Essays in the Economic History of South Asia: 1891 to 2009

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Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in History

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Abstract

This thesis presents research that subscribes to the broader theme of the Economic History of South Asia from 1891 to 2009. First, Chapter 2 shows that the Partition induced expulsion of religious minorities reduced school provision in Pakistan. The effect of minorities is explained by their education, occupational structure and their contribution towards local social capital. Then, Chapter 3 examines how areas affected by the Partition fare in terms of long-run agricultural development in India. It finds that areas that received more displaced migrants after Partition perform better in terms of crop yields, are more likely to take up of high yielding varieties (HYV) of seeds, and are more likely to use agricultural technologies. It highlights the superior educational status of the migrants as a potential pathway for the observed effects. Next, Chapter 4 shows that the agricultural productivity shock induced by the adoption of HYV of seeds reduced infant mortality across districts in India. It uses data on the characteristics of children and mothers in the sample to show that it was children born to mothers whose characteristics generally correlate with higher child mortality, children born in rural areas, boys, children born in rice and wheat producing districts and children born in poorer households who benefit more from HYV adoption. Furthermore, Chapter 5 shows that baseline differences in irrigation prior to the adoption of HYV are associated with differences in the growth of yields after adoption. It explores the relationship between irrigation and yields over time to uncover potential mechanisms for the observed relationship. Finally, Chapter 6 empirically investigates the relationship between religious shrines and literacy in the Punjab province of Pakistan.

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Statement of Originality

My thesis comprises five essays. Below, I provide details of my individual contributions to each paper.

"Minorities and Public Goods Provision: Evidence from Pakistan through Partition" (sole-authored)

This is a sole-authored paper wholly written by myself.

"Displacement and Development: Partition of India and Agricultural Development" (with Prashant Bharadwaj)

Prashant and I jointly developed the initial research hypothesis and empirical framework. I collected and cleaned the data and conducted the empirical analysis. Prashant and I jointly wrote the text of the paper.

"The Green Revolution and Child Mortality in India" (with James Fenske, Prashant Bharadwaj and Namrata Kala)

All authors jointly developed the initial research hypothesis. James developed the empirical framework, cleaned the data and conducted the empirical analysis. James and I collected the data. I wrote the entire text of the paper.

"Irrigation, the Green Revolution and Agricultural Development in India" (sole-authored)

This is a sole-authored paper wholly written by myself.

"Religion, Land and Politics: Shrines and Literacy in Punjab" (with Adeel Malik)

Adeel and I jointly developed the initial research hypothesis. I collected and cleaned the data. I also developed the empirical framework and conducted the empirical analysis. Adeel and I jointly wrote the text of the paper.

Abstract

The research presented in this thesis subscribes to the broader theme of the Economic History of South Asia from 1891 to 2009. First, Chapter 2 evaluates the impact on school provision of the Partition induced expulsion of religious minorities from Pakistan. Its results show that the presence of minorities contributed towards school provision. The effect of minorities is in part explained by their higher pre-partition literacy rates. However, the minorities were also important because of their occupational structure and the social capital that they sustained through their participation in shared religious festivals. Next, Chapter 3 examines how areas in post-independence India affected by the Partition fare in terms of their long-run agricultural development. It finds that areas that received more displaced migrants after Partition have higher average crop yields, are more likely to take up high yielding varieties of seeds, and are more likely to use agricultural technologies. It highlights the education of the displaced migrants as a potential a pathway for the observed effects. Furthermore, Chapter 4 finds that the adoption of high yielding varieties of seeds reduced infant mortality across districts in India. It shows that children born to mothers whose characteristics generally correlate with higher child mortality, children born in rural areas, boys, children born in rice and wheat producing districts and children born in poorer households benefit more from HYV adoption. Then, Chapter 5 shows that areas that had an initial advantage in irrigation infrastructure prior to the Green Revolution experienced greater increases in both wheat and rice yields after the start of the Green Revolution. While for wheat there was additional growth in yields immediately after the start of the Green Revolution started in districts with an initial irrigation advantage, however, in subsequent periods, districts without an initial advantage were able to catch up. For rice, districts with an initial advantage experienced greater increases in yields throughout the period after the start of the Green Revolution. Finally, Chapter 6 empirically examines the impact of the historical concentration of religious shrines on literacy in the Punjab province of Pakistan. It shows that areas that have a higher concentration of shrines are worse off in terms of their literacy in the long-run. It attributes the low literacy in areas with a high concentration of shrines to the confluence of three key resources – religion, land and politics – that the guardians of shrines control.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

This thesis presents research that subscribes to the broader research theme of the economic history of South Asia from 1891 to 2009. A common research aim of the chapters is to examine the impact of history on the long-term development trajectories of areas across South Asia through the use of a historical event or institution. In this regard, Chapters 2 and 3 furnish an understanding of how a major historical event (i.e. The Partition of British India) influenced the evolution of public schools in Pakistan and the development of agriculture in India.

In particular, Chapter 2 evaluates the impact on school provision of the Partition induced expulsion of religious minorities from Pakistan. It shows that the expulsion of minorities at Partition constrained the provision of schools after Partition. This result implies that the minorities contributed positively towards school provision. The result survives a series of robustness tests and covers an extended period, from 1891 to 2008. The influence of minorities on school provision was in part due to their higher literacy rate and their higher concentration in commercial occupations. It was also because of their contribution towards sustaining the social capital that was important to school provision.

Next, Chapter 3 examines the long-term consequences of the Partition on agricultural development in India. It uses migrant presence as a proxy for the intensity of Partition to show that areas that received more migrants at Partition experienced greater agricultural development over the next sixty years. In particular, the high migrant areas had higher crop yields and greater adoption of high yielding variety of crops throughout most of the post-Partition period. Furthermore, the positive impact of Partition is reinforced by the advent of the Green Revolution. In order to show that the effects of the Partition are not solely explained by selective migration into districts with a higher potential for agricultural development this chapter carries out an important empirical exercise. Using pre-partition agricultural data, it shows that migrant placement is uncorrelated with soil conditions and agricultural yields prior to 1947.

PARTITION : The Partition of British India in 1947 was a landmark occasion that led to the largest population exchange in history, and involved nearly a million deaths in the wake of the communal riots that ensued between Hindus and Muslims on either side of the newly created India-Pakistan border (Bharadwaj, Khwaja, and Mian, 2009). The decision to Partition British India was the result of disagreements between the two major Indian political parties of the time – Congress and Muslim League – over the constitutional structure of the unified Indian state that would emerge after the end of colonial rule.

In order to discuss the transfer of power from the colonial government to the Indian political leadership, a delegation was setup in 1946 by the then British Prime Minister Clement Attlee. The delegation famously known as the "Cabinet Mission Plan" was tasked with creating consensus amongst leaders of the Congress and the Muslim League on the constitutional structure of a united Indian state that would emerge after independence. Despite its efforts at balancing the demands of the Congress for a strong centralised state with those of the Muslim League for a loose federation in which there would be autonomy for Muslim majority areas, the Cabinet Mission failed in its objective. The failure of the Cabinet Mission led to the partitioning of British India along religious.

The decision to partition gave rise to 'profound confusion' about the precise boundaries that were to carve up British India (Khan, 2007, p. 96). In fact, 'nobody in India knew where the borders would lie on Independence itself' (Khan, 2007, p. 125). The environment of uncertainty led to 'rumours, hints and suggestions' being circulated as to the exact nature of the boundary line (Khan, 2007, p. 125). The uncertainty and confusion was caused by the decision of the boundary commissions to keep their plans secret until the last moment. Once the Partition border was revealed, however, its haphazard and random nature became clear. The border 'line zigzagged precariously across agricultural land, cut off communities from their sacred pilgrimage sites, paid no heed to railway lines or the integrity of forests, [and] divorced industrial plants from the agricultural hinterlands' (Khan, 2007, p. 126).

The population exchange that accompanied Partition involved the movement of Hindus and Sikhs from areas that went to Pakistan to areas that went to post-Independence India. It also involved a substantial out-migration of Muslims from areas that went to post-independence India to areas that went to Pakistan. In total, an estimated 17 million people ended up migrating as a consequence of the Partition (Bharadwaj, Khwaja, and Mian, 2009, p. 2). In addition to radically altering the religious composition of post-independence India and Pakistan, the Partition also changed the demographic composition of both the nation states. This was because the migrants differed from the resident (i.e. non-mover) population along demographic lines. In particular, migrants were ‘more likely to be men, educated, and choose non-agricultural professions’ (Bharadwaj, Khwaja, and Mian, 2009, p. 2). The migratory flows also caused social change by weakening old caste networks and clan relationships. This was because the migrants also differed from the resident population in terms of their caste (Hasan et al., 2009).

There are several other aspects of Partition that are worth highlighting. The first is the variation in Partition-induced violence across both space and time. While the two most contested states of Punjab and Bengal faced the brunt of the communal rioting and killings, other states like Madras and Bombay Presidency were relatively calmer. Also, directly administered British districts were more ‘affected than many neighbouring princely states’ (Shaikh, 2011, p. 14). Furthermore, the violence at Partition was the culmination of a series of communal riots and killings that increased in both intensity and frequency in the build-up to Partition.

The resettlement experiences of refugees that ended up on either side of the Partition border also varied across regions. For instance, the refugees in Pakistani Punjab were resettled in a short amount of time. On the other hand, not only was the process of resettling refugees in the Sind province of Pakistan ‘more drawn out’, but it was also complicated by the migrants being ethnically and linguistically different from the resident population (Shaikh, 2011, p. 15).

Another historical event that had an enduring influence over development across South Asia was the adoption of high yielding varieties of seeds (HYV) in the late 1960s – an event referred to in the literature as the Green Revolution. Accordingly, Chapters 4 and 5 explore some of the long-term development consequences of the Green Revolution in India. Specifically, Chapter 4 uses a difference-in-differences approach to show that agricultural productivity gains from the Green Revolution reduced infant mortality in India. It employs three different strategies to explore the mechanisms that link the HYV adoption to infant mortality. First, it uses heterogeneity in the impacts of HYV across sub-groups to show that it is children born to mothers whose characteristics generally correlate with higher child mortality, children born in rural areas, boys, children born in rice and wheat producing districts and children born in poorer households who benefit more from the adoption of high yielding varieties of crops. Second, it finds no obvious evidence for parental investments in child health outcomes being associated with early life health or the health of children who survive in response to the HYV adoption. Finally, it provides evidence for mothers who have a lower baseline risk of child mortality self-selecting into child bearing in response to HYV adoption.

The availability of a well-developed irrigation infrastructure was instrumental in bringing about the Green Revolution in South Asia. Accordingly, Chapter 5 combines the regional variation in irrigation prior to the Green Revolution with the timing of the Green Revolution to estimate the relationship between irrigation and agricultural productivity in India. It shows that areas that had an initial advantage in irrigation infrastructure prior to the Green Revolution experienced greater increases in both wheat and rice yields after the start of the Green Revolution. The chapter offers two further insights by examining the relationship between initial irrigation and yields over time. For wheat, there was additional growth in yields in the initial phase of the Green Revolution in districts that had an initial irrigation advantage. However, in the later phase, districts without such an advantage were able to catch up. With regard to rice, districts with an initial irrigation advantage experienced greater increases in yields throughout the period after the start of the Green Revolution. The differential relationships across wheat and rice reflect differences in the responsiveness of the successive generations of

HYV of the two crops to irrigation. Not only were the early wheat varieties highly adaptable to irrigated environments, but they also managed to spread to rain-fed regions fairly quickly. On the other hand, it was only in the later phase of the Green Revolution that the second-generation rice varieties were able to increase adoption substantially in irrigated areas. The chapter also uses historical data to show that the positive association between initial irrigation and post Green Revolution yields originated in public investments in canals made during the colonial period.

Green Revolution : The Green Revolution has its origin in the crossbreeding experiments carried out at the International Rice Research Institute (IRRI), set up in the Philippines in 1961, and the International Centre for Maize and Wheat Improvement (CIMMYT), established in Mexico in 1967. The main aim of the experiments was to come up with 'shorter, stiff strawed varieties' of wheat and rice that devoted much of their 'energy to producing grain and relatively little to producing straw or leaf material' (Evenson and Gollin, 2003a, p .758). For rice, the most successful hybrid variety developed was a cross between an Indonesian variety called 'Peta', and a semi-dwarf variety from Taiwan called 'Dee-Geo-Woo-Gen' (Gollin, Hansen, and Wingender, 2016, p. 8). In the case of wheat, the earliest successful cross was between a short variety developed in Japan in the 1930s called 'Norin', and an American variety called 'Brevor' (Gollin, Hansen, and Wingender, 2016, p. 9).

The high yielding varieties (HYV) were introduced in South Asia in the late 1960s and led to a phenomenal increase in agricultural productivity across the region. In particular, the production of wheat in India went up from twelve million tons to twenty million tons between 1966-67 and 1969-70 – an increase of 40% in a span of just three years (Chakravarti, 1973, p. 321). However, the Green Revolution should not be thought of 'as a one-time jump in production, occurring in the late 1960s, but rather as a long-term increase in the trend growth rate of [agricultural] productivity' (Evenson and Gollin, 2003a, p. 760). This is because successive generations of high yielding varieties were developed one after the other, each incorporating traits that contributed towards improving agricultural productivity over the long term.

In India, the 'Kalyan Sona' and 'Sonalika' wheat varieties that were released on a mass scale in 1967 became extremely popular and were adopted throughout the country's wheat growing areas (Munshi, 2004, p. 189). The dominance of the early wheat varieties was such that by 1990 they had been adopted in more than 85% of India's wheat growing areas (Byerlee and Moya, 1993, p. 60). There were several factors behind the success of the first-generation wheat varieties. First, was their resistance to the local pests and diseases (Munshi, 2004, p. 187). Another was the relatively homogenous agro-climatic conditions under which wheat is grown in India (Munshi, 2004, p. 187). Another important factor was the prevalence of a well-developed irrigation infrastructure in the wheat growing areas of the country. To fully utilize the yield potential of the wheat varieties it is necessary to apply considerably large doses of water per unit of land, which is only possible through irrigation (Baird, 2003, p. 3). The traditionally wheat growing states of Punjab, Haryana and Uttar Pradesh all have an elaborate network of irrigation canals that proved crucial to the adoption of the early wheat varieties.

Building on the success of the early wheat varieties, agricultural scientists began concentrating their research on developing new varieties for what were termed 'marginal environments'. These comprised of low rainfall areas with limited or no irrigation infrastructure. As a consequence of the research efforts, the new wheat varieties increased adoption in marginal environments in the later phases of the Green Revolution (Byerlee and Moya, 1993, p. XI).

The development of rice varieties followed a different trajectory to that of wheat. In contrast to the early wheat varieties, the first generation rice varieties of 'Padma' and 'Jaya' were only marginally successful in penetrating the rice growing areas of India. They proved unsuitable for the varied agro-climatic conditions under which rice is grown in the country (Munshi, 2004, p. 190). In India, rice is grown in 'wet humid climates at relatively high temperatures' with excessive rainfall creating drainage problems (NCA, 1976a, p. 337). Additionally, 'cyclones and visitations of flood are not uncommon in the rice growing areas' of the country (NCA, 1976a, p. 337). The early rice varieties were also highly susceptible to a number of local pests and diseases which made farmers reluctant to adopt them (Munshi, 2004, p. 190).

The low adoption rate of the first-generation rice varieties made agricultural scientists focus their research on developing newer varieties that were specific to the varied agro-climatic conditions of rice growing regions and also incorporated resistance to local pests and diseases (Evenson and Gollin, 2003a, p. 759). The Indian state started implementing flood control and drainage in the rice regions (Evenson and Gollin, 2003b, p. 91). Many state-financed irrigation projects were also launched in the rice areas and rice farmers were incentivized to invest in ground water irrigation via tube wells (Evenson and Gollin, 2003b, p. 91). All such efforts led to an increase in the rate of adoption of the second-generation rice varieties in the late 1970s (Evenson and Gollin, 2003b, p. 91). In particular, the second-generation varieties increased the rate of adoption from around 35% to 80% in the rice growing regions (Evenson and Gollin, 2003a, p. 759).

The high yielding varieties of crops other than wheat or rice took longer to develop because of the limited stock of knowledge scientists had to build upon (Gollin, Hansen, and Wingender, 2016). For instance, only a few hybrids had been developed for crops like sorghum, pulses, millet, barley and other root crops as late as the 1980s (Evenson and Gollin, 2003a, p. 758).

The final chapter of the thesis empirically investigates the impact of a historical religious institution on contemporary development in Pakistan. Compiling a unique database covering the universe of shrines across Pakistani Punjab, the chapter explores whether the presence of holy Muslim shrines helps to explain regional variation in literacy rates. Its results demonstrate that the presence of shrines adversely affects literacy only in regions where shrine-related families have a direct political influence. Shrines in these regions represent the confluence of three resources – religion, land and politics – that together constitute a powerful structural inequality with potentially adverse consequences for development. The chapter also probes the determinants of political selection, and finds that shrines considered important in the British colonial assessment were more likely to select into politics in post-partition Punjab.

Chapter 2

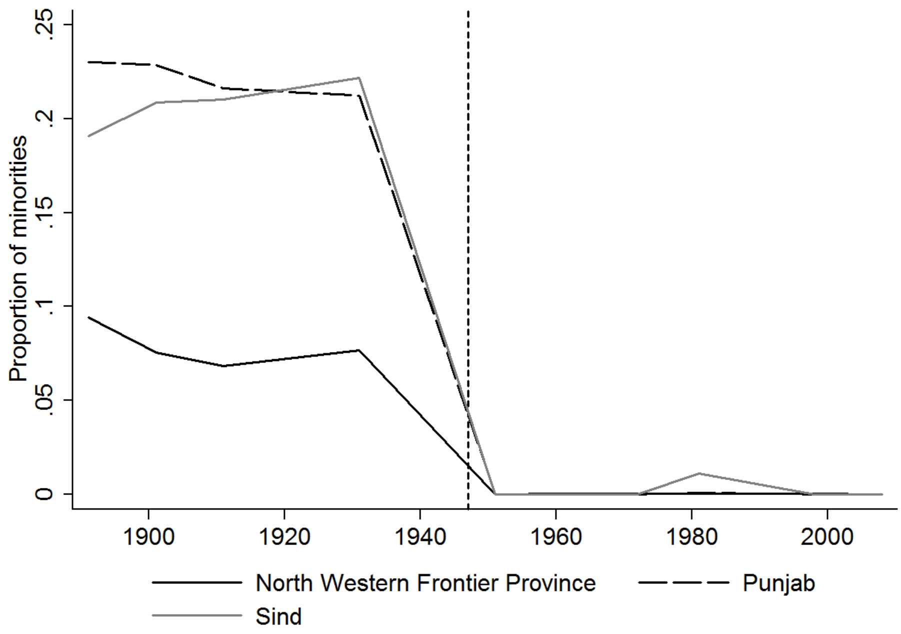
Minorities and Public Goods Provision: Evidence from Pakistan through Partition

2.1 Introduction

The partition of British India in 1947 was a landmark occasion that led to the largest population exchange in history, and involved nearly a million deaths in the wake of the communal riots that ensued between Hindus and Muslims on either side of the newly created India-Pakistan border (Bharadwaj, Khwaja, and Mian, 2009). What is surprising is the dearth of studies that analyze the impact of such a monumental event on the economic development of post-Independence India and Pakistan. While there are papers (Bharadwaj, Khwaja, and Mian, 2009; Jha and Wilkinson, 2012; Bharadwaj and Fenske, 2012a; Bharadwaj and Mirza, 2016) that contribute in important ways to our understanding of the demographic consequences of partition, the role of combat experience during WWII on ethnic cleansing during the partition, and the impact of partition-related migratory movement on jute cultivation and crop yields, none of them offer an explanation of the consequences of partition for public goods provision.

