discouraged with the protection of peasant land from moneylenders by the British administration fearing that could lead to another

³³ *Triennial Report on the working of the Charitable Dispensaries under the Government of Bengal (1901)*. Pages 26-27.

³⁴ *Annual Report of the Dispensaries and Charitable Institutions of the Punjab (1901)*. Page 9.

³⁵ On officers' ideology before the revolt see Stokes (1959). On the post-mutiny conservative policies see Metcalf (1962) and Washbrook (1981).

mass revolt (Washbrook, 1981, p. 684-686). Another example of these policy changes is the restoration of taluqdars in Oudh.³⁶ The EIC acquisition of Oudh through the Doctrine of Lapse led to the introduction of a mostly non-landlord system following that introduced in the western districts of the United Provinces. The annexation and the loss of land rights by most pre-colonial tax collectors -taluqdars- partly motivated the uprising of 1857, which was led by taluqdars as well as former rajas and had the support of most peasants, who viewed the taluqdars as the true and rightful landowners. In the end, despite suppressing the revolt, the British acknowledged the importance of having the taluqdars on their side by making them landowners, valuing their favour over social reform (Metcalf, 1962, p. 156).

Table 9: OLS estimates testing the alignment mechanism

	Revolt BS	Native subscriptions revenue		
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	88.979** (36.810)			
Distance to the nearest battle site in km		-0.633*** (0.142)	-0.386*** (0.134)	-0.314** (0.145)
Constant	205.135*** (21.242)	188.745*** (41.154)	-1076.150*** (249.773)	-755.229** (319.269)
Observations	1675	1675	1675	1675
R-Squared	0.038	0.024	0.061	0.066
District Population	NO	YES	YES	YES
Hospital and dispensary controls	NO	NO	YES	YES
District controls	NO	NO	NO	YES
SE Clustered at district level	YES	YES	YES	YES

Note: OLS estimates testing the need to show alignment as a mechanism driving the link between landlord areas and native subscriptions revenue. (1) estimates the relation between the distance to a 1857 revolt battle site and hospitals and dispensaries in landlord districts. (2), (3) and (4). Data sources are pointed out in Section 3.1 and Section 4.2.

These policy changes show the huge shadow that the revolt of 1857 had on the British administration, and point at the need and eagerness of such administration to formalize alliances with the Indian society and its elites, specially after the revolt and in areas mostly affected by it. With that in mind, I explore this British need for alliances and landlord willingness to show allegiance as a driver of these larger revenues from native subscriptions in landlord areas. More specifically, I argue that the revolt was most acute in landlord areas. That encouraged landlords to show their allegiance after the revolt and showed the British whose allegiance they should look for. That being said, providing donations and subscriptions whilst, at the same time, lobbying to reduce the land revenue demand -as argued in Section 4.2.1- could be contradictory behaviours by the landlords. However, the payment of land revenue was a necessary condition to hold landownership. This means that landlords already received a return for that payment -landownership-, which was independent of the amount paid. Therefore, it would make sense for them to minimize land revenue demands and use private subscriptions and donations to show allegiance, as these donations were voluntary and sent a clearer -probably cheaper- message to the British. In line with that, some works have pointed at the preference of landowners to finance public goods through donations rather than taxation, specially in anglophone countries -see for instance (Goñi, 2021)-.

To test the role of allegiance driving larger private subscriptions in landlord areas, I look at the distance of hospitals and dispensaries from the closest battle fought during the 1857 revolt. I also test whether landlord areas were more prone to have battles occurring during the revolt. The data on the battle sites comes from Schwartzberg (1978) map on the 1857 revolt.³⁷ Results from Table 9 show how hospitals and dispensaries in landlord districts were significantly closer to battle sites from the 1857 revolt -see column (1)-. Also, the further away from a 1857 revolt battle site, the lower the revenue from native subscriptions. Once considering all my controls -see column (4)- a mean increase in the distance to a battle site results in a significant 0.1 standard deviation reduction

³⁶Taluqdars were the tax collectors in Oudh before the EIC annexation.

³⁷This data and all maps from Schwartzberg (1978) are available [online](#). For a map representing the battle sites with the non-landlord proportion of each district see Figure 5 from Section 6.6 in the Appendix.

of the native subscriptions revenue. This value may seem small, but for the native subscriptions revenue, a standard deviation translates into 3.7 times its mean.