In this paper I focus on the long-term impact of the partition induced expulsion of religious minorities (henceforth termed minorities) from Pakistan on one particular development outcome: the provision of schools. The minorities are either Hindus or Sikhs. My reason for including only the members of these two communities as minorities is because they formed almost the whole of non-Muslim population in the the three regions of Colonial India – Western Punjab, Sind and North Western Frontier Province – that later became part of Pakistan. Throughout the period before partition there was significant heterogeneity in the proportion of minorities across these regions. However, the mass exodus of the minorities in the wake of the communal rioting that took place around the time of partition substantially reduced these proportions almost immediately to negligible levels. Visually, this is corroborated by Figure 2.1. Such a sudden and universal drop in the proportion of minorities combines with the pre-partition differences in the proportion of minorities to allow for a treatment-control strategy that I use to identify the impact of the expulsion of minorities on school provision. As part of my identification strategy, I argue that the partition represents a plausibly exogenous source of variation in the proportion of minorities. This is because the decision to partition was a consequence of a religio-political struggle that expelled minorities from districts on both sides of the partition border, irrespective of the economic characteristics or potential for later school expansion of those districts. Using pre-partition schooling data, I verify that this is indeed the case by showing that the number of schools per thousand persons is similar between districts that are on either side of the partition border prior to 1947.

FIGURE 2.1: Drop in proportion of minorities after partition



Notes: The figure excludes the 1941 census numbers that are widely regarded as being unreliable. Furthermore, most of the out migration of minorities shown in the figure took place in the brief period between 1947 and 1951.

I find that the expulsion of minorities had a statistically significant and negative impact on school provision after partition. Specifically, those districts that had a higher proportion of minorities prior to partition experienced smaller increases in the number of schools per thousand persons after partition, relative to districts with a lower proportion of minorities prior to partition. Hence, implying that districts from where there was a greater out-migration of minorities suffered more in terms of school provision post-partition. The causal inference that can be drawn from such a result is that the presence of minorities had a positive influence over the provision of schools, which the partition managed to remove. I find this result using a long panel dataset that brackets the date of partition. Furthermore, the result is not sensitive to the inclusion of several controls such as the log of population density, the interaction between post-partition dummy and average annual rainfall during pre-partition, the interaction between post-partition dummy and the literacy of in-migrants in 1951, district fixed effects, year fixed effects and region-specific trends. Moreover, the result is also robust to controlling for partition-related violence through the inclusion of the interaction between post-partition dummy and the number of army personnel per thousand persons in 1931.

I argue that the educational profile of the minorities who left at partition played a role in terms of their positive contribution towards school provision. The minorities were more literate than both the majority who stayed behind and the in-migrants who replaced them. They were also concentrated in mercantile occupations and sustained local social capital through their attendance at shared religious gatherings. Given the positive association of adult literacy, mercantile occupations and social capital with school provision, I highlight the demographic changes induced by the expulsion of minorities as a plausible mechanism for my result.

The identification strategy used in this paper is motivated from Bleakley (2007). His study uses differences in hookworm infection rates prior to a targeted public-health intervention campaign that substantially reduced hookworm infection to identify the impact of hookworm disease on school enrolment, attendance and literacy in the American South. Another methodologically related paper is Topalova (2010). Her paper investigates the impact of trade liberalization on poverty and inequality. It uses district level variation in the pre-liberalization composition of industries to identify the effect of liberalization reforms on poverty incidence and depth across rural Indian districts. Finally, this paper is also methodologically similar to Acemoglu, Lyle, et al. (2004). That study exploits differences in the pre-World War II mobilization rates of men to identify the impact of female labour supply on wage structure post-World War II.

This paper extends the literature on the long-term impacts of historical events on contemporary economic outcomes (see Nunn (2009) for a review). A closely related study is Acemoglu, Hassan, and Robinson (2010). The study utilizes pre-World War II heterogeneity in the proportion of the population that is Jewish to identify the long-term impact of the holocaust on economic and political outcomes in post-World War II Russia. Another relevant paper is McQuoid (2011). His paper examines the effect of the mass in-migration of Jews after the collapse of the Soviet Union on local public goods expenditures in Israel. In yet another related study Bhalotra and Clots-Figueras (2014) show how differences in the participation of women in state legislatures across India are related with improvements in the provision of antenatal and childhood health services. Although these papers offer valuable insights into the effect of a highly skilled workforce on various economic development outcomes, none of them focus on the provision of public goods. This paper fills such a gap by emphasizing the role played by highly skilled minorities in the provision of public goods.

This study also makes an important contribution to the literature on the relationship between diversity and economic development (Easterly and Levine, 1997; Miguel and Gugerty, 2005; Alesina, Baqir, and Easterly, 2000; Alesina and La Ferrara, 2005). By showing that districts with a higher pre-partition proportion of minorities suffered more from the expulsion of minorities in terms of school provision, this paper provides evidence of diversity being beneficial to the provision of public goods. Such evidence is contrary to the conventional explanation offered in the literature, according to which an increase in diversity hampers collective action and leads to fewer public goods being provided.

The rest of this paper is organized as follows. Section 2.2 provides a summary of the main developments in the educational system both during the colonial era and in post-partition Pakistan. Section 2.3 describes the data and provides descriptive statistics. Section 2.4 explains the identification strategy and the empirical specification. Section 2.5 presents the results and discusses the outcome of a series of robustness exercises. Section 2.6 highlights the mechanisms that explain the results. Finally, Section 2.7 concludes the paper.

2.2 The Educational System

2.2.1 Colonial Era

An exhaustive review of the education system in colonial India has already been provided in Chaudhary (2007, 2012); Nurullah and Naik (1951); Agrawal (1986). Therefore, I will only focus on the key developments in education during the colonial era. Broadly speaking, the history of education in British India can be divided into four distinct periods. The first covers the early part of the 19th century, during which the pre-existing indigenous schooling system was replaced with the new state system of education introduced by the East India Company. Later on, beginning in the 1860s, the British Crown took over and brought the system under the direct control of the central colonial government. Then, after the Montague-Chelmsford reforms of 1919, the system was handed over to elected Indian ministers from the provinces under Dyarchy rule (Chaudhary, 2007). Finally, after the passing of the Government of India Act of 1935 that signalled the end of Dyarchy rule, changes were made to increase the direct control of elected Indian ministers over the system.

It was at the start of the third phase, with the advent of Dyarchy rule, that the foundations for a system of mass education were laid for the first time in

British India. The various Primary Education Acts that were passed in most of the British Indian provinces were the most significant pieces of legislation relating to this phase. The Acts were introduced in the Punjab in 1919 and in Sind in 1923. Although the Acts made Indian minsters elected at the provincial level responsible for the overall educational policy, the actual control and administration of schools was left up to the sub-provisional local authorities. The local authorities were given the task for examining the educational needs of their areas and for preparing schemes for the expansion and development of primary education within their jurisdiction. They were also to share the burden of the cost of providing schools with the central government. As per the cost sharing agreement the local authorities were to levy an educational tax to meet their own share of the cost of providing schools. They were also to be given public subsidies by the central government, known as grants-in-aid, to partially support schools that fulfilled certain criteria[1].

The phase under Dyarchy rule witnessed a rapid expansion of the educational infrastructure overseen by the local authorities. For instance, during the 1922-1927 quinquennium, the number of recognised primary schools for British India increased from 160,072 in 1922 to 189,348 in 1927[2]. Such figures represent an unprecedented 15.5% increase in the number of schools in just five years. The Hartog (1929) committee report that reviewed the growth of education in British India after the Dyarchy reforms noted that all provinces had contributed to a greater or lesser extent towards the rapid expansion in schools[3]. However, the increase in

[1]The criteria were that schools had to follow a secular curriculum, they had to be under private management, and they had to be open to public inspection

[2]Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 41

[3]Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 40

educational infrastructure did not translate into a corresponding increase in the literacy rate of the population. This is clear from the figures given in the Hartog (1929) committee report. As per the report, a literate person was someone who managed to achieve success up to Class IV in school. Using such a definition, the report noted that for every hundred students who were enrolled in Class I at the start of the 1922-1927 quinquennium, only eighteen were enrolled in Class IV in 1925-26. Such a low level of literacy despite the investment in schools was looked upon as being 'very disturbing' by the Hartog (1929) committee report[4]. In summary, the years of Dyarchy rule were characterised by a rapid expansion in educational infrastructure without a corresponding increase in the literacy rate.

The fourth and final phase of educational development in colonial India begins with the passing of *The Government of India Act* in 1935 and ends with the outbreak of World War II in 1939. There are no significant developments to report in this brief phase and trends in education remained much the same as in the previous phase.

2.2.2 Post-Partition

The period immediately following the partition paints a dire picture of the state of the education in Pakistan. There was a severe dislocation of educational infrastructure in the newly created nation. For instance, Raychaudhuri, Habib, and Kumar (1983), when discussing the aftermath of partition in Pakistan, observe that the event caused a severe dislocation of the educational institutions in the

[4]Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 44

country[5]. The First Five Year Plan of the Planning Commission of Pakistan notes that, on gaining independence, the country was faced with the immediate task of saving the education system from collapse, a task that 'was made difficult by the loss of supervisory and teaching personnel' who came mainly from the Hindu and Sikh minority communities[6]. In yet another reference to the grim state of education the 1951 census of Pakistan observes that the partition caused 'wide gaps' to occur in the educational institutions of the country[7].

Once the period immediately following the partition was over, successive attempts were made by the Pakistani state to revive the education sector in the country. A list of such attempts covering most of the period since partition is provided in Table 2.8. Unfortunately, despite all the attempts at improving education the fact remains that as late as 2012 there were 49.5 million illiterate adults in the country - the third largest illiteracy rate globally[8].

2.3 Data

For the empirical analysis I construct a panel dataset at the district level from 1891 to 2008. To construct the panel, I use data sources from both the pre and post-Partition periods. The following paragraphs describe my data sources and the method I used in constructing the variables in my analysis.

[5]Raychaudhuri, Tapan, Irfan Habib, and Dharma Kumar, eds. The Cambridge economic history of India. Vol. 2. CUP Archive, 1983. Page 998

[6]Planning Commission. Government of Pakistan. The First Five Year Plan 1955-60. (1957). Page 539

[7]Pakistan, M. H. Census of Pakistan. Punjab and Bahawalpur State. Volume 5. (1951). Page 34

[8]UNESCO, E., 2012. Education for All Global Monitoring Report 2012 Fact Sheet: Education in Pakistan. Page 1

2.3.1 Dependent Variable

For my dependent variable, I aggregate the number of schools across gender (i.e. male and female) and across type (i.e primary, middle and high) to arrive at the total number of schools at the district level. I then divide the total number of schools in each district by the district population and multiply the resulting ratio by 1000 to calculate my dependent variable: the number of schools per thousand persons. The pre-partition data on the number of schools, which covers the years 1891, 1901, 1911 and 1931, come from the Colonial District Gazetteers[9]. The Gazetteers are a rich source of data that record the number of primary, middle and high schools for each district for both males and females. Additionally, they have information on enrolment in and expenditure on schools. The data on enrolment and expenditure is difficult to collect because it exists across several tables, each given in a separate Gazetteer. The post-partition data on the number of schools at the district level come from the District Census Reports of Pakistan that cover the years 1961, 1972, 1981 and 1998, as well as the 2008 Provincial Development Statistics of Pakistan.

Moreover, I use the Colonial Census Reports to get the numbers on district population for the pre-partition period. The Census Reports date back to 1872, when the first systematic attempt to record the Indian population using modern methods was made. However, it was not until 1881 that the first synchronous census, covering both British India and the Princely States, was held. After 1881, a census was held at ten year intervals until 1941 - the last census year before the partition. Each census, aside from the one of 1941, covers a wide range of information

[9]The data on districts within the Sind province for 1921-22 is used to approximate the data for 1931. This is because there is no data available in the Colonial District Gazetteers for Sind for 1931.

relating to the population such as age, sex, religion, literacy, marital status, civil condition, occupation, caste, language and migration. Finally, I extract the numbers on district population for the post-partition period from the District Census Reports of Pakistan.

2.3.2 Main Explanatory variable

For my main explanatory variable I aggregate the number of Hindus and Sikhs at the district level for the pre-partition years of 1891, 1901, 1911 and 1931. I then divide these sums by the district population to compute the proportion of minorities for each of the years. Finally, I multiply the pre-partition proportion of minorities with the post-partition dummy (i.e. an indicator variable that takes a value one if the year is greater than or equal to 1947 and 0 otherwise) to construct my main explanatory variable – $Minorities_i^{Pre} \times Post_t$. I use the Colonial Census Reports to get the district population and the population of Hindus and Sikhs in each district.

2.3.3 Control Variables

In addition to including district fixed effects, year fixed effects, and region specific trends, my specification includes several control variables. The first is the log of population density. The second is the interaction between pre-partition average annual rainfall and the post-partition dummy, $Rain_i^{Pre} \times Post_t$. I included such an interaction to control for the capacity of initial economic development to predict later trends in public goods provision of the districts[10]. Third is the interaction between the number of army personnel per thousand persons in 1931 and the

[10] According to Bloom, Sachs, Collier, and Udry (1998) districts' geographical characteristics, such as rainfall, are important determinants of their development trajectories

post-partition dummy, $Army_i^{1931} \times Post_t$. Such an interaction term controls for the capacity of partition-related violence to predict later trends in public goods provision[11]. Finally, I included the interaction between the literacy rate of in-migrants in 1951 and the post-partition dummy, $MigLit_i^{1951} \times Post_t$, to control for the influence of the literacy of in-migrants at partition on school provision post-partition. I use the 1951 census of Pakistan to extract the literacy rates for in-migrants at partition. The census provides literacy rates for displaced in-migrants that arrived in each district.

2.3.4 Other Variables

I also calculate the literacy rate of the minority and majority communities during the pre-partition period. In the case of the minority community I aggregate the number of literate persons who are either Hindu or Sikh at the district level for the pre-partition years of 1891, 1901, 1911 and 1931. I then divide the sum by the district population to calculate the proportion of literate minorities for each of the years. I repeat the same exercise to calculate the literacy rate of the Muslims for the same pre-partition years. I use the data on the literacy rates of the different religious communities to draw Figure 2.4. Additionally, I use the 1931 Colonial Census Report to record the traditional occupations that are followed in the Hindu, Sikh and Muslim communities. The 1931 Census Report provides data on caste for persons who come from each religion. The castes covered are of a wide variety and each one of them has a traditional occupation associated with it. I use the information on the traditional occupation of each caste to create broader occupational categories for each religion. The occupational categories I create are

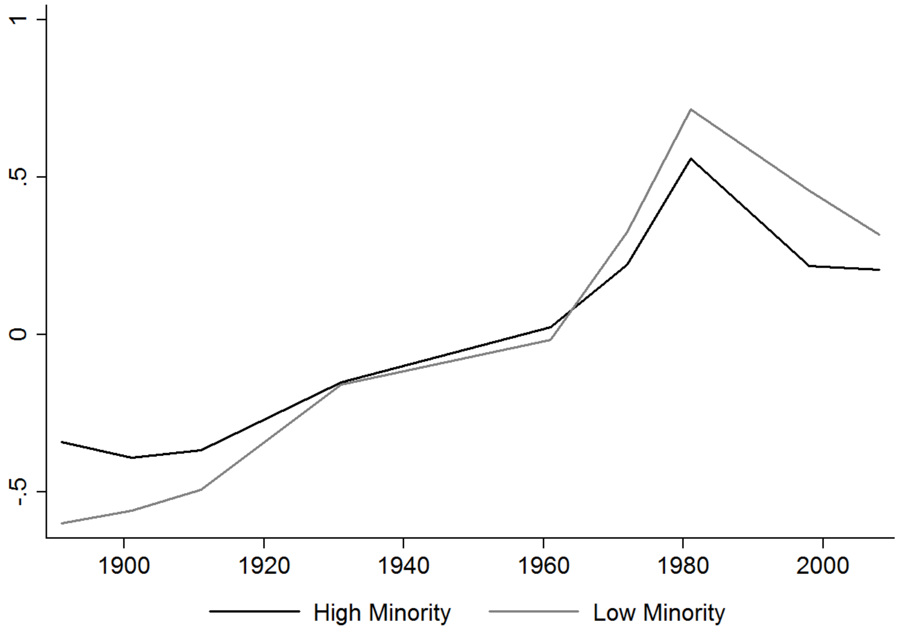
[11] Jha and Wilkinson (2012) in their paper show that military experience prior to the partition increased the propensity for ethnic cleansing at the time of partition

agricultural, religious, mercantile, artisan, menial and outcast and other. I use the data on the occupational categories for each religion in Table 2.9.

2.4 Descriptive Statistics

There are two outcomes that are consistent with the expulsion of minorities at partition having a negative impact on school provision after partition. Firstly, the high-minority districts would have to have a greater number of schools per thousand persons relative to low-minority districts prior to partition. Secondly, the increase in schools per thousand persons would have to be smaller for high-minority districts relative to low-minority districts after partition. Both Table 2.1 and Figure 2.2 show that this is indeed the case. Table 2.1 shows smaller increases in schools per thousand persons between 1891 and 2008, alongside lower average number of schools per thousand persons in 1891, in the high-minority districts relative to the low-minority districts. Figure 2.2 shows that high-minority districts have more schools per thousand persons relative to the low-minority districts prior to partition, but then the trend switches to low-minority districts having greater schools per thousand persons relative to high-minority districts throughout most of the period after partition. It is important to note here that Figure 2.2 *does* take into account district fixed effects. The high-minority districts were also different along other dimensions in 1891. As shown in Table 2.1, they had higher population density, lower average annual rainfall and fewer army personnel per capita during pre-partition. The district fixed effects I include in my analysis removes these potential confounders, as well as others that are unobserved.

Figure 2.2: Minority presence and school provision



Notes: The variable on the y-axis which is the predicted residuals for the annual number of schools per thousand persons has been stripped of district fixed effects. To do so I first regressed the number of schools per thousand persons on district dummies. I then predicted the residual values for schools per thousand persons and plotted these residuals by year, distinguishing between high and low minority districts based on the mean proportion of minorities in the 1891 sample of districts.

2.5 Empirical Framework

2.5.1 Identification

The identification strategy that I use in this paper has three main components. Firstly, as shown in Figure 2.1, there is substantial variation in the proportion of minorities across districts during the pre-partition period. For instance, the proportion of minorities varies from thirty nine percent in the district with highest proportion of minorities to five percent in the district with the lowest proportion of minorities in 1891. Such heterogeneity allows for a treatment-control framework within which to identify the impact of the expulsion of minorities on school provision post-partition. Secondly, the partition of India was the result of a political struggle that removed minorities from districts irrespective of their economic characteristics or their potential for school expansion. Therefore, the partition should not be thought of as being endogenous with respect to pre-partition differences in economic development. I carry out the following empirical exercise to show that this is the case. In Table 2.2, I compare schools per thousand persons between Pakistani and Indian districts that are contiguous to the border to show that they are similar during the pre-partition era[12]. The table provides suggestive evidence that schools per thousand persons are not significantly correlated with the selection into the Indian side of the partition border. Finally, the partition led to the expulsion of minorities within a short span of time. Bharadwaj, Khwaja, and Mian (2008) show that most of the minorities had been expelled from the regions that became part of Pakistan within the first four years after partition. This is a sudden and sharp decline in the proportion of minorities on the long time scale upon which I examine school provision and as such represents a shock to religious diversity.