5 Conclusions

In this paper I analyse the impact of land revenue systems on the funding of hospitals and dispensaries in colonial India. Based on a new georeferenced database on 1901 hospitals and dispensaries I present the following results. First, there were important differences in the resources available to hospitals and dispensaries, which can be partially explained by the introduction of certain land revenue systems. Second, hospitals and dispensaries in non-landlord districts received a significantly larger revenue from district and local boards and overall revenue. Alternatively, hospitals and dispensaries in landlord districts had a significantly larger revenue from native subscriptions. Finally, the effect of land revenue systems was driven by their interaction with local elites, who influenced revenue collection and the revenue from private subscriptions and donations. These findings are robust to various checks and alternative estimations.

Such evidence complements the literature on the determinants of public goods provision -e.g. (Chaudhary, 2009; Galor et al., 2009)- looking at the determinants of health provision, which have mostly been overlooked in the literature. Also, these findings contribute to the literature exploring institutions as drivers of development by highlighting how local agency can drive the effect of colonial institutions on public goods provision and development in general. Hence, the impact of a colonial institution -land revenue systems- on development is not only dependent on colonial agency but also on the interests and actions of the natives. This is also in line with the ambivalent effect of decentralization signalled by Lindert (2004): in landlord districts, local landlords were powerful enough to lower the resources available to the district and local boards, while that did not occur in non-landlord districts. Additionally, the results presented in this paper are in line with the literature on the evolution of western medicine in colonial India. Finally, this paper provides an explanation for the differences in colonial healthcare provision that might relate with persistent effects on health outcomes and trust on western medicine observed in India and other former colonies.

In a nutshell, colonial institutions -e.g. land revenue systems- can explain differences in the funding of hospitals and dispensaries, and do so through their interaction with the agency of local elites and their capacity to limit tax collection. Exploring the impact of the agencies of other social groups on health and the provision of other public goods could be a productive avenue for future research. Finally, the effect of these hospitals and dispensaries on the way Indian people perceived western medicine and its potential long-lasting impacts might also be an interesting research topic.

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6 Appendix

6.1 Distribution of hospitals and dispensaries in 1901

6.2 Infant mortality rates and per capita revenue for hospitals and dispensaries

In this section I provide some preliminary evidence on the link between infant mortality rates and per capita revenue for hospitals and dispensaries clustered at the district level. To measure infant mortality, I use the number of male and female children that