2.5.2 Specification

I use the reduced form equation below to estimate the impact of the expulsion of minorities on school provision.

$$Y_{it} = \beta(Minorities_i^{Pre} \cdot Post_t) + \gamma_t + \mu_i + \phi_t(X_i' \cdot Post_t) + \rho Density_{it} + \zeta_j \times t + \epsilon_{it} \quad (2.1)$$

Y_{it} represents the outcome of interest (i.e. numbers of schools per thousand persons) in district i at time t. γ_t are year dummies controlling for calendar year

[12]For Table 2.2 the sample is restricted to the Punjab state that was bifurcated at partition and was the most contested.

fixed effects, μ_i are district dummies controlling for district fixed effects, and $\zeta_j \times t$ are region-specific time trends controlling for region-specific time-varying characteristics. $X_i' \cdot Post_t$ is a set of time-invariant initial district characteristics – average annual rainfall in millimetres between 1919 and 1923, proportion of literate in-migrants in 1951 and the number of army personnel per thousand persons interacted – all interacted with the post-Partition dummy. The interaction between the pre-partition proportion of minorities and the post-partition dummy, $Minorities_i^{Pre} \cdot Post_t$, is the main variable of interest. It assesses the impact of the expulsion of minorities on observed changes in school provision across districts post-partition. Given the panel nature of the data, I cluster standard errors at the district and year levels.

2.6 Results

2.6.1 Full Sample

In this subsection, I estimate the impact of the partition induced expulsion of minorities on school provision using equation (2.1) above. The results from estimating equation (2.1) are presented in Table 2.3. They are organized into four panels. Panel A displays the estimates of the variable of interest, $Minorities_i^{1891} \cdot Post_t$, based on the pre-partition year 1891. Panels B, C and D show the estimates of the variable of interest based on the pre-partition years of 1901, 1911 and 1931, respectively. The choice of four separate pre-partition years is to show the robustness of the results throughout the pre-partition period. Column 1 shows the estimate for the most parsimonious specification that includes only the district dummies, year dummies and region specific trends. Column 2 includes the log of population density, the interaction between post-partition dummy and number of army personnel per thousand persons in 1931 and the interaction between post-partition dummy and average annual rainfall in millimetres between 1919 and 1923. Finally, column 3 adds the interaction between post-partition dummy and proportion of literate in-migrants in 1951 to the specification in Column 2.

I find a reduction in schools per thousand persons in the post-partition period for districts that had a higher proportion of minorities prior to partition. This is true for all the specifications and for each of the four pre-partition years upon which the variable of interest is based. Such results are reassuring as they indicate that the estimates are robust to the variable of interest being based on any of the four pre-partition years. Specifically, the point estimate of -0.911 on $Minorities_i^{1891} \cdot Post_t$ in Column 3 of Panel A implies that a 10-percentage point increase in the proportion of minorities in 1891 translates into a 0.0911 decrease in the number of schools per thousand persons in the post-partition period. The coefficient estimate should be considered in comparison to: a mean of 0.22 and a standard deviation of 0.27 schools per thousand persons in 1891, a mean of 0.95 and a standard deviation of 0.42 schools per thousand persons in 2008 and a mean of 0.99 and a standard deviation of 0.42 schools per thousand persons for the post-partition period.

2.6.2 Subsamples

The estimated relationship between pre-partition minorities and post-partition school provision exhibited noteworthy differences across various subsamples. Firstly, there were differences in the way in which male and female schools were affected by pre-partition minorities. I ran separate regressions using male and female schools per thousand persons as the dependent variable. The results, not presented here, show a negative and significant impact of pre-partition minorities on male schools per thousand persons, however, the impact on female schools per thousand persons is not significant. Secondly, both primary and secondary (middle and high) were affected negatively by pre-partition minorities. I ran separate regressions using primary and secondary schools per thousand persons as my dependent variable. The results, presented in Table 2.4, show a negative and significant impact of pre-partition minorities on both primary and secondary school provision.

2.6.3 Robustness

Difference-in-Differences

To reinforce my results, I utilize an alternative specification – see equation (2.2) below – where I regress the number of schools per thousand persons in district i at time t, Y_{it}, on the proportion of minorities in district i at time t, $Minorities_{it}$, along with the district fixed effects and the year fixed effects for the whole panel. The specification represents a standard difference-in-differences approach that allows more variation in proportion minorities in the pre-partition period to be used for identifying the impact of minorities on school provision.

$$Y_{it} = \beta(Minorities_{it}) + \gamma_t + \mu_i + \epsilon_{it} \tag{2.2}$$

The results of the regression are presented in Table 2.6. The sign on the coefficient of the proportion of minorities variable, $Minorities_t$, is both positive and significant. This provides further evidence that the positive influence of minorities in increasing the number of schools per thousand persons persists throughout the whole period of my panel from 1891 to 2008.

Fully Flexible

In addition to using a standard difference-in-differences specification I also utilize a fully flexible specification to examine how the relationship between pre-partition minorities and public school provision evolves over time. Equation (2.3) below represents the fully flexible specification:

$$Y_{it} = \beta_t Minorities_i^{Pre} \cdot \gamma_t + \phi_t X_i' \cdot \gamma_t + \rho Density_{it} + \mu_i + \gamma_t + \epsilon_{it} \tag{2.3}$$

Where the pre-partition proportion of minorities, $Minorities_i^{Pre}$, is interacted with each of the year fixed effects[13]. Moreover, $X_i' \cdot \gamma_t$, is a set of time-invariant initial district characteristics – average annual rainfall in millimetres between 1919 and 1923, proportion of literate in-migrants in 1951 and the number of army personnel per thousand persons interacted – all interacted with each of the year fixed effects. The estimated vectors of $\beta_t's$ reveal the correlation between pre-partition proportion of minorities and school provision in each time-period. Since the variable $Minorities_i^{Pre}$ is time invariant and equation (2.3) includes country and time-period fixed effects, the estimated $\beta_t's$ must be measured relative to a baseline time-period, which I take to be the first census year in the panel (i.e. 1891).

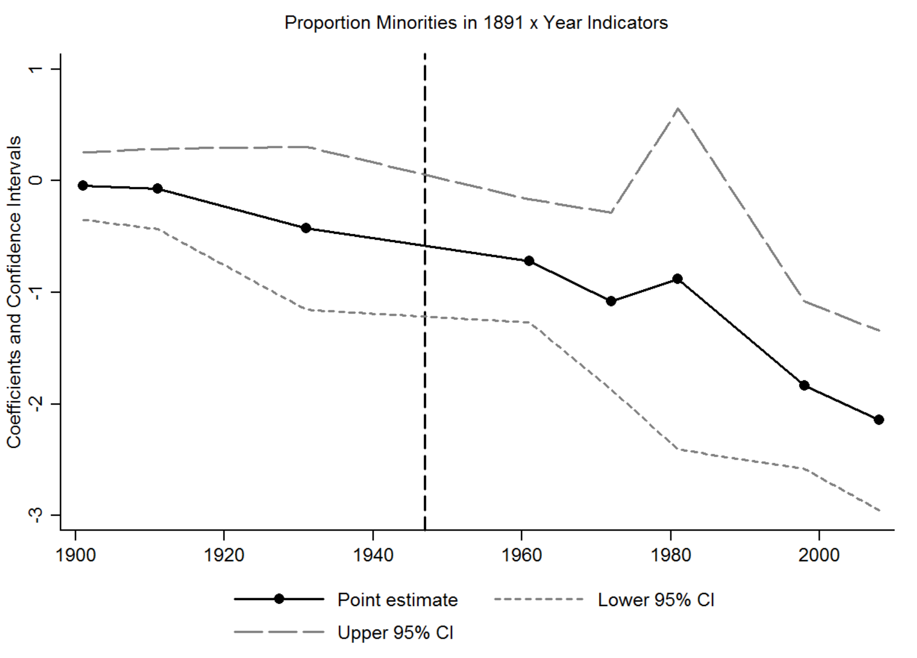
The results presented in Table 2.7 show the estimated coefficients of each of the interactions between the pre-partition proportion of minorities and the year fixed effects. Column (1) includes no controls, Column (2) includes some controls and Column (3) includes the full set of controls. It can be clearly observed from the estimated coefficients reported in Column (3) that the pre-partition proportion of

[13] The pre-partition year from which the proportion of minorities is used in the specification is 1891.

minorities only begin to have negative and significant effect on school provision after partition.

Additionally, Figure 2.3 plots the estimated coefficients and the associated confidence intervals from Column (3). The pattern that the estimated coefficients take over time suggests that the impact of pre-partition minorities is insignificant in the period before partition, but that after partition the impact becomes negative and significant. In particular, there is a discontinuity in the pattern around the time of the partition, which suggests that it was the partition induced expulsion of minorities that restrained school provision.

FIGURE 2.3: Fully flexible estimates of the relationship between pre-partition proportion of minorities and schools per thousand persons



Notes: The figure plots the estimated coefficients and their associated confidence intervals for each of the interactions between proportion minorities in 1891 and year fixed effects

Other Robustness

An important concern with my results is that they could be due to mean reversion rather than due to minorities. In other words, those districts that had fewer schools because of a temporary shock in the pre-partition period could have experienced greater increases in schools per thousand persons post-partition, even if the removal of minorities had not influenced school provision. I controlled for such mean reversion by including region-specific trends in all my regressions.

Another concern is the relabelling of schools from being secular (i.e. religiously neutral) to religious during the post-partition period[14]. If, in the districts that had a higher proportion of minorities during pre-partition, more secular schools were relabelled as being religious during the post-partition period, then my results would be driven by a substitution rather than a levels effect. I show that this is not the case by providing the ratio of religious schools to secular schools for the post-partition period from 2005-06 to 2007-08 in two provinces of Pakistan in Table 2.5. The ratio remains consistently small throughout the period in both provinces.

2.7 Mechanisms

The results of this paper show that areas that experienced greater out-migration of minorities at partition suffered more in terms of school provision after partition. Hence, implying that the presence of minorities had a beneficial impact over the supply of schools. However, the channels through which such an influence operated have not been explored thus far. This section will, therefore, highlight three

[14]Note that I only include secular schools in my panel dataset

such channels. Firstly, the minorities formed a highly literate community that was important to the day-to-day running of schools. Secondly, because of their concentration in mercantile occupations, they formed a constituency for whom the education provided in schools was highly valued. Finally, by participating actively in mixed religious gatherings they sustained the social capital that was crucial to the provision of public goods, including schools. There are other channels through which it could be argued that minorities had an impact on schooling that are not included in this paper. This section, therefore, does not offer a comprehensive explanation for the influence of minorities. Instead it documents in detail three channels that are important.

2.7.1 Minorities and Literacy

Figure 2.4 compares the literacy rate of the minorities with that of the majority Muslim population in each of the three colonial regions that became part of Pakistan for the pre-partition census years of 1901, 1911, 1921 and 1931. The Hindus and Sikhs had a much higher literacy rate relative to the Muslims throughout the four census years. The educational ascendency of minorities, however, is not just restricted to trends in the data. It is also apparent in the observations of colonial administrators given in official documents. The 1907 gazetteer of the Attock district noted that literacy was highest amongst Hindus and Sikhs[15]. The 1883-84 gazetteer of the Lahore district termed the pre-eminence of the Hindus in education as 'remarkable' and acknowledged the 'considerable progress that had been made in the education of Sikh males'[16]. Even in the Rawalpindi dis-

[15]Gazetteers, Punjab District (1932). Gazetteer of the Attock District, part A, with maps, 1930. Lahore: Supt., Govt. Printing, Punjab. Page 304

[16]Gazetteers, Punjab District (1894). Gazetteer of the Lahore District, 1893-94. Revised Edition. Lahore: "Civil and Military Gazette" Press. Page 84

trict where the overall literacy rate was low compared to other districts, the Sikhs and Hindus were had a better position in terms of their education relative to the Muslims[17]. Moreover, in a study on Hindu-Muslim literacy differences in colonial India, Chaudhary and Rubin (2011) show that the Hindu lead over Muslims in terms of literacy persisted throughout the colonial era.

The educational superiority of the minorities has its origins in the caste histories of the Hindus and Sikhs. Most of the Hindus and Sikhs in those districts that went to Pakistan belonged to the three exclusively Hindu or Sikh castes of the *Khatris*, *Aroras* and *Baniahs*. The *Khatris* in particular were the predominant Hindu or Sikh caste of the Punjab. Members of the *Khatri* caste had acquired educational skills long before the system of public schools was set up by colonial authorities in the late nineteenth century. This is because they took up positions in the administration of the Delhi Sultanate and the Mughal State through which they gained a thorough training in both literacy and numeracy. The *Khatris* 'appeared to have emerged as an important social group in the [Delhi] Sultanate during the fourteenth century' after acquiring 'proficiency in accountancy and arithmetic' for the purposes of seeking employment in the Sultanate's administration (Ludden, 1994, p. 40-41). From the 'middle of the seventeenth century, the departments of accountancy (*siyaq*), draftsmanship (*insha'*), and the office of revenue minister (*divan*) were all predominantly comprised of *Khatris* (Alam and Subrahmanyam, 2004, p. 62).

Some of the well known *Khatris* who made substantial contributions to the Indo-Persian language and literature during the pre-colonial period were Madho Ram, Sujan Rai, Malikzadah, Bhupat Rai, Khushhal Chand, Anand Ram "*Mukhlis*"

[17] Gazetteers, Punjab District (1884). Gazetteer of the Rawalpindi District, 1883-84. Lahore: "Civil and Military Gazette" Press. Page 98

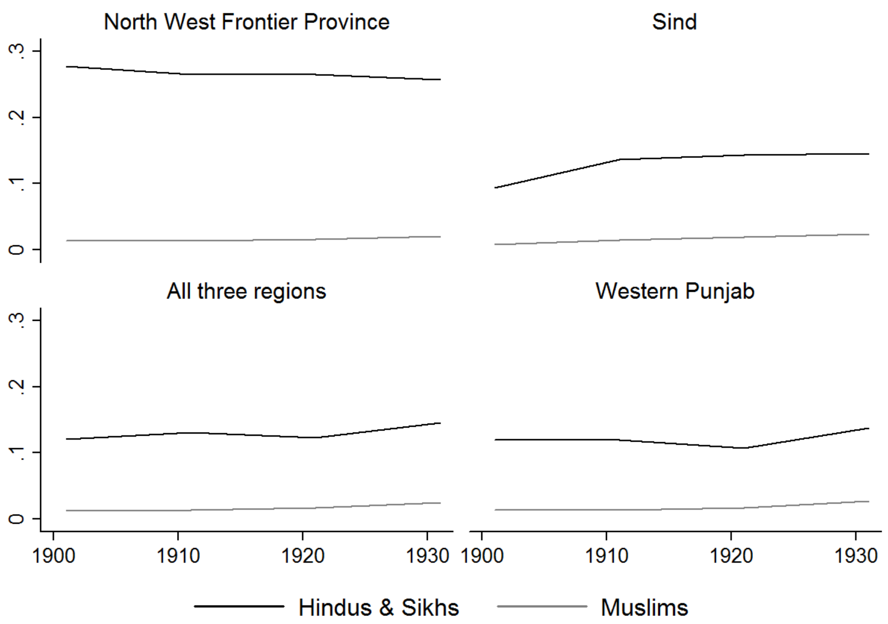
and Bindraban "*Khwushgu*" (Alam and Subrahmanyam, 2004, p. 64). Possibly, the most famous of all the *Khatris* of the pre-colonial times was Todar Mal, the revenue administrator during Emperor Akbar's reign who was credited with bringing about innovative reforms in the Mughal treasury (Alam and Subrahmanyam, 2004, p. 64). The importance of education to the administration in the Delhi Sultanate and the Mughal State can be gauged by the following excerpt from a letter written by a Hindu *Brahman* to his son who was aspiring to become an administrator:

> "The main thing is to be able to draft in a coherent manner, but at the same time good calligraphy possesses its own virtues and it earns you a place in the assembly of those of high stature. O dear son! Try to excel in these skills. And together with this, if you manage to learn accountancy [*siyaq*], and scribal skill [*navisindagi*], that would be even better. For scribes who know accountancy as well are rare. A man who knows how to write good prose as well as accountancy is a bright light even among lights". (Alam and Subrahmanyam, 2004, p. 64)

In so far as the Hindu and Sikh *Khatris* had a comparative advantage in education over the Muslim majority, their experience is similar to that of the Jews discussed in Botticini and Eckstein (2002). In their paper, Botticini and Eckstein (2002) argue that the comparative advantage of the Jews over the Muslims in education in the Middle Ages had its origins in a widespread educational and social reform in Judaism in the first century CE requiring fathers to educate their children (Botticini and Eckstein, 2002, p. 12). Along similar lines, the comparative advantage of the Hindus and Sikhs over the Muslims discussed in this paper derived from a social reform that encouraged members of the *Khatri* caste to take up high posts in state administration during pre-colonial times.

The other Hindu caste that dominated education was the *Baniahs*. The *Baniahs* were the pre-eminent commercial caste of pre-colonial times. Their success as merchants and traders 'lay in the training they received from early childhood in arithmetic and accountancy' (Tracy, 1993, p. 383). Being experts in the 'casting of accounts and writing' meant that they had an advantage over other Indians in the practice of trade (Tracy, 1993, 383).

FIGURE 2.4: Hindu, Sikh and Muslim literacy prior to Partition



Notes: Since the literacy rate for the Khairpur Princely State is not available on a consistent basis throughout pre-partition it is excluded from the line graph for Sind

The trends in literacy, the observations of colonial administrators and the history of the Hindu and Sikh castes summarised above all suggest that the minorities did indeed represent a highly literate constituency. However, what remains to be shown is how the literacy of the minorities impacted school provision. Here I turn to the literature in economics that argues for the positive externalities of adult literacy in terms of education. There are two strands of such a literature. The first links adult literacy with the demand for education. It shows that literate parents are more likely to enrol their children into schools and take an active interest in their education. For instance, Behrman, Khan, Ross, and Sabot (1997) find that the education of fathers improves the performance of children on various tests at schools in rural Pakistan. Moreover, Brown (2006); Lavy (1996); Tansel (1997); Mincer (1974); Becker (1975); Arrow (1973); Riley (1976, 1979) all find that educational outcomes are positively associated with the parental education in the context of other developing countries.

There are several statements in the colonial reports from the pre-partition period that point to the eagerness with which the literate minorities sought education for their children. For instance, the 1929 Muzaffargarh district gazetteer, when referring to the Hindus and Sikhs, observes that no special measures were necessary to promote literacy amongst these groups as they were ready to take advantage of every opportunity of providing education to their children[18]. Similarly, the 1921 gazetteer of the Gujrat district points out that the Hindus were quick to take advantage of the education offered in schools and had successfully managed to secure jobs in government departments[19].

Another strand of the literature argues that higher adult literacy reduces the constraints on the supply of schools by increasing the pool of teachers that are available in the local population. This is especially relevant in the case of rural areas in developing countries where school teachers have to be hired locally due to lower occupational mobility and higher relocations costs. Two relevant studies here are Andrabi, Das, and Khwaja (2013) and Andrabi, Das, and Khwaja (2008).

[18] Gazetteers, Punjab District (1931). Gazetteer of the Muzaffargarh District, part A, with maps, 1929. Lahore: Supt., Govt. Printing, Punjab. Page 291

[19] Gazetteers, Punjab District (1921). Gazetteer of the Gujrat District, part A, with maps, 1921. Lahore: Supt., Govt. Printing, Punjab. Page 50

Both show a positive impact of adult female education on educational access in rural Pakistan. They find that schools are more likely to emerge in villages that have a government girls' secondary school as opposed to those that do not. The reason given is that villages with girls' secondary schools have a readily available supply of low-cost teachers in form of educated adult females who are crucial to the functioning of schools.