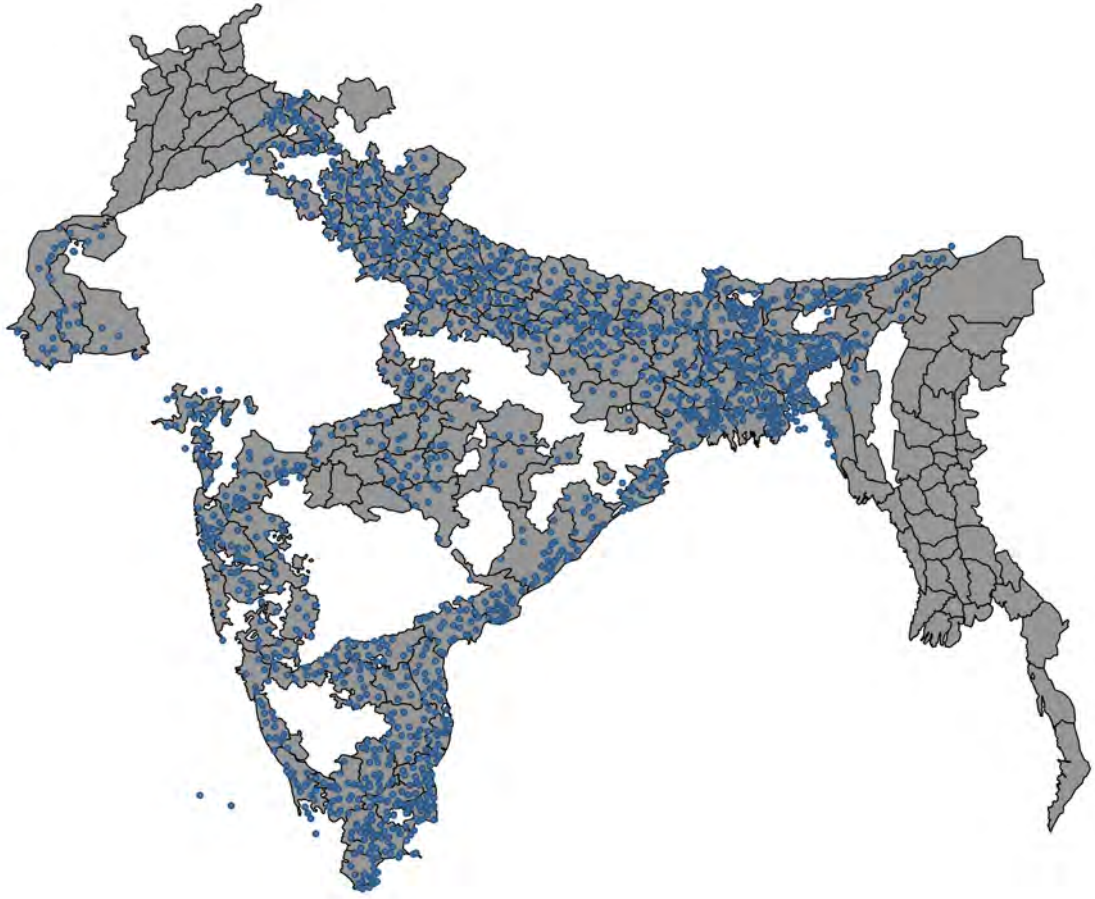


Figure 4: Map showing the georeferenced hospitals and dispensaries in 1901. I have no data on the Pakistani part of Punjab -top left corner-, Berar -in between the Central Provinces and Bombay- and Burma -right hand side-.

died with less than a year and divide that by the number of male and female births respectively. This data was collected from the provincial *Annual Sanitary Reports* for years 1901 and 1910. Data on total revenue for hospitals and dispensaries comes from 1901 provincial *Reports on the civil hospitals and dispensaries* whilst the population data to convert these revenues on per capita terms comes from *Census of India (1901)*. Table 10 shows the link between infant mortality rates in 1901 and 1910 with per capita revenue of hospitals and dispensaries clustered at the district level.

Results show a negative but weak link between the two, which is significant only for 1910. More specifically, a 1 standard deviation increase in the district total revenue for hospitals and dispensaries per capita in 1901 resulted in a reduction of 0.01 standard deviations of the male infant mortality rate in 1910. These results would suggest that whilst there might have been some effect of more revenue for hospitals and dispensaries on short-term infant mortality rates, such effect was not large nor systematically significant. Finally, it is also worth mentioning that the coefficient becomes more negative in all specifications for 1910 infant mortality rates. This could be due to the fact that 1901 was a year with famines but it could also be that the link strengthened over time as more people engaged with hospitals and dispensaries and changed to more healthy habits.

Table 10: Infant mortality rates and per capita revenue for hospitals and dispensaries

	1901 infant mortality rate by sex			
	Male	Female	Male	Female
Total revenue per capita per district	-0.084 (0.057)	-0.024 (0.061)	-0.043 (0.071)	0.058 (0.077)
Constant	0.215*** (0.004)	0.203*** (0.005)	0.220*** (0.083)	0.283*** (0.087)
	1910 infant mortality rate by sex			
	Male	Female	Male	Female
Total revenue per capita per district	-0.104* (0.054)	-0.111* (0.062)	-0.140** (0.069)	-0.066 (0.062)
Constant	0.225*** (0.004)	0.214*** (0.004)	0.164* (0.087)	0.183** (0.086)
Observations	169	169	169	169
Geographic controls	NO	NO	YES	YES
Economic controls	NO	NO	YES	YES
Caste and religious controls	NO	NO	YES	YES

Note: Infant mortality rates and per capita revenue for hospitals and dispensaries. Data sources for controls are pointed out in Section 3.1.

6.3 District Board per capita medical expenditure

As pointed out in Section 3.1, the 1901 Provincial *Reports on the civil hospitals and dispensaries* did not report revenues from district and local boards separately from other local public institutions. Despite most revenue reported as local funds seems to be from district and local boards, these local funds are not perfectly capturing revenue from district and local boards.

To mitigate concerns on the impact of this noise, I introduce Table 11, which regresses my IV with the per capita medical expenditure by district boards in 1901. This is also not a perfect measure of expenditure of district and local boards on hospitals and dispensaries, as other expenditures -e.g. vaccination- are also included. However, the results are very similar to the results in my IV estimates -see Table 3-. After including all controls, a non-landlord district has a district board per capita medical expenditure 0.87 standard deviations larger than a landlord district. This effect is almost identical in magnitude to my IV estimate including all controls -0.90 standard deviations- from column (3) in Table 3-. Overall, it seems like the potential measurement error from using revenue from local funds reported in the 1901 provincial *Reports on the civil hospitals and dispensaries* as revenue from district and local boards

should not affect my results.

Table 11: IV using District Board per capita medical expenditure in 1901

	District Board per capita medical expenditure in ln			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	1.190*** (0.261)	0.785** (0.357)	0.707* (0.372)	0.868** (0.354)
Constant	-5.035*** (0.149)	-2.101 (2.073)	-3.848* (1.970)	-8.612*** (2.337)
Observations	155	155	155	155
Kleibergen-Paap rk Wald F statistic	58.804	31.675	31.935	29.177
R-Squared	0.318	0.381	0.403	0.441
Geographic controls	NO	YES	YES	YES
Economic controls	NO	NO	YES	YES
Caste and religious controls	NO	NO	NO	YES

Note: District Board per capita medical expenditure in 1901 in natural logarithms is the dependent variable in all specifications. Data comes from the different *District Gazetteers*. Geographic controls include district longitude, latitude, mean altitude, maximum altitude, rainfall and a coastal dummy. Economic controls include railway miles in the district and the urbanization rate. Finally, caste and religious controls include the CRFI, the share of Hindus and the share of Muslims. Data sources are pointed out in Section 3.1.

6.4 Dropping potential outliers

Determining a threshold to consider observations as outliers -and drop them from the analysis- is subjective. Therefore, in Table 12, I provide for several thresholds from which I could consider observations as outliers and drop them. From there, it is clear how my results are not sensitive to the threshold I chose to consider observations as outliers.

6.5 Alternative measures of spatial correlation

A part from using Conley standard errors, I estimate my IV baseline results using Spatial Autoregressive Models (SAR). These models are estimated using Generalized Spatial Two Stage Least Squares (GS2SLS) and include a spatial weighted matrix W_n representing the inverse of the distances between the different district centroids. Interacting this spatial weighted matrix W_n allows these models to account for spatial lags of the dependent variable and spatial correlation within the error term -see equations 2 and 3-:

$$Revenue_{\delta,i} = \beta_0 + \beta_1 NonLandlord_r + \beta_2 Population_r + \beta_3 X_i + \beta_4 \Gamma_r + \lambda W_n Revenue_{\delta,i} + u_i \quad (2)$$

$$u_i = \rho W_n u + \varepsilon_i \quad (3)$$

λ in equation 2 represents the spatial lag coefficient for the dependent variable. ρ in equation 3 is the coefficient representing spatial dependence between the error term and the non-landlord proportion estimated using the type of settlement as instrument.

Estimations in Table 13 show how after including all my controls -see column (3)-, the IV coefficient remains significant for all revenue sources and with a similar magnitude to that reported in Table 3.

Finally, I look at the significance of my IV estimation for the non-landlord proportion using a different way to cluster standard errors than the one suggested by Conley (1999). I follow Colella et al. (2019) estimating a variance-covariance matrix accounting

Table 12: IV dropping potential outliers with high values of district and local boards, native subscriptions and total revenue

	District and local boards revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	355.160*** (128.654)	369.236*** (124.370)	320.447*** (115.572)	325.675*** (111.703)
Constant	-351.616 (735.093)	-470.474 (707.651)	-251.674 (661.127)	-523.216 (630.391)
	Native subscriptions revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	-146.213*** (35.662)	-128.327*** (30.740)	-100.085*** (25.681)	-90.840*** (23.108)
Constant	235.010 (199.379)	190.155 (174.153)	82.977 (146.690)	161.071 (132.314)
	Total revenue in ln			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	0.442*** (0.163)	0.435*** (0.167)	0.427** (0.170)	0.469*** (0.163)
Constant	6.629*** (0.914)	6.764*** (0.923)	6.621*** (0.915)	6.217*** (0.887)
Observations	1465	1434	1394	1338
Kleibergen-Paap rk Wald F statistic	26.175	25.129	24.413	27.475
District Population	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES
District controls	YES	YES	YES	YES
SE Clustered at district level	YES	YES	YES	YES

Note: IV estimates dropping observations within the highest (1) octile, (2) septile, (3) sextile and (4) quintile for every revenue source. Data sources are pointed out in Section 3.1.