Anecdotal evidence referring to the pre-partition period clearly points to the abundance of the literate minorities in the teaching profession. For instance, Raychaudhuri, Habib, and Kumar (1983), when discussing the aftermath of partition in Pakistan, observe that the event dislocated educational institutions in the country by causing the sudden departure of teachers and instructors who mainly came from the Hindu and Sikh populations. Additionally, the First Five Year Plan of the Planning Commission of Pakistan acknowledged the damage caused to the educational sector by the 'sudden departure of Hindu teachers and instructors' at partition who had manned the staff of the technical institutions, schools, colleges and universities[20]. However, the most vivid illustration of the involvement of minorities in the provision of schools is given in the Hartog (1929) committee report that reviewed the growth of education during the Dyarchy years between 1919 and 1930. The report states that in the Punjab and the North-West Frontier Province, the Hindu and Sikh minority communities did 'good service to the cause of education by the maintenance of a large number of schools and colleges'[21]. It goes on to state that the subscriptions and donations raised by the Hindus and Sikhs represented the 'nucleus of the financial resources' of the schools in the two

[20] Planning Board, Government of Pakistan (1958). The First Five Year Plan 1955-60. Karachi: Manager of Publications. Page 7

[21] Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 246

regions[22]. Such dominance of the educational sector by the minorities meant that their expulsion at partition resulted in a constraint being imposed on the supply of schools.

The above paragraphs have described how the minorities made a positive contribution to school provision by virtue of their higher literacy rates. I now investigate the extent to which the higher literacy of minorities can account for their impact on school provision described in my main results in Section 2.6. To do so, I first estimate equation (2.4) below with both the interaction term based on the pre-partition literacy rate, $Literacy_i^{Pre} \cdot Post_t$, and the interaction term based on the pre-partition proportion of minorities, $Minorities_i^{Pre} \cdot Post_t$, on the right hand side.

$$Y_{it} = \beta(Minorities_i^{Pre} \cdot Post_t) + \lambda(Literacy_i^{Pre} \cdot Post_t) + \gamma_t + \mu_i + \eta X_{it} + \zeta_j \times t + \epsilon_{it} \quad (2.4)$$

I then compare the estimates of equation (2.4) with the estimates of equation (2.1). For ease of comparison, I have reported the estimates of equation (2.4) alongside those of equation (2.1) in the last column of Table 2.3. Once the impact of pre-partition literacy on post-partition school provision has been controlled for, the impact of pre-partition minorities on post-partition school provision reduces somewhat in both magnitude and significance. This suggests that the positive influence of the minorities on schooling was at least in part mediated through their contribution towards literacy.

[22]Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 246

2.7.2 Minorities and Occupation

Aside from their higher literacy rates, the Hindus and Sikhs also differed in terms of their occupations in the regions that became part of Pakistan. Large proportions of them belonged to traditional mercantile castes that were involved in small-scale money lending to farmers for agricultural purposes[23]. Almost every village in western Punjab had a traditional moneylender who was either a Hindu or Sikh and who provided a 'much needed source of credit for cultivation' (Raychaudhuri, Habib, and Kumar, 1983, p. 998). Table 2.9 provides evidence for the predominance of the minorities in mercantile occupations during pre-partition. It shows the occupational distribution of the majority Muslim and the minority Hindu and Sikh communities in 1931 for each of the three colonial regions considered in this paper that became part of Pakistan. In all three regions the proportion of Hindus and Sikhs in mercantile castes is higher than the proportion of Muslims. As was the case with their dominance in terms of literacy, the higher concentration of the minorities in commercial occupations was also noted by colonial administrators in official publications. For instance, the 1881 census of the Punjab states that the Hindus and Sikhs were mostly traders in those districts where they formed a minority[24]. According to the 1884 gazetteer of the Muzzaffargarh district almost the whole of trade, moneylending, and banking was in the hands of the Hindus from the Arora caste[25]. The Hindu Aroras were also the chief moneylenders and capitalists and the chief creditors of the agriculturists in the Jhang district[26]. The

[23]The three main commercial castes of the Khatris, Aroras and Baniahs were all either Hindu or Sikh

[24]Punjab (India), and Sir Denzil Ibbetson. Report on the Census of the Panjab Taken on the 17th of February 1881. Superintendent of Government Prtg., 1883. Text and Appendices. Page 125

[25]Gazetteers, Punjab District (1884). Gazetteer of the Muzaffargarh District, 1883-84. Lahore: Lahore: Printed at the "Arya Press", by Ram Das. Page 70

[26]Gazetteers, Punjab District (1884). Gazetteer of the Jhang District, 1883-84. Lahore: Printed at the "Arya Press", by Ram Das. Page 68

Hindu and Sikh Aroras controlled the moneylending business in the Montgomery district [27]. The three most numerically important Hindu castes in the district of Attock were said to have divided amongst themselves almost the whole trade and money-lending business[28]. These statements and others like them provide ample evidence for the fact that the minorities had a substantial presence in commercial occupations in the districts from which they were expelled at partition.

Having established the high concentration of minorities in mercantile castes, I now argue that mercantile occupations are indeed important for schooling. The demand for schooling, and more broadly educational demand, is higher in occupations where the expected market returns to education are high. The strong positive correlation between market returns to education and the demand for education is corroborated by several studies (Nguyen, 2008; Jensen, 2010; Attanasio and Kaufmann, 2009). In mercantile occupations, where the market returns to academic skills such as numeracy and literacy are high, education plays a crucial role. It was the mercantile castes, composed largely of the minority Hindu and Sikh communities, that took a keen interest in education throughout the colonial period. For instance, the 1883-84 Jhang gazetteer notes that the Hindu mercantile castes of Khatris and Aroras chiefly availed themselves of the means of education in the district [29]. The 1929 Muzaffargarh gazetteer observes that the commercial castes of the district comprising mainly of Hindus had eagerly accepted education[30].

[27] Gazetteers, Punjab District (1884). Gazetteer of the Montgomery District, 1883-84. Lahore: Printed at the "Arya Press", by Ram Das. Page 69-70

[28] Gazetteers, Punjab District (1932). Gazetteer of the Attock District, part A, with maps, 1930. Lahore: Supt., Govt. Printing, Punjab. Page 115

[29] Gazetteers, Punjab District (1884). Gazetteer of the Jhang District, 1883-84. Lahore: Printed at the "Arya Press", by Ram Das. Page 52-53

[30] Gazetteers, Punjab District (1931). Gazetteer of the Muzaffargarh District, part A, with maps, 1929. Lahore: Supt., Govt. Printing, Punjab. Page 133-134

2.7.3 Minorities and Social Capital

Minorities were also important in sustaining the social capital that was crucial for school provision. Their presence at mixed religious gatherings in the various holy places – *shrines, temples and gurduwaras* – of Punjab, Sind and NWFP contributed to the promotion of local social capital. Most of the mixed religious gatherings took place at the shrines of various Muslim saints. These saints were held in great regard equally by Hindus, Sikhs and Muslims. The chief reason for this was the peculiar form that popular religion took in the collective consciousness of the populace. Hinduism, Islam and Sikhism in these regions, in their popular forms, were based on the common practice of saint veneration as opposed to a deeper understanding of the holy scriptures and theology. The work of Mir (2010) on culture in the colonial Punjab argues that the discourse on piety in Punjab was inextricably linked to the worshipping of sufi saints, a practice that attracted people of 'diverse religious and class affiliations'[31]. Perhaps, the most salient example of the shared worship of saints was the cult of the Panj Pir (i.e. Five Pirs). The Panj Pir was a term used for a collection of five saints that were worshiped by all Punjabis, regardless of their religion. However, who exactly the five saints were was always a matter of contention. They invariably contained a mixture of the famous personalities from all religions such as Guru Gobind Singh (Sikh), Sakhi Sarwar (Muslim), Baba Fariduddin Ganj-i-Shakar (Muslim), Vishnu (Hindu) and Durga (Hindu)[32].

Aside from the worship of the Panj Pir, there are several other references in colonial documents, which show that the worship of sufi saints was common amongst

[31] Mir. Farina. The social space of language: vernacular culture in British colonial Punjab. Vol. 2. University of California Press, 2010.Page 175

[32] Kamaljit Bhasin-Malik, M. (2007). *In the Making: Identity Formation in South Asia.* Gurgaon, India: Three Essays Collective, p.137

Punjabis from all religious backgrounds. Ibbetson (1883), when discussing the Muslim saints of Punjab, notes that they were revered by both Hindus and Muslims with the 'most absolute impartiality'[33]. In another instance, he expressed his bewilderment at the way in which the 'various observances and beliefs' that distinguished the followers of the major faiths of the Punjab 'in their purity were so strangely blended and intermingled' that it was often 'impossible to decide' in what category the people were to be classed[34].

The official colonial documents provide a rich illustration of the inter-religious gatherings at shrines across the Punjab. In the Dera Ghazi Khan district, the court appointed trustee of the Sakhi Sarwar shrine whilst commenting on its popularity stated that 'men, women and children, Sikhs, Hindus and Mohammedans alike' flocked to it from 'all the districts in the Punjab'[35]. Ibbetson (1883) also singled out the same shrine as an example of a place where 'religions intermingled in an extraordinary manner'[36]. Even in the Attock district of Northern Punjab, not known for its saints, both Hindus and Muslims attended the fair at the shrine of Sultan Sadr Din Bukhari in the thousands [37]. The shrine of Barri Latif Shah in Rawalpindi district attracted around 20,000 people, Hindus as well as Muslims, to its annual fair[38]. The shrine of the saint Shah Chan Charagh in the same district was also the scene of a gathering of both Hindus and Muslims every Thursday, with

[33]Denzil. Ibbetson, Outlines of Panjab Ethnography: Being Extracts from the Panjab Census Report of 1881, Treating Religion, Language and Caste. Page 115

[34]DenzilIbbetson, Outlines of Panjab Ethnography: Being Extracts from the Panjab Census Report of 1881, Treating Religion, Language and Caste. Page 101

[35]Audrey Orien, Mohammedan Saints of the Western Punjab. The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Volume 41. Page 519

[36]Denzil Ibbetson, Outlines of Panjab Ethnography: Being Extracts from the Panjab Census Report of 1881, Treating Religion, Language and Caste. Page 115

[37]Gazetteers, Punjab District (1909). Gazetteer of the Attock District, 1907. Lahore: "Civil and Military Gazette" Press. Page 145

[38]Gazetteers, Punjab District (1909). Gazetteer of the Rawalpindi District, 1907. Lahore: "Civil and Military Gazette" Press. Page 102-103

large crowds in attendance between the months of July and August[39]. Numerous small gatherings of an inter-religious nature were recorded at shrines throughout the Shahpur district[40]. Finally, the 1933 Montgomery district gazetteer notes that 'fairs of a religious or semi-religious nature' were 'recorded as taking place in no less than 219 places'[41]. Perhaps the largest inter-religious gathering took place at the Gullu Shah shrine in Sialkot district, where some 50,000 to 70,000 people attended the annual fair[42].

In addition to the fairs and festivals at shrines there were other public festivals and carnivals – *melas* – in which mixed-religious gatherings were also the norm. Oberoi (1994) argues that the *melas* were a 'motley assemblage of people from different neighbourhoods, villages and regions that diluted the codes of class, caste and religious differences'[43]. Foremost amongst these *melas* was the festival of *Baisakh* that was held to celebrate the arrival of spring. In the Multan district, which had a long tradition of a culture of tolerance towards its minorities, all communities including Hindus and Muslims joined freely in each other's festivals. Indeed, so widespread was the practice that it was even expressed unintentionally in a famous local proverb of the time: *Guzri Holi RahmatullaKhede* (i.e. The Holi (a Hindu festival) is over, yet Rahamatullah (a Muslim) goes on playing)[44].

[39]Gazetteers, Punjab District (1909). Gazetteer of the Rawalpindi District, 1907. Lahore: "Civil and Military Gazette" Press. Page 102-103

[40]Gazetteers, Punjab District (1918). Gazetteer of the Shahpur District, part A, with maps, 1917. Lahore: Supt., Govt. Printing, Punjab. Page 128

[41]Gazetteers, Punjab District (1935). Gazetteer of the Montgomery District, part A, with maps, 1933. Lahore: Supt., Govt. Printing, Punjab. Page 117

[42]Gazetteers, Punjab District (1921). Gazetteer of the Sialkot District, part A, with maps, 1920. Lahore: Supt., Govt. Printing, Punjab. Page 71

[43]Oberoi, Harjot. The construction of religious boundaries: Culture, identity, and diversity in the Sikh tradition. University of Chicago Press, 1994. Page 189-190

[44]Gazetteers, Punjab District (1927). Gazetteer of the Multan District, part A, with maps, 1923-24. Lahore: Supt., Govt. Printing, Punjab. Page 103

The above paragraphs show that the mixed religious gatherings represented a platform where shared experience amongst the populace was most regular and repetitive. It was at the gatherings that individuals from different religions interacted in a way that transcended religious and caste boundaries. In a society that was otherwise blighted by fissures along several lines, it was through such interactions that the raw materials for creating a common identity were formed. Importantly, the gatherings provided an environment where the collective action that was important to school provision could be nurtured. Social capital has been shown to be positively associated with several development outcomes. In particular, higher social capital increased economic growth in the post-World War II period (Temple and Johnson, 1998), reduce income inequality (Knack and Keefer, 1997) and improved adaption to climate change (Adger, 2010).

2.8 Conclusion

This study uses the partition-induced expulsion of religious minorities as an identification strategy to show the impact of religious minorities on school provision. Its results show that those areas that had a higher proportion of minorities prior to partition suffered more in terms of school provision after partition. Thus implying that the presence of minorities was important to the supply of schools. The positive impact of the minorities was in part due to them being more literate and having a better understanding of the material advantages to be gained from education. It was also because of their concentration in mercantile occupations where academic skills such as numeracy and literacy were considered desirable. Finally, the destruction of the social capital sustained by the minorities during pre-partition that could have facilitated school provision also had a role to play.

This study contributes to the literature on the relationship between diversity and public goods provision in two important ways. Firstly, it makes use of an effective identification strategy to examine the impact of religious diversity on school provision. The strategy relies on the use of the partition induced expulsion of minorities as an exogenous source of variation in religious diversity. Moreover, its results show that districts that experienced a greater reduction in religious diversity at partition suffered more in terms of school provision after partition. Such a result is contrary to the conventional explanation offered in the literature, according to which a reduction in diversity should have been beneficial to schooling.

Table 2.1: Descriptive statistics

	By pre Partition proportion of minorities			
	Whole Sample	High minorities	Low minorities	Source
Proportion of minorities (1891)	0.173	0.250	0.112	Census of India (1891)
Schools per thousand persons (1891)	0.222	0.352	0.118	Indian District Gazetteers
Change in schools per thousand persons (1891 to 2008)	3.288	1.517	7.514	Author's calculations
Population Density (1891)	0.012	0.013	0.012	Census of India (1891)
Average Annual Rainfall (1919-1923)	13.623	9.333	17.055	Indian District Gazetteers
Army Personnel per thousand persons (1931)	4.292	1.613	6.435	Census of India (1931)
In-Migrant Literacy (1951)	0.275	0.269	0.279	Census of Pakistan (1951)
Number of observations	27	12	15	

Notes: The high minority districts are the ones where the proportion of minorities is above the mean level based on the 1891 sample of districts. Similarly, 'low minority' districts are the ones where the proportion of minorities is below the mean level based on the 1891 sample of districts.

Table 2.2: Partition border and schooling

	Number of schools per thousand persons		
	(1)	(2)	(3)
Districts	1901	1911	1931
Contiguous to Pakistani border			
Lahore	0.13	0.15	0.30
Montgomery	0.15	0.15	0.43
Gujranwala	0.16	0.23	0.49
Sialkot	0.19	0.25	0.45
Contiguous to Indian border			
Gurdaspur	0.23	0.25	0.43
Amritsar	0.17	0.19	0.48
Jullundhur	0.20	0.11	0.49
Ferozepur	0.11	0.17	…
Hoshiarpur	0.16	0.24	0.45

Notes: The sample is restricted to the Punjab state that was bifurcated at Partition and was the most contested. The source for the data is the Punjab District Gazetteer Series.

Table 2.3: Minorities and public goods provision

	Number of schools per thousand persons			
	(1)	(2)	(3)	(4)
	Panel A			
Post Partition Dummy X Proportion of Minorities (1891)	-0.988**	-0.905***	-0.911***	-0.849***
	(0.430)	(0.350)	(0.318)	(0.302)
Post Partition Dummy X Proportion of Literates (1891)				-10.233**
				(4.958)
	Panel B			
Post Partition Dummy X Proportion of Minorities (1901)	-1.009***	-0.887***	-0.937***	-0.972***
	(0.360)	(0.310)	(0.266)	(0.238)
Post Partition Dummy X Proportion of Literates (1901)				-4.229**
				(2.121)
	Panel C			
Post Partition Dummy X Proportion of Minorities (1911)	-1.127***	-0.986***	-1.035***	-0.874***
	(0.359)	(0.324)	(0.288)	(0.216)
Post Partition Dummy X Proportion of Literates (1911)				-3.345*
				(1.770)
	Panel D			
Post Partition Dummy X Proportion of Minorities (1931)	-1.379***	-1.207***	-1.314***	-0.885**
	(0.391)	(0.366)	(0.310)	(0.400)
Post Partition Dummy X Proportion of Literates (1931)				-2.938
				(2.258)
Number of observations	242	242	242	234

Notes: Column 1 of this table shows the regression of annual schools per thousand persons for the period 1891 to 2008 on the interaction terms based on the pre Partition proportion of minorities in 1891, 1901, 1911 and 1931, respectively. Additionally, Column 2 includes log of population density, the interaction between post-Partition dummy and number of army personnal per thousand persons in 1931 and the interaction between post Partition dummy and average rainfall in millimetres in the period 1919 to 1923. Column 3 adds the interaction between post Partition dummy and proportion of literate in-migrants in 1951 to the model in Column 2. Finally, Column 4 adds the interaction terms based on the pre Partition proportion of literates in 1891, 1901, 1911 and 1931, respectively, to the model in Column 3. All the above models include district fixed effects, year fixed effects and state-specific time trends. * p < .10, ** p < .05, *** p < .01. Two-way clustering by district and year. Clustered standard errors in parentheses.

Table 2.4: Minorities and public goods provision: primary vs secondary

	No. of primary schools per thousand persons		No. of secondary schools per thousand persons	
	(1)	(2)	(3)	(4)
	Panel A			
Post Partition Dummy X Proportion of Minorities (1891)	-0.847**	-0.818***	-0.200***	-0.179***
	(0.385)	(0.306)	(0.064)	(0.032)
	Panel B			
Post Partition Dummy X Proportion of Minorities (1901)	-0.917***	-0.861***	-0.180***	-0.146**
	(0.299)	(0.241)	(0.058)	(0.039)
	Panel C			
Post Partition Dummy X Proportion of Minorities (1911)	-1.098***	-1.034***	-0.154***	-0.123***
	(0.299)	(0.244)	(0.060)	(0.042)
	Panel D			
Post Partition Dummy X Proportion of Minorities (1931)	-1.344***	-1.313***	-0.149***	-0.115**
	(0.311)	(0.235)	(0.081)	(0.063)
Number of observations	239	239	239	239

Notes: Observations are at the district-year level. Column 1 of this table shows the regression of the number of primary schools per thousand persons for the period 1891 to 2008 on the interaction terms based on the pre Partition proportion of minorities in 1891, 1901, 1911 and 1931, respectively. Additionally, Column 2 includes log of population density, the interaction between post-Partition dummy and number of army personnal per thousand persons in 1931, the interaction between post Partition dummy and average rainfall in millimetres in the period 1919 to 1923 and the interaction between post Partition dummy and proportion of literate in-migrants in 1951 to the model in Column 1. In Columns 3 and 4 the dependent variable is replaced by the number of secondary schools per thousand persons. All the above models include district fixed effects, year fixed effects and state-specific time trends.
* p < .10, ** p < .05, *** p < .01. Two-way clustering by district and year. Clustered standard errors in parentheses.

Table 2.5: Religious schools post-Partition

Year	Ratio of religious schools to secular schools	
	Punjab	NWFP
2005-06	0.099	0.090
2006-07	0.102	0.100
2007-08	0.087	0.104

Notes: The data sources are the Education Census of Pakistan (2005-06), the Punjab Development Statistics (2006-07 and 2007-08) and the NWFP Development Statistics (2006-07 and 2007-08).