Table 13: Spatial Autoregressive Models (SAR)

	District and local boards revenue		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	659.144*** (232.514)	915.939*** (183.101)	872.680*** (185.528)
λ	2.519*** (0.868)	2.644*** (0.618)	2.541*** (0.612)
ρ	-0.226* (0.128)	-0.306** (0.141)	-0.287** (0.142)
Constant	19.264 (175.741)	-1621.686* (839.252)	-2888.861** (1138.554)
	Native subscriptions revenue		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	-223.650 (135.331)	-206.839 (138.626)	-244.468* (138.626)
λ	2.433 (2.125)	2.491* (1.285)	1.754 (1.301)
ρ	-1.330 (1.375)	-1.021 (1.085)	-0.935 (1.241)
Constant	268.311** (126.812)	-303.869 (621.565)	360.072 (852.405)
	Total revenue in ln		
	(1)	(2)	(3)
Non-landlord proportion (B&I)	0.398** (0.176)	0.528*** (0.123)	0.424*** (0.125)
λ	0.161** (0.073)	0.137*** (0.051)	0.138*** (0.049)
ρ	0.357 (0.234)	0.123 (0.360)	0.090 (0.394)
Constant	7.083*** (0.134)	6.316*** (0.566)	7.031*** (0.767)
Observations	1675	1675	1675
District Population	YES	YES	YES
Hospital and dispensary controls	NO	YES	YES
District controls	NO	NO	YES
SE Clustered at district level	NO	NO	NO

Note: (1) shows the SAR controlling only for district population for all revenue sources. (2) introduces hospital and dispensary controls for all revenue sources. Finally, (3) presents the SAR with all controls for all revenue sources. Data sources are pointed out in Section 3.1.

for the spatial autocorrelation in the error term through arbitrary clustering structures with different sizes. Table 14 shows these estimations which suggest that the non-landlord proportion remains a significant factor explaining the revenue received by hospitals and dispensaries from district and local boards, native subscriptions as well as total revenue.

Table 14: IV estimates considering arbitrary clustering structures

	District and local boards revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	1037.235*** (269.412)	1037.235*** (289.516)	1037.235*** (312.795)	1037.235*** (297.739)
Constant	-3796.732** (1727.878)	-3796.732** (1872.805)	-3796.732* (1979.447)	-3796.732** (1889.136)
	Native subscriptions revenue			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	-259.518** (107.852)	-259.518** (126.156)	-259.518* (143.860)	-259.518* (155.181)
Constant	396.278 (599.090)	396.278 (716.931)	396.278 (789.369)	396.278 (866.967)
	Total revenue in ln			
	(1)	(2)	(3)	(4)
Non-landlord proportion (B&I)	0.552*** (0.167)	0.552*** (0.182)	0.552*** (0.193)	0.552*** (0.195)
Constant	6.325*** (0.990)	6.325*** (1.055)	6.325*** (1.060)	6.325*** (1.002)
Observations	1675	1675	1675	1675
District Population	YES	YES	YES	YES
Hospital and dispensary controls	YES	YES	YES	YES
District controls	YES	YES	YES	YES
SE Clustered at district level	NO	NO	NO	NO

Note: IV estimates considering arbitrary clustering structures with various distances (in km) which spatial dependence is likely to reach. (1) shows the results for an arbitrary cluster distance of 25km. (2) shows the results for an arbitrary cluster distance of 50km. (3) shows the results for an arbitrary cluster distance of 75km. Finally, (4) shows the results for an arbitrary cluster distance of 100km. Data sources are pointed out in Section 3.1.