Table 2.6: Standard difference-in-differences estimation

	Number of schools per thousand persons (1)
Proportion of minorities	1.100* (0.638)
Mean Outcome	0.653
No. of observations	213

Notes: This table shows the regression of the number of schools per thousand persons for each census year on the proprotion of minorities in that year for the period 1891 to 1998. Both district fixed effects and year fixed effects are included. * p < .10, ** p < .05, *** p < .01. Two-way clustering by district and year. Clustered standard errors in parentheses.

Table 2.7: Fully flexible estimation

	Number of schools per thousand persons		
	(1)	(2)	(3)
1901 X Proportion of Minorities (1891)	-0.147	-0.134	-0.048
	(0.137)	(0.135)	(0.154)
1911 X Proportion of Minorities (1891)	-0.253***	-0.198	-0.074
	(0.059)	(0.135)	(0.183)
1931 X Proportion of Minorities (1891)	-0.695***	-0.720***	-0.425
	(0.219)	(0.269)	(0.373)
1961 X Proportion of Minorities (1891)	-0.948***	-0.958***	-0.718**
	(0.259)	(0.252)	(0.282)
1972 X Proportion of Minorities (1891)	-1.408***	-1.467***	-1.078***
	(0.335)	(0.348)	(0.404])
1981 X Proportion of Minorities (1891)	-0.590	-1.078	-0.880
	(0.732)	(0.685)	(0.780)
1998 X Proportion of Minorities (1891)	-2.497***	-2.550***	-1.833***
	(0.599)	(0.482)	(0.383)
2008 X Proportion of Minorities (1891)	-2.336**	-2.434***	-2.147***
	(0.524)	(0.431)	(0.410)
Controls (x Year Fixed Effects):			
Average Rainfall (1919-1923)	No	Yes	Yes
Proportion of literate in-migrants (1951)	No	Yes	Yes
Proportion of army personnel (1931)	No	No	Yes
Time Varying Controls:			
Log of Population Density	No	No	Yes
Number of observations	243	243	243

Notes: Observations are at the district-year level. All regressions use a consistent sample of 27 districts. The periods are 1891, 1901, 1911, 1931, 1961, 1972, 1981, 1998 and 2008. The dependent variable is number of schools per thousand persons. The Proportion of Minorities in 1891 is interacted with an indicator for each period of the sample. All the above models include district fixed effects and year fixed effects. * p < .10, ** p < .05, *** p < .01. Two-way clustering by district and year. Clustered standard errors in parentheses.

Table 2.8: List of educational reforms

Attempt at improving Education	Period
National Education Conference	1947-54
First Five Year Plan: 1955-60	1955-59
Second Five Year Plan	1960-64
Third Five Year Plan	1965-69
The New Education Policy	1970-71
The Education Policy	1972-77
Fifth Five Year Plan	1978-82
Literacy and Mass Education Commissic	1981
The 10-Point Programme	1983
Sixth Five Year Plan	1983-87
National Literacy Plan	1984-86
Drop-In Schools	1986-89
Nationwaide Literacy Programme	1986-90
Nai Roshni Schools	1986-90
Seventh Five Year Plan	1988-92
Eight Five Year Plan	1993-97
National Education Policy	1998-2010

Source: Bengali, K., 1999. History of educational policy making and planning in Pakistan. Sustainable Development Policy Institute.

Table 2.9: Occupational distribution pre-Partition

Occupational Classification	Western Punjab	Sind	NWFP
Agricultural	57	73	76
Religious	2	0	4
Mercantile	**2**	**1**	**1**
Artisan	13	0	8
Menial & Outcast	19	1	5
Other	7	24	6
Total Muslim	100	100	100
Agricultural	10	23	7
Religious	11	4	9
Mercantile	**58**	**60**	**64**
Artisan	5	6	1
Menial & Outcast	13	7	5
Other	3	1	13
Total Hindu	100	100	100
Agricultural	63	0	6
Religious	1	0	4
Mercantile	**15**	**100**	**22**
Artisan	7	0	0
Menial & Outcast	12	0	1
Other	3	0	67
Total Sikh	100	100	100

Notes: Data collected from the Indian Census Reports of 1931

Chapter 3

Displacement and Development: Partition of India and Agricultural Development

3.1 Introduction

The end of the British Empire in India in 1947 was marked with an unprecedented mass migration of nearly 17 million people, and a human rights disaster involving nearly a million deaths in the wake of the riots that ensued between Hindus and Muslims on either side of the newly created India-Pakistan border. The emergence from nearly a century of colonial rule left an indelible mark on Indian history. Historical events undoubtedly shape modern day institutions and development (Acemoglu, Hassan, and Robinson, 2011; Nunn, 2008; Banerjee and Iyer, 2005; Acemoglu, Johnson, and Robinson, 2002; Chaney and Hornbeck, 2015; Dippel, 2014; Dell, 2010), and with India fast emerging as a major economic force, it is important to look back on her origins as an independent country and examine the legacy of the partition on an important aspect of economic progress – agricultural development.

Using migrant presence as a proxy for the intensity of the impact of the partition, this paper highlights important correlations between areas that received migrants and subsequent agricultural development in those areas. Documenting these correlations is an important contribution as mass migrations, institutional upheaval, and partitions are a reality today.[1] It is crucial therefore to understand how communities and areas develop long after such events take place. While affected areas suffer in the short run, it is critical to document whether the legacy of such events forever change the long run trajectory of these places.

We find that the partition had a statistically significant but moderate impact on agricultural development in the decades after India's independence. Between 1957 and 2009, areas that received migrants saw average annual wheat yields increase by 3.2% compared to areas that received no migrants. We find similar results when examining annual revenue per hectare;[2] this measure is used so as to not be reliant on any specific crop for our productivity measures. In the case of wheat, we find that most of the effects of partition are concentrated after the start of the Green Revolution. The green revolution transformed Indian agriculture in the 1960s, making crops less susceptible to destruction via pests and droughts, increasing yields and increasing land-based investments like irrigation. We find that migrant presence is also strongly correlated with the use of tractors (a 10%

[1] The current (as of September 2015) refugee crisis in Europe is a relevant example of a mass migration with the potential to affect labor markets and economic development of receiving countries. The most recent example of a partition is that of Sudan where in a referendum held in January 2011 in the south showed that an overwhelming 98.8 percent of the population were in favor of secession. As a consequence, constitutional declaration of the independence of South Sudan took place on 9 July 2011. The other recent example is the Dayton peace agreement of November 1995, which led to the partition of Bosnia and brought an end to the Bosnian War. Yet another prominent example is the partition of Cyprus into Greek and Turkish speaking separate territorial units after the Turkish invasion and occupation of Northern Cyprus in 1974 (Christopher, 2011; Kumar, 2004; Kliot and Mansfield, 1997).

[2] This measure uses data on the production of wheat, rice, sugar, jowar, maize, bajra, barley, cotton, groundnut, jute gram, potato, ragi, rapeseed, mustard, sesame, soybean, sugarcane, sunflower, tobacco, tur and other pulses.

increase in migrants is correlated with a 2% increase in the use of tractors between 1957-1987) and fertilizers (phosphorous and nitrogen), which is in line with the idea that partition-affected districts were more likely to adopt HYVs and other technologies related to the green revolution. These results are not just driven by migration into agriculturally suitable states like the Punjab – the results are robust to the inclusion of state fixed effects and state specific time trends. Finally, using agricultural data from before 1951, we show that migrant presence in 1951 is uncorrelated with yields or soil types, suggesting that selective migration at the district level cannot solely explain our results.

While we believe these results to be important, we want to be upfront about the scope and limitations of this paper. This research is motivated by the goal of linking partition to subsequent economic development (as measured by income, health and human capital); however, in this paper we specifically (and only) examine agricultural outcomes. There are two main reasons for this: first, agricultural outcomes are available at a yearly level, at fine levels of administrative disaggregation, and over a long period of time; and second, agriculture was, and still is, an important part of employment and economic output in India.[3]

A second limitation of this study is due to the fact that the partition was an event that resulted in many changes: migration, new governments, mass deaths, demographic changes and loss and restructuring of land. It is difficult therefore to have a single variable that captures all of these forces, or even obtain data on most of these individual changes. Our way of measuring the intensity of the impact of partition is to use displaced person population in 1951. By this, we assume that

[3]In 2014 approximately 17 percent of Indian GDP was made up of the agricultural sector and for the decade prior to that it fluctuated between 18 and 17 percent. In 2012 as much as 47 percent of the total Indian workforce was employed in agriculture (data from World Bank Economic Indicators).

areas (districts in our case) that received migrants due to partition were more "affected" along various dimensions, like the ones we just mentioned, by partition than districts that did not receive any migrants. While we use displaced person population as our metric for the intensity of the impact of partition, we do not wish to interpret our results as solely the effects of partition induced *migration*. For example, districts with more migrants could have received more government aid in the years after partition, and our effects should be interpreted as capturing the effect of both migration and government assistance. Finally, where displaced populations chose to settle was not, and could not plausibly be, random. While we make the case that migrant settlement was not correlated with the potential for agricultural growth, we have no illusions of making causal claims in this paper.

While it is imperative to uncover the precise mechanisms or governmental policies (or lack thereof) that led to these long run effects, we are unable to do so in this paper. Data limitations and the sheer magnitude of the event makes it nearly impossible to make precise statements about any *one* leading factor. We do, however, provide some preliminary evidence that the composition of migrants played a qualitatively important role in the future agricultural development of more affected areas. Migrants who moved to India were more educated than the natives who stayed behind (Bharadwaj, Khwaja, and Mian, 2009). Given the positive correlation between education and the better use and take up of agricultural technologies (Feder, Just, and Zilberman, 1985), the demographic changes induced by partition could be a plausible mechanism for the effects seen. The migrants were also more likely to have been involved in money lending and other commercial aspects of farming. Since credit is an important aspect of agriculture and especially so for the take up of newer technologies it is likely that the presence of migrants during the green revolution helped along this dimension as well.

This paper contributes to the economics literature on the long term impacts of historical events in general (see Nunn (2009) for a review), and also to the literature more focussed on the impacts of history and colonization in India (Jha, 2013; Chaudhary and Rubin, 2011; Donaldson, 2010; Iyer, 2010). Most closely related is the work of Banerjee and Iyer (2005), who show that different institutions (specifically practices regarding land rights) during the colonial period had a profound impact on agricultural development long after the British left India. They find that these institutions played an important role after the start of the Green Revolution, where individual rights to ownership of land were a crucial aspect of districts that were able to take advantage of HYV seeds, fertilizers, and other agricultural technologies. This paper also builds on and extends the research that is directly related to the partition of India (Bharadwaj, Khwaja, and Mian, 2009; Jha and Wilkinson, 2012; Bharadwaj and Fenske, 2012b). While these papers contribute in important ways to our understanding of the event by analyzing the demographic consequences of partition, the role of combat experience during WWII on ethnic cleansing during the partition, and the impact of partition related migratory movement on jute cultivation, they do not examine long run consequences. Hence, the main contribution of this work is to examine how partition (as measured by the presence of displaced populations) impacted long run economic outcomes such as agricultural development.

3.2 Data and Empirical Framework

3.2.1 Post-Partition Data

For our post-partition analysis the data comes from three different sources: the 1951 census of India, the Indian Agriculture and Climate Dataset (i.e. IACD) and the Village Dynamics in South Asia Dataset (i.e. VDSA). The 1951 census data was used to construct a measure of displacement that was then related to measures of agricultural development from 1957 to 2009 that were constructed from data in the IACD and VDSA datasets.[4] An important task in relating the two measures was to make district boundaries comparable between 1951, the year in which displacement data was recorded, and the first year for which data is available in the combined IACD and VDSA panel dataset (i.e.1957).[5] For those districts that were partitioned between 1951 and 1957 we used a mapping procedure to achieve such a task. Our procedure involved the following steps. We first identified the districts that were created between 1951 and 1957. We called these are our child districts. We then identified the 1951 districts from which our child districts were created between 1951 and 1957. We called these our parent districts. We then recorded the areas of all our child and parent districts. Next, we divided the area of the child district by the area of its corresponding parent district to determine the proportion of the 1951 parent district that was made up of the child district. Finally we use the resulting proportions to estimate 1951 numbers for the child districts that were created between 1951 and 1957.

1951 Census of India

The 1951 census of India was carried out in the last three weeks of February 1951 with enumerators revisiting households from the 1st to the 3rd of March

[4] In constructing our agricultural development measures from 1957 to 2009 we combined the IACD data from 1957 to 1965 with the VDSA data from 1966 to 2009. For the period where there was an overlap between the IACD and the VDSA (i.e. 1966 to 1987) we carried out empirical exercises to show that the data contained in both of them were not significantly different from each other.

[5] The district boundaries were kept constant for the period 1957 to 2009 in the combined IACD and VDSA panel. Therefore, making the 1951 district boundaries comparable with those in the first year of the combined IACD and VDSA panel (i.e. 1957) also makes them comparable with the boundaries in all the subsequent years of the panel (i.e. from 1958 to 2009).

of the same year. It is significant for having recorded the initial and the most substantial phase of migration inflows that resulted from partition. A total of 7.3 million displaced in-migrants were enumerated, of whom 4.7 and 2.55 million had come from West and East Pakistan, respectively, and 0.05 million did not specify their place of origin (Visaria, 1969). Information on the in-migrants was disaggregated by gender, age, occupation and region of origin. In the case of sex, separate inflows were recorded for both males and females. According to Bharadwaj, Khwaja, and Mian (2009) the percentage of men in the inflows was, on average, 1.09 percentage points lower than the residents. For age structure, the refugees were classified in ten-year age groups going from ages 5-14 through 65-74. The region of origin for each in-migrant was identified as being either West or East Pakistan. In addition to demographic characteristics, there was also data on the occupation of in-migrants. Appendix II of Table IV of the census provides a detailed occupational classification of the in-migrants. Here again according to Bharadwaj, Khwaja, and Mian (2009) the in-migrants tended to engage more in non-agricultural professions relative to the resident population.

The 1951 census provides the best estimate to date of the spatial distribution of the immigration from Pakistan into India due to partition. That said, it does have some drawbacks. Firstly, the data on region of origin does not provide enough granularity to identify the district of West or East Pakistan from which an in-migrant came from. Secondly, substantial changes in the administrative machinery and the relatively unsettled conditions in those districts that received in-migrants casts doubt over the quality and coverage of the data (Visaria, 1969). On the other hand the multiple counting of persons crossing the border into India more than once caused an over reporting of in-migrants (Visaria, 1969). Finally, the high mortality rate amongst the refugees who arrived between 1947 and 1951 meant that the true scale of partition related displacement could not be established (Visaria, 1969).

Indian Agriculture and Climate Dataset

The Indian Agriculture and Climate Dataset is a panel dataset that covers 271 districts across thirteen states of India and includes annual data on agricultural, economic, climate and edaphic variables for the period 1957 to 1987. The states covered are Haryana, Punjab, Uttar Pradesh, Gujarat, Rajasthan, Bihar, Orissa, West Bengal, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Madhya Pradesh. One of the key concerns that the compilers of the dataset addressed was to keep district boundaries constant between 1957 and 1987 so as to make the data comparable over time. They did so by taking into account all the changes in district boundaries that occurred between 1957 and 1987. More, specifically they preserved the original district boundaries by consolidating new districts created after the start date of the panel (i.e. 1957) into previous parent districts. For this reason the actual number of districts at the end of the panel period (i.e. 1987) is larger than the 271 districts contained in it.

In particular, the dataset includes annual information on the quantity produced of each crop (in tons), the area planted to each crop (in hectares), the area planted to high yield varieties of each major crop (in hectares) and the price of each crop. The quantity and price of the various inputs used in agriculture such as bullocks, tractors, and fertilizer (in tons) is also given. The climatic variables included are average monthly rainfall (in millimetres) and average monthly temperature (in degree celsius) for the period 1957 to 1987. Data from the population census is available on the number of persons, literacy, number of cultivators and the number of agriculture laborers. Finally, there is a set of 21 indicator variables each specifying a different soil quality type in the dataset.

Village Dynamics in South Asia Dataset

The Village Dynamics in South Asia Dataset is a panel dataset that covers 281 districts across nineteen states of India and includes annual district level data on agricultural, socioeconomic, climate, edaphic variables and agro-ecological variables for the period 1966 to 2009. It builds and expands on the thirteen states given in the IACD by including the six additional states that are Assam, Himachal Pradesh, Kerala, Chhattisgarh, Jharkhand and Uttarakhand. The dataset uses 1966 as the base year for its districts. Hence, data from child districts formed after 1966 are given back to their respective parent districts to form a comparable sample of districts from 1966 to 2009 that is based on 1966 district boundaries. This is the same process of consolidating child districts into their parent districts that is used by the IACD dataset.

Specifically, the VDSA dataset includes annual information on crop area (in hectares) and production (in tons), price of crops (in rupees), area planted to high yield varieties of each major crop (in hectares), irrigated area, livestock, agricultural implements, annual rainfall (in millimetres), fertilizer consumption (in tons) and operational holdings. It also contains population census data on number of persons, literacy, number of cultivators and the number of agricultural laborers.

Combining the IACD with the VDSA datasets

In constructing our panel we combined the data on the thirteen states contained in the IACD dataset from 1957 to 1965 with the data on the same thirteen states in the VDSA dataset from 1966 to 2009. For the period where the two datasets overlapped (i.e. 1966 to 1987) we used the data from the VDSA dataset. A concern here was that for the overlapping period the data in the IACD dataset could be significantly different from the data in the VDSA dataset. We carried out two empirical exercises to show that this is not the case. Firstly, in Figures 3.A.1 and 3.A.2 we show that the correlation between the data on the annual wheat yields and the annual proportion of wheat HYV in the two datasets are quite high. Secondly, in Appendix Table 3.A.5 we show regressions for annual wheat yields and annual proportion wheat HYVs that exclude observations that are zero in one of the datasets and non-zero in the other. As is clear from the results, dropping observations that are not similar across the two datasets does not reduce the significance or the magnitude of our results.

3.2.2 Pre-Partition Data

Agricultural Statistics of British India

For our pre-partition analysis we use the Agricultural Statistics Reports of British India to extract information on yields for each of the major crops: Wheat, Rice, Sugar and Maize. The reports were produced on an annual basis by the Department of Revenue and Agriculture of the Colonial government. They contained information on yields for all major crops and most other crops for districts of British India and a select group of princely states. Although the reports came out on an annual basis, the yield numbers were only revised every five years. Therefore the pre-partition panel dataset we constructed contains information on yields for only four years during the period stretching from 1910 to 1940.[6] The colonial

[6] To be more precise the exact years are 1911, 1921, 1932 and 1938.

government started recording rough estimates of acreage and production of the major crops from as early as 1861. However, a concerted effort to systematically collect such information on most crops only began in 1891-92 (Heston, 1973). Our selection of 1910 as the starting point of our pre-partition panel was determined by the substandard quality of data prior to that date.

3.2.3 Empirical Specification

Our main estimating equation takes the form:

$$Y_{ist} = \beta D_{is}^{51} + \delta Pop_{is}^{51} + \gamma Den_{is}^{61} + \mu Z_{ist} + \zeta_s \times t + \zeta_s + \alpha_t + \epsilon_{ist} \quad (3.1)$$

Y_{ist} represents the outcome of interest in district i, in state s, at time t. We examine 2 *crop specific* agricultural outcomes: yield and HYV adoption (defined as acreage using HYV seeds divided by the total amount of land under cultivation). In order to compare districts that grow different crops, we use an overall revenue based measure as well. This measure uses a single calendar year price (in our case 1960)[7] for each crop produced in the district, then dividing by the area under cultivation in that district to construct our "revenue per acre" measure. In some specifications, we also use other measures of technology adoption like tractors and fertilizer use per acre, and pre-partition yields to examine the role of migrant placement based on land productivity prior to partition. While our main specification uses the data in panel form, an analogous specification would be to collapse the data at the district level by taking averages for the entire period for which we have agricultural data, or for specific decades or years. This would analyse cross-sectional variation. Not surprisingly, the results with the cross

[7]We do this to avoid the fact that production in any given year can affect prices.

sectional approach are similar and presented in the appendix. The main advantage of the panel form is in our examination of the effect of displaced persons after the start of the Green Revolution. In some specifications, we interact D_{is}^{51} with the calendar year in the district when the acreage under HYV exceeds 5% (our approximate measure of when the green revolution started in that district). The interaction thus represents the differential impacts due to partition on agricultural outcomes after the start of the green revolution

D_{is}^{51} is the main independent variable of interest, the log number of displaced persons (in-migrants) in the district i (this is measured at a single time period in 1951). In order to control for the overall size of the district in 1951 we also crucially include the log of the population of that district in 1951 (Pop_{is}^{51}). Z_{ist} is a vector of controls representing agricultural characteristics of the district like rainfall and soil types (soil types do not vary over time in the district). As mentioned earlier, the IACD data contains information on soil types at the district level, and we control for these as soil conditions might play an important role in the adoption of agricultural technology and agricultural productivity. Finally, we control for broader time-invariant characteristics at the state level with state fixed effects (ζ_s), for country level year specific effects with calendar year fixed effects (α_t), and also for state-specific time varying characteristics with state-time trends ($\zeta_s \times t$). Given the panel nature of the data, it is crucial that we cluster our standard errors at the district level.

Although we claim to not highlight a causal link between migration and agricultural development in this paper, it is useful (perhaps for future work in this area) to consider some of the biases that might be present when estimating equation (3.1). A leading candidate for a variable that we do not measure, but that could be correlated with both displaced persons and agricultural development is government intervention or aid for migrants. There were many programs set up by the government to help with refugee resettlement (land redistribution for example) and these programs could have had direct bearing on agriculture as well. Our estimates on displaced persons in the above estimating equation therefore represent a reduced form or "net" effect of migration and associated changes due to migration on agricultural development. Such an interpretation is still useful, as rarely in the world would a mass movement of people take place without other, simultaneous responses (either by governments or by people in receiving countries).

3.3 Results

The results from estimating equation (3.1) with different controls is presented in Table 3.2. The outcome variable in Table 3.2 is the revenue per acre using 1960 prices. As mentioned earlier, the data is in panel form and hence, we cluster the standard errors at the district level (comparable estimates from a cross section where the average over the entire period is used is presented in Appendix Table 3.A.1). In column 1 of Table 3.2, we estimate equation (3.1) with no controls for soil conditions and population density, but including controls for state and year fixed effects, as well as state specific time trends. So as to control for the size of the district, we include log of the population in 1951 in all our specifications as well. Column 1 shows that a 10% increase in migrants, is correlated with an increase in revenue by 1.4 Rupees per hectare. Given the average revenue per hectare of approximately 485 Rupees, this is a rather small increase. This average effect likely hides important heterogeneity since some districts had much larger inflows than others. In the Punjab for example, districts like Gurdaspur, Kapurthala and Jalandhar, after partition, were made up of 34, 28 and 25 percent migrants, respectively. On the other hand, districts like Mysore, Bangalore and Hassan in Karnataka all had close to 0 percent migrants.

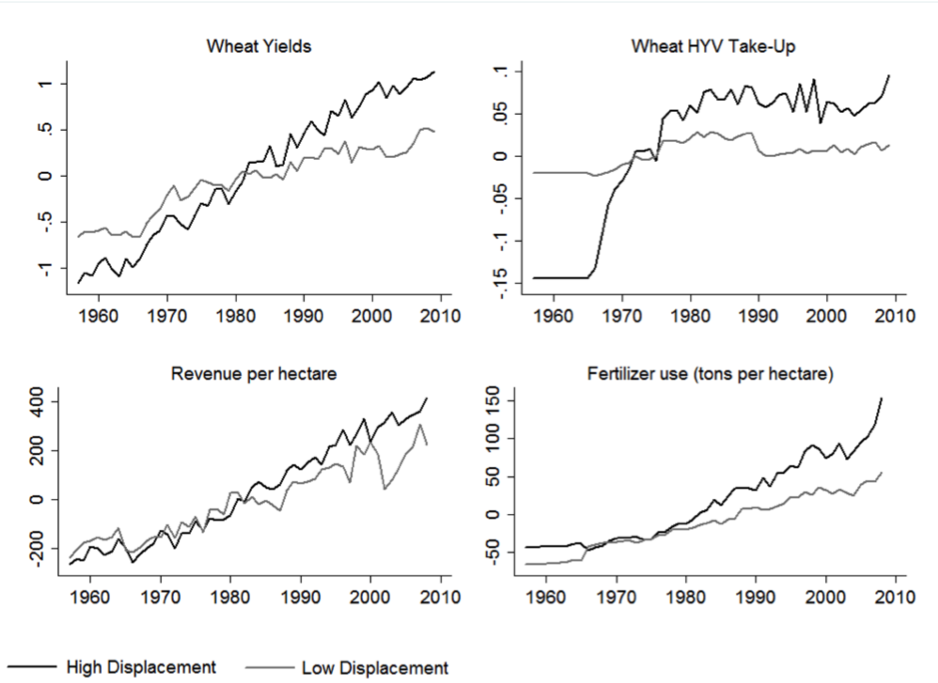
In Columns 2 and 3, we sequentially add the controls of soil quality, population density and rainfall. We do this primarily to asses whether migrant selection into districts was systematically correlated with these variables, which might also affect the outcome of interest. For example, the estimate on log migrants in Column 2 is very similar to the estimate in Column 1 (indeed, they are not statistically significantly different from one another), suggesting that migrant selection on the basis of soil quality and suitability for agriculture is not a concern in our case. Similarly, adding population density and rainfall keeps the results largely stable (although the estimates are not statistically significant in columns 2 and 3).

Table 3.3 examines whether the effect of migrant presence is greater after the start of the Green Revolution starts in that particular district. We define the start of the green revolution as the calendar year after which 5% or more of acreage is under HYV seeds.[8] Note that we do not interpret the timing of the green revolution as exogenous. In fact, as we show in Table 3.4, migrant presence was correlated with the take up of HYV seeds. Instead, our preferred interpretation is that once a certain fraction of acreage is under HYV, the presence of migrants helps revenue from agriculture improve *even more*. The positive and significant coefficients in Table 3.3 on the interaction confirm this.

Table 3.4 examines wheat yields and the take up of HYV varieties of wheat as the dependent variables of interest. Both yields and the take up of HYV are significantly correlated with migrant presence, and the effects are only larger once

[8]The results on take up of HYV varieties of wheat are similar if we define the green revolution timing to be based on a *national* level; that is, defining green revolution start as the first year when more than 5% of crops nationally were HYV. These results are available upon request.

FIGURE 3.1: Migrant presence and agricultural outcomes net of state fixed effects



Notes: In High Displacement districts the proportion of in-migrants is either equal to or above the 75th percentile based on the full sample and in the Low Displacement districts it is either equal to or below the 25th percentile. The variable on the y-axis has been stripped of the state fixed effects. For instance in the case of the top left plot we first regressed the wheat yields on state dummies. We then predicted the residual values for wheat yields and plotted these residuals by year, distinguishing between High and Low Displacement districts. We employed the same procedure for all plots in this figure.

the green revolution occurs in that district (the cross sectional results for take up of HYV are presented in Appendix Table 3.A.2). Visually, this is confirmed in Figure 3.1. It is important to note here that the individual figures *do* take into account state fixed effects. The figures show that high displacement areas and low displacement areas within a state were quite similar until the mid-late 1960s, after which the high displacement districts see greater revenue, wheat yields, tractor use, and acreage under HYV seeds. This is broadly consistent with the timing of the green revolution (Foster and Rosenzweig, 1996). Table 3.4 Column 1 suggests that, compared to districts that received no migrants, districts that received migrants saw yields increase by 3.2%. As expected, this effect is stronger after the start of the Green Revolution occurs in a given district. Column 3 of Table 3.4 suggests that districts with migrants saw an increase in HYV use of 6% compared to districts with no migrants. These results are similar when we specify the right hand side variable in terms of the proportion of migrants (rather than log number of migrants) as shown in Appendix Table 3.A.4. While Columns 1 and 3 are not statistically significant, the migrant proportion interacted with the green revolution dummy is statistically significant. Appendix Table 3.A.5 shows that these results are also robust to exclusion of mismatching data across the overlapping years in the VDSA and IACD data sets.

Table 3.5 confirms the graphical result seen for tractor and fertilizer use in regression form – tractor use per acre is 20% higher in areas with migrants compared to areas without, and is even more so after the start of the Green Revolution; nitrogen fertilizer use is 4.6% higher and phosporous fertilizer use almost 7% in districts with some migrants. Finally Tables 3.6 and 3.7 examines the yields of other important crops like rice, sugar and maize (cross sectional regressions are presented in Appendix Table 3.A.3). We find a significant correlation between migrant presence and the yields of all crops.

An important consideration here is whether migrant presence was correlated with characteristics of a district that made it predisposed to better agricultural development. For example, if a district had better access to waterways or better soil, and if migrants concentrated in these districts, it would be difficult to separate the forces of selective migration into districts from the effects of migrant presence and other partition related forces on agricultural outcomes. We have shown earlier in Table 3.2 and 3.3 that soil conditions do little to change the overall estimates, suggesting that migrant presence is not correlated systematically in ways with soil conditions that matter for agricultural output. In Table 3.8, we conduct a more direct test by regressing *pre-partition* agricultural output on migrant presence in 1951. While wheat yields appear significantly correlated with migrant presence, this result is not robust to dropping a few states where pre-partition data on agricultural yields is considered questionable (Heston, 1973, 1978). Appendix Tables 3.A.6 and 3.A.7 confirm that even for this limited sample, our *post* partition results are statistically significant with the same sign.

3.4 Mechanisms

Our empirical analysis in the previous section has shown a positive correlation between the number of migrants and long-run agricultural development. In this section we will elucidate two channels through which such a relationship operated. Firstly, migrants were more literate than the natives of the districts in which they settled. This in turn meant that they were capable farm managers who were more likely to adopt newer agricultural technologies. Secondly, for a substantial period prior to partition the migrants had been involved in lending to small-scale farmers for agricultural purposes. Therefore, it is also likely that they influenced agricultural development through their contribution towards credit expansion.

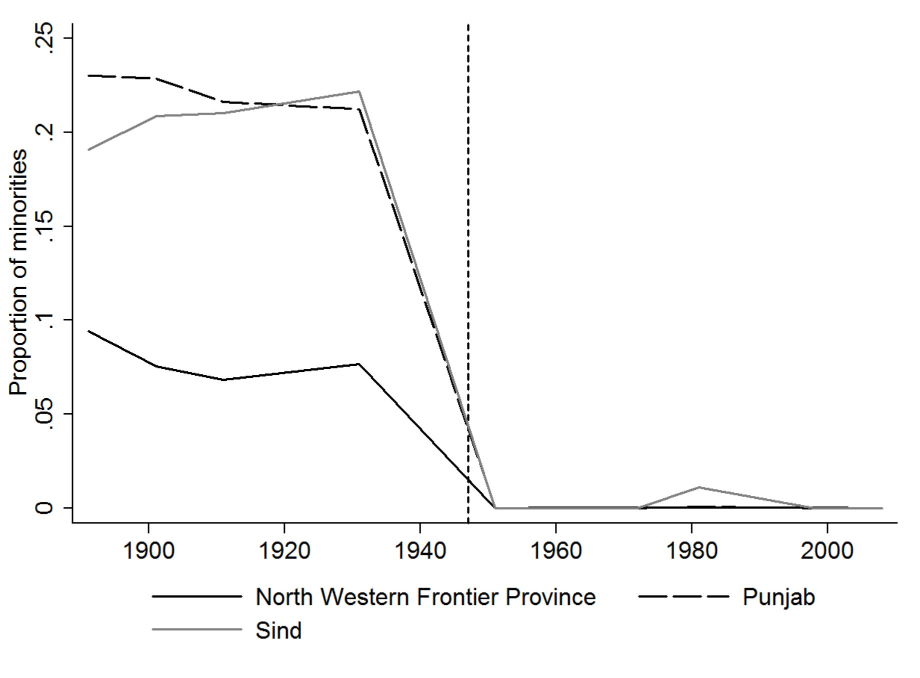
3.4.1 Migrants and Human Capital

The migrants who came to post-independence India were the Hindus and Sikhs who were expelled from areas that later became post-independence Pakistan[9]. Figure 3.2 provides a visual illustration of their expulsion from three regions of colonial India that went to post-independence Pakistan – Western Punjab, Sind

[9]Ideally, we would have liked to distinguish between the affect of Hindu and Sikh migrants in our paper. However, the 1951 census of India does not record the religion of the displaced migrants.

and North Western Frontier Province. Between 1931, the last reliable census prior to partition, and 1951, the first census after partition, the percentage of Hindus and Sikhs in the regions drop from 20% to 0.3%. Such a sudden and universal drop is evidence of there being no selective out-migration from the districts that went to post-independence Pakistan.

FIGURE 3.2: Drop in proportion of Hindus and Sikhs around partition

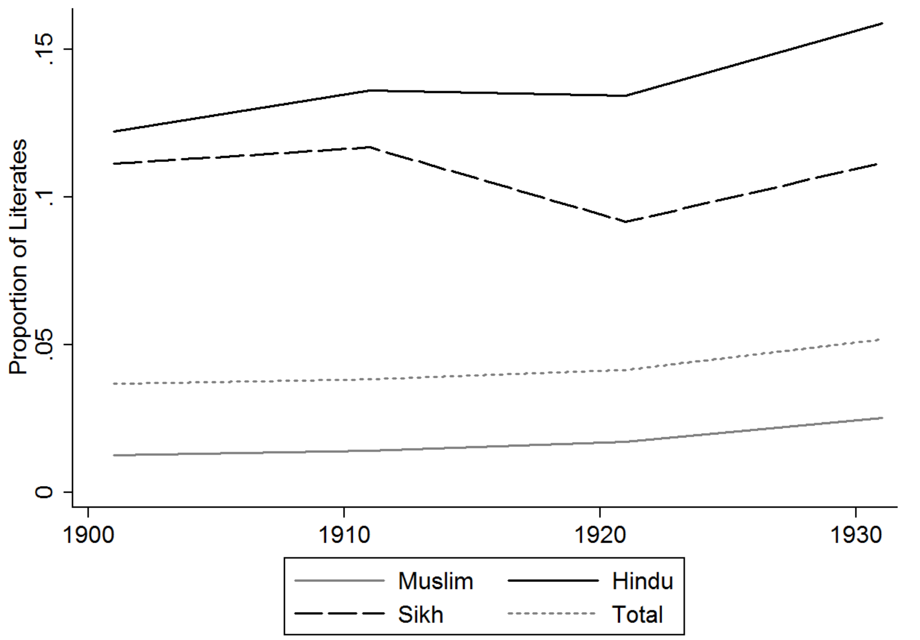


Notes: The figure excludes the 1941 census numbers that are widely regarded as being unreliable. Furthermore, most of the out migration of minorities shown in the figure took place in the brief period between 1947 and 1951.

An important characteristic of the Hindu and Sikh migrants who came to India was their above average literacy rates in the areas from which they were expelled. Figure 3.3 compares the literacy rate of Hindus and Sikhs with those of the Muslims in the districts that later became post-independence Pakistan for the period prior to partition. The stark difference between the literacy rates is quite revealing. The Hindus and Sikhs out performed the Muslims in terms of literacy throughout the four pre-partition census years of 1901, 1911, 1921 and 1931. It is therefore plausible that the migrants, at least in part, contributed towards agricultural development through their impact on literacy. Simple correlations show that migrant presence is indeed correlated with increased literacy of Indian districts in the years after partition. We find that the correlation coefficient between log number of migrants in 1951 and rural male literacy in 1961 is 0.1204 and is significant at the 10% level. It increases in both magnitude and significance between 1961 and 1991.

There are several papers that correlate education with agricultural technology adoption and crop yields (Schultz, 1964; Gerhart, 1974; Jamison, Lau, et al., 1982; Rosenzweig, 1978; Ram, 1976; Sidhu, 1976). The argument usually put forward is that the adoption of agricultural technology requires the ability to perceive, interpret, and respond to new events in the context of risk, and that such ability is derived through human capital (Schultz, 1964). The underlying hypothesis of such an argument is that education increases the ability of farmers to "understand and evaluate the information on new products and processes", thereby incentivizing them to adopt new technologies (Feder, Just, and Zilberman, 1985). Rosenzweig (1978) finds that the probability of adopting high yield varieties of grain in the Indian Punjab is positively related to farmer education and farm size. Sidhu (1976) in another study on the Indian Punjab finds that the education of farmers has a positive impact on both the crop yields and gross sales revenue from the lands that were cultivated in the early stages of the Green Revolution. Finally, Ram (1976) in yet another study on India show that the contribution of farm operators to production was positively related to their education. Feder, Just, and Zilberman (1985) provide a comprehensive review of the broader literature connecting human capital with agricultural technology adoption. In our context, we find using simple correlations in that literacy at the district level is positively correlated to the take up of high yielding variety of seeds in the years subsequent to the partition. The correlation coefficient between take up of high yielding variety of all major crops and rural male literacy in 1971 is 0.2691, is 0.0843 in 1981 and is 0.2640 in 1991.

FIGURE 3.3: Hindu, Sikh and Muslim literacy prior to partition.



Notes: The figure is based on the three colonial regions of Western Punjab, Sind and North West Frontier Province, all of which became part of post-independence Pakistan

To substantiate our claim that the migrants influenced agricultural development through their impact on literacy we present anecdotal evidence which suggests that the migrants were literate cultivators who were known for their superior farming practices. Our evidence comes from those districts of colonial India that later became post-independence Pakistan and from where the migrants emigrated. For instance, the Hindu Jats[10] of the Lyallpur district were considered by the colonial authorities as being the "most useful class of peasants"[11]. The Hindu and Sikh Jats of the Sialkot district were deemed to be far superior cultivators

[10] An agricultural caste of the Punjab

[11] Gazetteers, Punjab District. Gazetteer of the Chenab Colony, 1904. Vol.A. Page 51

than their Muslim counterparts[12]. The gazetteer of the Lahore district notes that the Hindu and Sikh Jats were "good husbandsmen"[13]. The Sikh Virakhs[14] of the Montgomery district were considered first-rate cultivators[15]. Most emphatically, the (1881) census of the Punjab states that a substantial proportion of the Sikh Jats belonging to the Lahore and Gujranwala districts were "stalwart, sturdy yeomen of great independence, industry, and agricultural skill" who collectively formed "perhaps the finest peasantry in India"[16].