6.6 1857 revolt battle sites

6.7 Summary statistics

1857 Revolt and non-landlord proportion

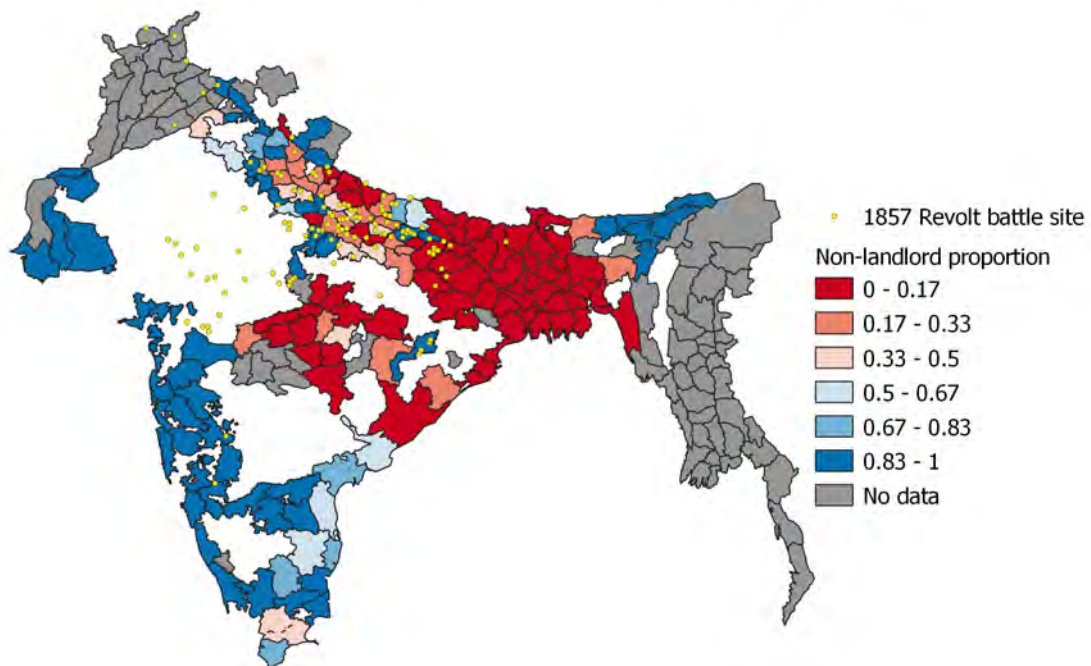


Figure 5: Map showing the georeferenced 1857 battle sites and the non-landlord proportion at the district level. Data on the battle sites from Schwartzberg (1978).

Table 15: Summary statistics

Output variables					
	Obs	Mean	Std. dev	Min	Max
District and local boards revenue	1675	816.4357	1150.431	0	13598.06
Native subscriptions revenue	1675	220.547	815.9373	0	12628
Total revenue in ln	1675	7.344834	.842895	1.989585	11.03823
Variables of interest and instruments					
	Obs	Mean	Std. dev	Min	Max
Non-landrod proportion (B&I)	1675	.4758093	.4194363	0	1
Non-landrod proportion (IPS)	1675	.4918135	.4121098	0	1
Districts conquered between 1820 and 1856	1675	.1307463	.3372233	0	1
Distance from Plassey battle site	1675	1022.092	637.305	21.87218	2345.739
Population controls					
	Obs	Mean	Std. dev	Min	Max
District population	1675	1482392	798508	82434	3915068
Hospital and dispensary controls					
	Obs	Mean	Std. dev	Min	Max
Hospital dummy	1675	.4316418	.495453	0	1
Female institution dummy	1675	.0197015	.139014	0	1
Hospital or dispensary longitude	1675	81.73214	5.976632	67.16514	95.62938
Hospital or dispensary latitude	1675	21.83282	5.975821	8.266022	32.53668
Hospital or dispensary altitude	1675	179.5307	271.7204	0	2258
Distance to railway	1675	21.68464	26.0051	.0007121	228.7479
<i>Type of soil dummies</i>					
Cambisols dummy	1675	.1934328	.3951073	0	1
Fluvisols dummy	1675	.1140299	.3179424	0	1
Luvisols dummy	1675	.2364179	.4250086	0	1
Nitisols dummy	1675	.0561194	.2302209	0	1
District controls					
	Obs	Mean	Std. dev	Min	Max
Mean rainfall	1675	53.38664	32.54309	3	215.5
Coastal dummy	1675	.32	.4666155	0	1
Urbanization rate	1675	.0951132	.0734564	0	.3689131
Caste and religious fragmentation (CRFI)	1675	.7480754	.1848934	.027702	.931729
Hindu share	1675	.7346475	.2395947	.0264722	1
Muslim share	1675	.2120882	.2318868	.0019228	.9015148