Official colonial documents also acknowledge the superior position held by the migrants in terms of education in the districts from which they came from. For instance, literacy was highest "among Hindus and Sikhs, among the non-Christian population" of the Attock district[17]. In the Lahore district the pre-eminence of the Hindus in education was deemed "remarkable" and the considerable progress that had been made in "education of Sikh males" recognized[18]. Interestingly, the 1929 Muzaffargarh district gazetteer went so far as to suggest that "no special measures were necessary in the case of Hindus and Sikhs" as they were "ready to take advantage of every opportunity" of providing education to their children[19]. A more systematic record of statements contrasting the pre-partition literacy rate of Hindus and Sikhs with those of the Muslims in the districts that went to post-independence Pakistan is given in Appendix Table 3.A.8. Other sources, outside of the official colonial publications, also point to the contribution the migrants had made to education. Raychaudhuri, Habib, and Kumar (1983) when discussing the

[12] Gazetteers, Punjab District. Gazetteer of the Sialkot District, 1893-94. Page 75

[13] Gazetteers, Punjab District (1884). Gazetteer of the Lahore District, 1883-84. Calcutta: Calcutta Central Press Co. Page 65

[14] An agricultural caste of the Punjab

[15] Gazetteers, Punjab District. "Gazetteer of the Montgomery District, 1898-99. Page 86

[16] Report on the Census of the Panjab Taken on the 17th of February 1881. Page 229

[17] Gazetteers, Punjab District. Gazetteer of the Attock District, 1907. Page 304

[18] Gazetteers, Punjab District. Gazetteer of the Lahore District, 1893-94. Page 84

[19] Gazetteers, Punjab District. Gazetteer of the Muzaffargarh District, 1929. Page 291

aftermath of partition in post-independence Pakistan observe that the event led to the sudden departure of teachers and instructors who mainly came from the Hindu and Sikh communities[20]. The First Five Year Plan of the Planning Commission of Pakistan acknowledges the damage done to the educational sector by the "sudden departure of Hindu teachers and instructors" who had manned the staff of the technical institutions, schools, colleges and universities in the country[21]. The Hartog (1929) committee report that reviewed the growth of education in late colonial India notes that in the Western Punjab and the North Western Frontier Province–both regions that later became part of post-independence Pakistan–the Hindus and Sikhs had done "good service to the cause of education by the maintenance of a large number of schools and colleges"[22].

In line with the evidence presented above, we posit that at least part of the impact of migrants on agricultural outcomes that we document statistically is mediated through their impact on literacy. Literacy, however, is not the only dimension of human capital along which the migrants could have contributed. We, therefore, consider occupation as another dimension of human capital through which the migrants could have influenced agricultural development. It is well documented that lack of credit is a constraint farmers in developing countries face in adopting new technologies (Bhalla, 1979; Pitt and Sumodiningrat, 1991; Lipton, 1976). Often, introducing a high yielding variety of a crop or purchasing a tractor requires having access to loans because farmers simply do not have adequate savings to make such investments on their own. Access to credit then

[20] Raychaudhuri, Tapan, Irfan Habib, and Dharma Kumar, eds. The Cambridge economic history of India. Vol. 2. CUP Archive, 1983. Page 998

[21] Planning Commission. Government of Pakistan. The First Five Year Plan 1955-60. (1957). Page 7

[22] Hartog, P.J., 1929. Interim Report of the Indian Statutory Commission: Review of Growth of Education in British India by the Auxiliary Committee Appointed by the Commission . Vol. 3407. HM Stationery Office. Page 246

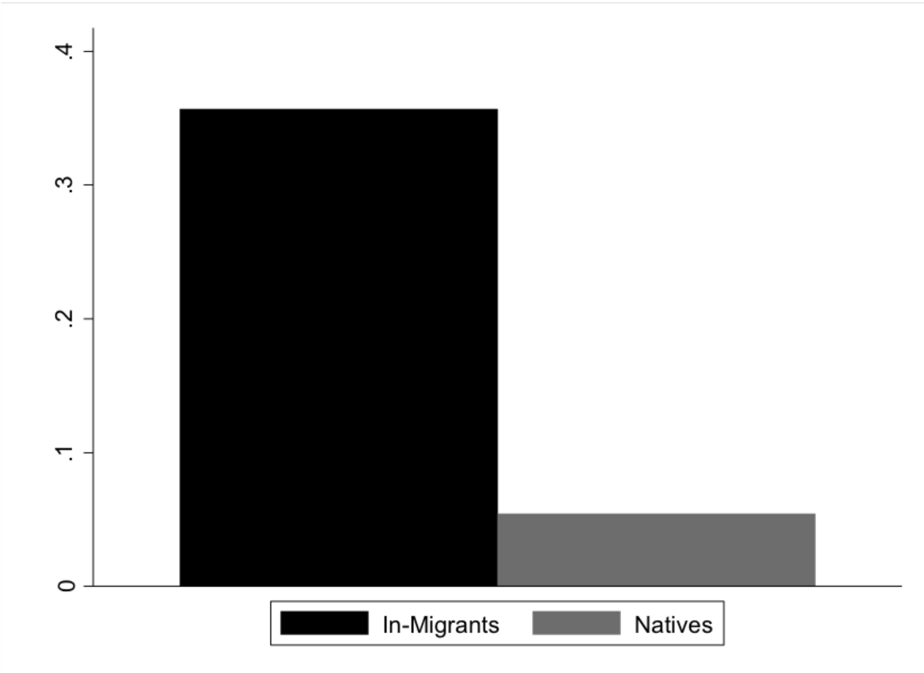
acts as a supplement to savings that can be used to invest in technology. The provision of credit also reduces the risks farmers face in their lives as it cushions them from extreme fluctuations in agricultural output. The reduction in risk in turn makes them more likely to adopt newer, more riskier, technologies.

From the anecdotal evidence we have gathered we know that large proportions of the migrants were involved in small-scale money lending to farmers for agricultural purposes in the districts from which they emigrated. They provided a "much needed source of credit for cultivation" (Raychaudhuri, Habib, and Kumar, 1983) for local farmers who would otherwise not have had access to formal credit markets. Most of them belonged to the three great Hindu and Sikh mercantile castes of India–Khatris, Aroras and Baniahs–that dominated commercial activity. Figure 2.4 provides a snapshot of the predominance of the migrants in commercial occupations at the time of partition. It compares the proportion of migrants engaged in commerce against the same proportion for the natives based on actual data on both groups from the 1951 census of India. Again, the stark contrast between the two groups in terms of their involvement in commerce is clearly apparent.

As was the case with their educational superiority the higher concentration of the migrants in commercial occupations was also noted in official publications dating from the colonial period. The notes, again, pertain to the Hindu and Sikh communities in areas that later became post-independence Pakistan. For instance, the (1881) census of Punjab states that the Hindus and Sikhs were mostly traders.[23] Hindus from the Arora caste controlled "almost the whole of the trade, moneylending, and banking" in the Muzaffargarh district.[24] The Hindu Aroras were also considered as being the "chief moneylenders and capitalists" and the

[23]Report on the Census of the Panjab Taken on the 17th of February 1881. Page 125-138.
[24]Gazetteers, Punjab District. Gazetteer of the Muzaffargarh District, 1929. Page 78.

FIGURE 3.4: Proportion in the commercial sector at partition.



Notes: The bar for migrants is the proportion of the displaced persons in 1951 that were previously engaged in commerce. This data is given in Appendix II of Table IV of the 1951 census of India. The bar for natives is the proportion of the non-displaced persons that were previously engaged in commerce. This data is also available in the 1951 census of India.

"chief creditors of the agriculturists" in the Jhang district.[25] Yet again, the Hindus and Sikhs from the Arora caste were identified as being the main moneylenders in the Montgomery district[26]. In the Attock district "almost the whole trade and money-lending business" was divided by the the three most numerically important Hindu castes amongst themselves[27].

In line with the above evidence we conclude that in addition to literacy the other channel through which the migrants influenced agricultural development was commercial occupations.

3.5 Conclusion

In this study, we examine the impact of partition on agricultural productivity and the take up of agricultural technology post-partition. Using migrant presence as a proxy for the intensity of displacement, we find that areas with more migrants have higher average yields, are more likely to take up High Yielding Varieties (HYV) of seeds, and are more likely to use agricultural technologies within the first 60 years after partition in India. We further show, using pre-partition agricultural data, that the effects are not solely explained by selective migration into districts with a higher potential for agricultural development. We then argue that the greater levels of education of the migrants and their higher concentration in commerce relative to both the natives who stayed and the migrants who moved contributed to agricultural development post partition.

[25] Gazetteers, Punjab District. Gazetteer of the Jhang District, 1883-84. (1884). Page 68.

[26] Gazetteers, Punjab District. Gazetteer of the Montgomery District, 1883-84. (1884). Page 69-70

[27] Gazetteers, Punjab District. Gazetteer of the Attock District, 1930. Page 115.

While our work highlights important correlations in this area, it should not be interpreted as the causal effect of partition induced migration. The main reason for this is that the partition simultaneously resulted in many changes, migration being just one component. Hence, isolating the effect of migration alone is a rather impossible task. Despite these caveats, we believe this paper makes an important contribution towards understanding the long run trajectory of places affected by the partition in India. More studies are needed in this area as partitions accompanied by mass human movements are still very much a part of the current global political environment, and understanding their lasting impacts on growth and economic development will be crucial.

Table 3.1: Summary Statistics

Variable	Mean	Median	Standard Deviation	Number of Observations
Annual Wheat Yields (1957-2009) (tons per hectare)	1.489	1.292	0.893	12763
Annual Take-Up of HYVs of Wheat (1957-2009) (proportion)	0.070	0.005	0.128	11573
Annual Revenue per hectare based on 1960 prices (rupees per hectare)	493.391	386.945	356.939	11500
Annual consumption of Nitrogen Fertilizer (tons)	40.241	16.262	118.801	13001
Annual consumption of Phosphorus Fertilizer (tons)	15.812	5.906	50.427	13001
Annual consumption of Potassium Fertilizer (tons)	10.257	1.258	99.389	13001
Annual number of tractors per 1000 hectares (1957-1987)	1.811	0.395	4.896	8370
Log of Number In-Migrants (1951)	7.443	7.549	2.576	270
Log of Population (1951)	13.792	13.846	0.639	270
Annual Rainfall (1966-2009) (millimeters)	1039.807	945.000	573.994	13971
Population Desnity (1961)	1.789	1.251	2.117	270

Notes: Data for annual rainfal from 1957 to 1965 does not exist. This is because the Indian Agriculture and Climate Dataset from which the data between 1957 and 1965 is taken only provides estimated average rainfall for each district for each month across all the years between 1957 and 1987.

Table 3.2: Revenue per hectare based on 1960 prices and log in-migrants

	Annual revenue (in Rupees) per hectare based on 1960 prices		
	(1)	(2)	(3)
Log of In-Migrants (1951)	14.143*	12.704	11.266
	(7.597)	(8.481)	(8.026)
Mean Outcome	485.640	484.677	478.071
No of observations	11194	11164	11008
Controls			
Soil type Dummies	No	Yes	Yes
Population Density (1961)	No	No	Yes
Annual Average Rainfall	No	No	Yes

Notes: This table shows regressions of annual revenue per hectare based on 1960 crop prices for the period 1957 to 2009 on the log number of In-Migrants in 1951. The unit in which revenue is measured is rupees. All the above models include the log of population in 1951, state fixed effects, year fixed effects and state-specific time trends. Additionally, Model 2 includes 21 dummies which caputre soil type and Model 3 includes both the soil 21 type dummies, annual average rainfall and population density in earliest available year which is 1961.* p < .10, ** p < .05, *** p < .01. Clustered standard errors (at the district level) in parentheses. Data used is a

Table 3.3: Revenue per hectare based on 1960 prices and interaction between log in-migrants & post Green Revolution dummy

	Annual revenue (in Rupees) per hectare based on 1960 prices		
	(1)	(2)	(3)
Log of In-Migrants (1951)	9.698	8.674	7.379
	(6.407)	(7.449)	(7.052)
Log of In-Migrants (1951) X Green Revolution	7.243*	6.600*	6.333*
	(3.852)	(3.764)	(3.665)
Mean Outcome	485.640	484.677	478.071
No of observations	11194	11164	11008
Controls			
Soil type Dummies	No	Yes	Yes
Population Density (1961)	No	No	Yes
Annual Average Rainfall	No	No	Yes

Notes: This table shows regressions of annual revenue per hectare based on 1960 crop prices for the period 1957 to 2009 on the interaction between the post green revolution dummy and log number of In-Migrants in 1951 and the green revolution dummy. The unit in which revenue is measured is rupees. All the above models include the interaction between the post green revolution dummy (defined as taking a value 1 on or after the first year in which the proportion of HYV area for all major crops exceeds 5% and 0 otherwise) and the log number of In-Mgrants in 1951, the log of population in 1951, the interaction of log of population in 1951 with post green revolution dummy, the post green revolution dummy, state fixed effects, year fixed effects and state-specific time trends. Additionally, Model 2 includes 21 dummies which caputre soil type and Model 3 includes both the soil 21 type dummies, annual average rainfall and population density in earliest available year which is 1961.* $p < .10$, ** $p < .05$, *** $p < .01$. Clustered standard errors (at the district level) in parentheses. Data used is a combination of IACD (1957 to 1965) and VDSA (1966-2009).

Table 3.4: Wheat yields, HYV take up and log in-migrants

	Annual yields		Take up of HYV Variety	
	(1)	(2)	(3)	(4)
Log of In-Migrants (1951)	0.048***	0.020**	0.004***	-0.002*
	(0.012)	(0.010)	(0.001)	(0.001)
Log of In-Migrants (1951) X Green Revolution		0.048***		0.013***
		(0.009)		(0.002)
Mean Outcome	1.459	1.459	0.071	0.071
No of observations	12018	12018	10969	10969
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: Column 1 of this table shows the regression of annual wheat yields for the period 1957 to 2009 on log of In-Migrants in 1951. Column 2 adds the interaction between the post green revolution dummy (defined as taking a value 1 on or after the first year in which the proportion of HYV area for all major crops exceeds 5% and 0 otherwise) and the log number of In-Mgrants in 1951, the interaction of log of population in 1951 and post green revolution dummy and the post green revolution dummy to the regression model in Column 1. Columns 3 and 4 replace annual wheat yields with annual rice yields as the dependent variable. The unit in which yields are measured is tons per hectare. All the above models include the log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors (at the district level) in parentheses. Data used is a combination of IACD (1957 to 1965) and VDSA (1966-2009).

Table 3.5: Use of tractors & fertilizers & log in-migrants

	Tractors per 1000 hectares of land		Consumption of Nitrogen fertilizer per hectare		Consumption of Phosphorus fertilizer per hectare	
	(1)	(2)	(3)	(4)	(5)	(6)
Log of In-Migrants (1951)	0.379***	0.176***	1.534**	0.123	0.918***	0.258
	(0.078)	(0.045)	(0.661)	(0.477)	(0.302)	(0.226)
Log of In-Migrants (1951) X Green Revolution		0.375***		2.541***		1.212***
		(0.093)		(0.698)		(0.366)
Mean Outcome	1.811	1.811	33.187	33.187	13.115	13.115
No of observations	8370	8370	12229	12229	12229	12229
Controls						
Soil type Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The annual use of tractors is measured as the number of tractors per thousand hecatares of the land that is planted in a given year. Tractor data is only avaialble in the IACD dataset, and hence available from 1958-1987. Data on fertilizers is available in both the VDSA and IACD and is available from 1957-2009. The annual consumption of Nitrogen and Phosphorus fertilizers is measured in tons per hectare. All the above models include log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type and population density in earliest available year which is 1961.* p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

Table 3.6: Yields of other crops & log in-migrants

	Annual yields		
	Rice	Sugar	Maize
	(1)	(2)	(3)
Log of In-Migrants (1951)	0.037***	0.080***	0.029***
	(0.014)	(0.028)	(0.011)
Mean Outcome	1.313	5.152	1.318
No of observations	12408	12035	11900
Controls			
Soil type Dummies	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes

Notes: Column 1 of this table shows the regression of annual wheat yields for the period 1957 to 2009 on log of In-Migrants in 1951. Columns 2 and 3 replace annual rice yields with annual sugar yields and annual maize yields, respectively, as the dependent variable. The unit in which yields are measured is tons per hectare. All the above models include log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type, annual average rainfall and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors (at the district level) in parentheses.

Table 3.7: Yields of other crops and the Green Revolution

	Annual yields		
	Rice	Sugar	Maize
	(1)	(2)	(3)
Log of In-Migrants (1951)	0.017	0.079***	0.016
	(0.012)	(0.030)	(0.012)
Log of In-Migrants (1951) X Green Revolution	0.035***	0.002	0.022**
	(0.009)	(0.025)	(0.011)
Mean Outcome	1.313	5.152	1.318
No of observations	12408	12035	11900
Controls			
Soil type Dummies	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes

Notes: Column 1 of this table shows the regression of annual wheat yields for the period 1957 to 2009 on on the interaction between the post green revolution dummy and log number of In-Migrants in 1951. Columns 2 and 3 replace annual rice yields with annual sugar yields and annual maize yields, respectively, as the dependent variable. The unit in which yields are measured is tons per hectare. All the above models include log of population in 1951, interaction between log of population in 1951 and post green revolution dummy, post green revolution dummy, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type, annual average rainfall and population density in earliest available year which is 1961.. * p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses. Data used is a combination of IACD (1957 to 1965) and VDSA (1966-2009).

Table 3.8: Rice & wheat yields during pre-Partition and log in-migrants

	Annual yields during pre-partition	
	Wheat	Rice
Log of Number In-Migrants (1951)	22.97*	15.01
	(12.69)	(17.31)
Mean Outcome	789.04	844.92
No of observations	295	282

	Annual yields during pre-partition, excluding Bihar and Orissa	
	Wheat	Rice
Log of Number In-Migrants (1951)	18.54	5.162
	(13.66)	(17.93)
Mean Outcome	813.28	858.29
No of observations	248	240

	Annual yields during pre-partition, excluing Bihar, Bengal and Orissa	
	Wheat	Rice
Log of Number In-Migrants (1951)	20.10	5.268
	(13.93)	(18.27)
Mean Outcome	810.09	849.29
No of observations	228	220

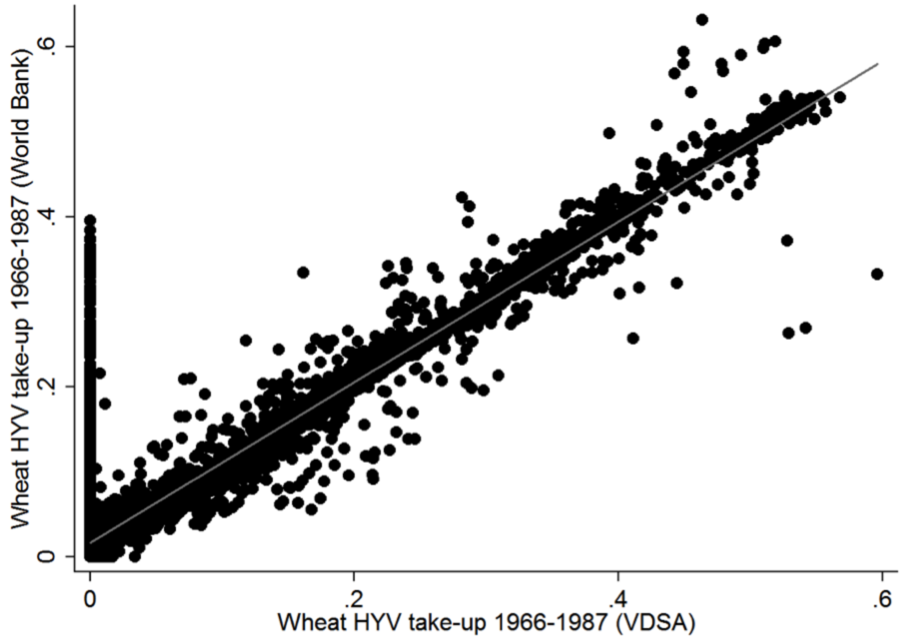
Notes: This table shows regressions of annual wheat yields for the pre-partition period 1911 to 1938 on the log number of In-Migrants in 1951. The unit in which yields are measured is lbs per acre. All the above models include log of population in 1951, state fixed effects, year fixed effects and state-specific time trends.* p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

3.A Appendix

Figure 3.A.1: Comparison of yields between IACD and VDSA (1966-87).

Notes: There were 19 cases in which for the same year and district the annual wheat yield was zero in the World Bank dataset but was non-zero in the VDSA dataset. 68% of these cases came from the Andhra Pradesh state and 32% came from the Karnataka state. On the other hand there were 5 cases in which for the same year and district the annual wheat yield was zero in the VDSA dataset but was non-zero in the World Bank dataset. 80% of these cases came from the Karnataka state and 20% came from the Maharashtra state.

FIGURE 3.A.2: Comparison of HYV take-up between IACD and VDSA (1966-87).



Notes: There were 22 cases in which for the same year and district the annual fraction of HYV of wheat was zero in the World Bank dataset but was non-zero in the VDSA dataset. 82% of these cases came from the Maharashtra state, 9% came from the Gujarat state, 4.5% from Rajasthan state and 4.5% from Tamil Nadu state. On the other hand there were 475 cases in which for the same year and district the annual fraction of HYV of wheat was zero in the VDSA dataset but was non-zero in the World Bank dataset. 98.3% of these cases came from the Uttar Pradesh state, 0.9% came from the Andhra Pradesh state, 0.2% came from the Gujarat state, 0.4% came from the Madhya Pradesh state and 0.2% came from the Orissa state.

Table 3.A.1: Average annual revenue per hectare based on 1960 prices (1957 to 2009) and log in-migrants

	Average Annual Revenue Per Hectare Based on 1960 prices (1957 to 2009)		
	Model (1)	Model (2)	Model (3)
Log of In-Migrants (1951)	20.263***	20.941**	20.580**
	(7.793)	(9.135)	(9.155)
Mean Outcome	501.811	501.999	501.999
No of observations	269	268	268
Controls			
Soil type Dummies	No	Yes	Yes
Population Density (1961)	No	No	Yes

Notes: This table shows regressions of annual revenue per hectare of from all crops averaged over the period 1957 to 2009 on the log number of In-Migrants in 1951. The annual revenue is measured in terms of Rupees. All the above models include state fixed effects. Additionally, Model 2 includes 21 dummies which caputre soil type and Model 3 includes both the 21 soil type dummies and population density in earliest available year which is 1961.* p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

Table 3.A.2: Average annual take-up of HYVs of wheat (1957 to 2009) and log in-migrants

	Average Annual Take-Up of HYVs of Wheat (1957 to 2009)		
	Model (1)	Model (2)	Model (3)
Log of In-Migrants (1951)	0.003**	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
Mean Outcome	0.070	0.070	0.070
No of observations	269	268	268
Controls			
Soil type Dummies	No	Yes	Yes
Population Density (1961)	No	No	Yes

Notes: This table shows regressions of annual take-up of High Yielding Varieties (HYVs) of wheat averaged over the period 1957 to 2009 on the log number of In-Migrants in 1951. The annual take-up of HYV of wheat is measured as the proprotion of total area planted to all crops in a given year that is devoted to HYVs of wheat. All the above models include state fixed effects. Additionally, Model 2 includes 21 dummies which caputre soil type and Model 3 includes both the 21 soil type dummies and population density in earliest available year which is 1961.* p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

TABLE 3.A.3: Average annual yields for rice, sugar and maize (1957 to 2009) and log in-migrants

	Average Annual Yields (1957 to 2009)			
	Rice	Sugar	Maize	Wheat
Log of In-Migrants (1951)	0.031**	0.105***	0.033***	0.046***
	(0.015)	(0.033)	(0.012)	(0.012)
Mean Outcome	1.344	5.243	1.337	1.389
No of observations	265	263	266	264
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: This table shows regressions of annual yields for rice, maize and sugar averaged over the period 1957 to 2009 on the log number of In-Migrants in 1951. The unit in which yields are measured is tons per hectare. All the above models include state fixed effects, 21 dummies which caputre soil type and population density in earliest available year which is 1961.* p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

Table 3.A.4: Yields and proportion in-migrants

	Annual Wheat Yields		Annual Rice Yields	
	(1)	(2)	(3)	(4)
Proportion In-Migrants (1951)	0.366	-0.227	0.448	-0.499
	(0.306)	(0.249)	(0.542)	(0.463)
Proportion In-Migrants (1951) X Green Revolution		0.870***		1.373***
		(0.254)		(0.433)
Mean Outcome	1.459	1.459	1.313	1.313
No of observations	12018	12018	12408	12408
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: Column 1 of this table shows the regression of annual wheat yields for the period 1957 to 2009 on Proportion In-Migrants in 1951. Column 2 adds the interaction between the green revolution dummy (defined as taking a value 1 on or after the first year in which the proportion of HYV area for all major crops exceeds 5% and 0 otherwise) and Proportion In-Migrants in 1951 and the green revolution dummy to the regression model in Column 1. Columns 3 and 4 replace annual wheat yields with annual rice yields as the dependent variable. The unit in which yields are measured is tons per hectare. All the above models include state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type, annual average rainfall and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors (at the district level) in parentheses.

Table 3.A.5: Wheat yields, HYV take up and log in-migrants - accounting for overlapping data

	Annual yields		**Take up of HYV Variety**	
	(1)	(2)	(3)	(4)
Log of In-Migrants (1951)	0.048***	0.020**	0.004***	-0.002
	(0.011)	(0.010)	(0.001)	(0.001)
Log of In-Migrants (1951) X Green Revolution		0.048***		0.013***
		(0.009)		(0.002)
Mean Outcome	1.461	1.461	0.074	0.074
No of observations	11999	11999	10528	10528
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Annual Average Rainfall	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: Column 1 of this table shows the regression of annual wheat yields for the period 1957 to 2009 on log of In-Migrants in 1951. Column 2 adds the interaction between the post green revolution dummy (defined as taking a value 1 on or after the first year in which the proportion of HYV area for all major crops exceeds 5% and 0 otherwise) and the log number of In-Mgrants in 1951, the interaction of log of population in 1951 and post green revolution dummy and the post green revolution dummy to the regression model in Column 1. Columns 3 and 4 replace annual wheat yields with annual rice yields as the dependent variable. The unit in which yields are measured is tons per hectare. All the above models include the log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type, average annual rainfall and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors (at the district level) in parentheses. Data used is a combination of IACD (1957 to 1965) and VDSA (1966-2009). Additionally for those years that overlap between the IACD and VDSA (1966 to 1987) it excludes observations where the dependent variable was either zero in IACD and non-zero in VDSA or non-zero in IACD and zero in VDSA.

Table 3.A.6: Wheat yields, HYV take up and log in-migrants for pre-Partition consistent sample

	Annual wheat yields		**Take up of HYV Variety**	
	(1)	(2)	(3)	(4)
Log of In-Migrants (1951)	0.062**	0.038	0.007**	-0.004
	(0.030)	(0.027)	(0.003)	(0.004)
Log of In-Migrants (1951) X Green Revolution		0.038**		0.022***
		(0.017)		(0.006)
Mean Outcome	1.531	1.531	0.121	0.121
No of observations	3342	3342	2703	2703
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Average Annual Rainfall	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: The yields regressions in this table are based on the sample of 67 districts for which there was data available on wheat yields on a consistent basis for the pre-partition period 1911 to 1938. Column 1 shows the regression of annual wheat yields for the period 1957 to 2009 on the log number of In-Migrants in 1951. Column 2 adds the interaction between the green revolution dummy and log number of In-Migrants in 1951, the green revolution dummy and the interaction between the green revolution dummy and log of population in 1951 to the regression model in Column 1. The unit in which yields are measured is tons per hectare. Columns 3 and 4 replace annual wheat yields with the take-up of High Yield Varieties (i.e. HYV) of Wheat as the dependent variable. The wheat HYV take-up regressions in this table are based on the sample of 68 districts for which there was data available on wheat yields on a consistent basis for the pre-partition period 1911 to 1938. The HYV take-up of Wheat is measured as the proprotion of total area planted to all crops in a given year that is devoted to HYVs of wheat. All the above models include log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type, average annual rainfall and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

Table 3.A.7: Wheat yields, HYV take up and log in-migrants for pre-Partition consistent sample (excluding Bihar, Bengal and Orissa)

	Annual wheat yields		**Take up of HYV Variety**	
	(1)	(2)	(3)	(4)
Log of In-Migrants (1951)	0.080**	0.043	0.010***	-0.006
	(0.035)	(0.031)	(0.003)	(0.004)
Log of In-Migrants (1951) X Green Revolution		0.058***		0.031***
		(0.020)		(0.006)
Mean Outcome	1.542	1.542	0.129	0.129
No of observations	2650	2650	2287	2287
Controls				
Soil type Dummies	Yes	Yes	Yes	Yes
Average Annual Rainfall	Yes	Yes	Yes	Yes
Population Density (1961)	Yes	Yes	Yes	Yes

Notes: The yields regressions in this table are based on the sample of 52 districts (excluding those of Bihar, Bengal and Orissa) for which there was data available on wheat yields on a consistent basis for the pre-partition period 1911 to 1938. Column 1 shows the regression of annual wheat yields for the period 1957 to 2009 on the log number of In-Migrants in 1951. Column 2 adds the interaction between the green revolution dummy and log number of In-Migrants in 1951, the green revolution dummy and the interaction between the green revolution dummy and log of population in 1951 to the regression model in Column 1. The unit in which yields are measured is tons per hectare. Columns 3 and 4 replace annual wheat yields with the take-up of High Yield Varieties (i.e. HYV) of Wheat as the dependent variable. The wheat HYV take-up regressions in this table are based on the sample of 53 districts (excluding those of Bihar, Bengal and Orissa) for which there was data available on wheat yields on a consistent basis for the pre-partition period 1911 to 1938. The HYV take-up of Wheat is measured as the proprotion of total area planted to all crops in a given year that is devoted to HYVs of wheat. All the above models include log of population in 1951, state fixed effects, year fixed effects, state-specific time trends, 21 dummies which caputre soil type and population density in earliest available year which is 1961. * p < .10, ** p < .05, *** p < .01. Clustered standard errors in parentheses.

Table 3.A.8: Hindu and Sikh literacy (anecdotal evidence)

District	**Statement on literacy of Hindus & Sikhs**	Source
Muzaffargarh	The district is still one of the most backward in the province. This backwardness is mainly among Muhammadans as the percentage of educated Muhammadans is only 1.12 against 15.47 of educated Hindus and 6.55 of educated Sikhs. No special measures are necessary in the case of Hindus and Sikhs as they are ready to take advantage of every opportunity; indeed, there are two private Hindu high schools in the district	Muzaffargarh District Gazetteer, 1929. Page 291.
Attock	Attock District is the most illiterate district in the Rawalpindi Division.... Literacy is highest among Hindus and Sikhs, among the non-Christian population	Attock District Gazetteer, 1907. Page 304.
Shahpur	The increase since the last census in the proportion of total males educated is largest for Sikhs, next for Hindus, and least of all for Musalmans; and now among Hindus one male out of every three is educated. Among the Sikhs almost half the male population have some education, but among Musalmans only about one if forty can read and write	Shahpur District Gazetteer, 1897. Page 91.
Jhelum	In the last Census, of the educated classes, 11,969 were Hindus and 9071 Musalmans. These figures are remarkable, when it is observed that the entire Hindu population amounts to 51,801, while the Musalmans number 526,725	Jhelum District Gazetteer, 1904. Page 259.
Lahore	The Sikhs show considerable progress in the education of males. The leading place taken by Hindus in the education among the three religions is remarkable	Lahore District Gazetteer, 1893-94. Page 84.
Multan	Among the Hindus the standard [of literacy] is very high, but the Muhammadans are very backward	Multan District Gazetteer, 1923-24. Page 260.
Gujrat	1.The majority of the girls are Hindu or Sikh. The Muhammadans are still slow to send their girls to school 2. He [the Hindu] has been quick to take advantage of the ducation in the schools, and his children have secured a large proprotion of Government appointments	Gujrat District Gazetteer, 1921. Page 156 and 50.
Jhang	Among Hindus and Sikhs apparently one in three males can read and write, while among Muhammadans about one in sixty only … Viewed in percentages the resut for females is less unsatisfactory, as among Hindus and Sikhs education has increased tenfold in the twenty and doubled among the Muhammadan population	Jhang District Gazetteer, 1908. Page 158.
Rawalpindi	As was expected, the Muhammadan portion of the population, in other words, the agricultural class, is grossly ignorant. Only two persons in a hundred can read and write, and only one is learning. Jains appear to be given a batter education than Sikhs, and Sikhs than Hindus. The district cannot be congratulated on the literacy acquirements of its inhabitants	Rawalpindi District Gazetteer, 1893-98.

Chapter 4

The Green Revolution and Child Mortality in India

4.1 Introduction

Despite making impressive investments for achieving its Millennium Development Goal target of reducing infant mortality by two thirds between 1990 and 2005, India, as of 2015, ranked 168 out of 248 countries in terms of its under-five mortality rate[1]. The country also recorded the highest number of stillbirths anywhere in the world that same year (Frøen, Friberg, and Lawn, 2016). Such dire statistics are a stark reminder that child health remains a core issue of India's development at the dawn of the 21st century. Recent research has identified several factors behind poor child health outcomes across the developing world: inadequate health care seeking and participation by distressed mothers in the labour market (Bhalotra, 2010), *in utero* dust exposure (Adhvaryu, Bharadwaj, Fenske, Nyshadham, and Stanley, 2016), reduced public expenditure on health infrastructure (Paxson and

[1] As part of the United Nations Global Strategy for Women's and Children's Health that was launched in 2010, India committed to allocating USD 3.5 billion annually for improving maternal and child health services across 235 districts that account for 70% of maternal and infant deaths in the country (Reddy, Pradhan, Ghosh, and Khan, 2012)

Schady, 2005; Cutler, Knaul, Lozano, Méndez, and Zurita, 2002; Maluccio et al., 2005) and a reduction in per capita income (Pritchett and Summers, 1996), among others. Extending such research, this paper uncovers another determinant of early childhood mortality in India: agricultural productivity gains. We conduct an empirical analysis of the impact of agricultural productivity gains on early childhood mortality in India. Our analysis stretches from 1966 to 1998 and covers much of India, allowing us to examine the impacts of agricultural productivity gains across states with different economic conditions and public health infrastructures.

Our study focuses on a specific source of agricultural productivity gains: the adoption of high yielding varieties (HYV) of seeds. The adoption of HYV began in the late 1960s in India with the advent of the Green Revolution and has continued ever since. The agricultural productivity gains from HYV adoption (henceforth HYV adoption) is documented in the literature on the Green Revolution (e.g. Evenson and Gollin (2003a)). In this paper, we show the reduced form relationship between HYV adoption and infant mortality across districts of India over time. Our research has benefitted from district level data on HYV that is available in the Village Dynamics in South Asia dataset. Our specific measure of HYV adoption is the share of cultivated area that is planted to HYV. We find evidence that agricultural productivity gains from HYV adoption decreases infant mortality over births. In particular, a one standard deviation increase in the share of cultivated area planted to HYV in the year of birth reduces infant mortality by 0.71 percentage points. This is substantial relative to the average infant mortality over births of 13% in our sample.

Our empirical strategy addresses standard concerns that can arise in examining the affect of HYV adoption on infant mortality. For instance, individuals might sort into high HYV adoption districts based on the characteristics of those districts. If the characteristics that are associated with sorting also affect infant mortality, then this could bias our results. Furthermore, individuals born in different years could be subjected to economic events, such as recessions, which could drive part of the correlation between HYV adoption and infant mortality. To address these concerns, our baseline specification includes district fixed effects that absorb all time-invariant characteristics of the district which are associated with HYV adoption and also affect infant mortality. It also includes year of birth fixed effects that account for any shocks to infant mortality, such as recessions, that coincide with the year of birth. Our baseline specification, therefore, compares two children from the same district who are subjected to different levels of HYV adoption based on their year of birth, over and above any unobserved shocks to infant mortality that vary by the year of birth.

To uncover the mechanisms through which HYV adoption affects infant mortality, we use three different strategies. First, we examine heterogeneity in the effect of HYV adoption across various sub-groups. We find that HYV adoption has a greater effect on children born to mothers with characteristics that generally predict higher child mortality[2]. The effect is also greater for a child born to a low caste mother, which suggests that children from poorer households are helped more by HYV adoption. However, the effect is smaller when the child born is a girl, which provides evidence for a gender-bias in child health. Finally, the effect is greater for a child born in a rural area, implying that the effect of HYV adoption was primarily mediated through agricultural incomes.

Next, we examine whether parents respond to HYV adoption by altering their investments in child health during the pre and post natal stages. We find no

[2] Parental experience is positively associated with the mother's education, age and the child's birth-order

evidence that parental investments mediate the effect of HYV adoption on infant mortality. Finally, we investigate whether HYV adoption affects infant mortality by influencing the profile of mothers who give birth. We find that a mother's education and the child's birth-order respond positively to HYV adoption. Such a finding is consistent with mothers with characteristics that generally predict lower child mortality self-selecting into child bearing as a result of HYV adoption.

We carry out several empirical exercises to show the robustness of our baseline results. First, we show that our baseline results are robust to the use of an instrumental variables approach that exploits the differential diffusion of HYV across districts that initially cultivated wheat and rice. Then, we show that replacing district fixed effects with DHS survey cluster fixed effects gives results that are close to the baseline estimates. Next, we replace district fixed effects with mother fixed effects and show that the results are broadly similar. That is, comparing two children born in the same village or even to the same mother, the child whose birth coincided with a greater prevalence of HYV cultivation is more likely to survive, net of other trends captured by our year fixed effects. Then, we address the concern of broad secular trends in infant mortality at the district level influencing our results. To account for such trends we include district-specific linear time trends and state-by-year fixed effects. Again, we find that the results remain significant and are close to the baseline estimates.

4.1.1 Contribution

We contribute to a literature that examines the microeconomics of technology adoption. This literature offers two leading explanations for why adoption rates vary across space and over time. One focuses on the role played by social learning in technology adoption (Besley and Case, 1993; Foster and Rosenzweig, 1995; Conley and Udry, 2010). The other identifies constraints on the supply of factor inputs and other local conditions as determinants of technology adoption (Singh and Kohli, 2005; McGuirk and Mundlak, 1991; Mundlak, Butzer, and Larson, 2004). Then, there are cross-country studies that analyze the social, economic and political impacts of technology adoption across both agricultural and non-agricultural sectors. For instance, Nunn and Qian (2011) examine the effects of potato adoption in Europe, and Bustos, Caprettini, and Ponticelli (2013) investigate the impact of agricultural productivity gains on the non-agricultural economic activity. There are also more focused studies examining whether agricultural science and research impacts economic or social outcomes at a smaller geographical scale (Hornbeck and Keskin, 2014; Fan, Zhang, and Zhang, 2000; Meinzen-Dick, Adato, Haddad, and Hazell, 2003; Dalrymple, 2008). Finally, the literature identifying sources of child health outcomes is also well developed (Bhalotra, 2010; Maluccio et al., 2005; Paxson and Schady, 2005; Cutler, Knaul, Lozano, Méndez, and Zurita, 2002; Pongou, Salomon, and Ezzati, 2006).

However, to our knowledge, no study exists that connects productivity gains from agricultural technology adoption to child health outcomes in micro-economic data. The first contribution of this paper is, therefore, to bridge such a gap in the literature by examining the impacts of HYV adoption on infant mortality in India. Our paper also contributes to this literature by examining these impacts across different areas of the same country. This has the advantage, over cross-country studies, of restricting the range of potential omitted variables and of comparing areas that have similar political and administrative set-ups (Banerjee and Iyer, 2008). Moreover, the data on parental investments in our panel allows us to test the extent to which households and institutions are able to respond to HYV adoption by increasing their investments in child health. We find no obvious evidence for the impact of HYV adoption on infant mortality being mediated through parental investments. What we do find, however, is that parents with characteristics that predict child survival–age and education–are better able to reap the benefits from HYV adoption in terms of reduced infant mortality.

We also find that girls' infant mortality is reduced by less in comparison to that of boys, suggesting that there is a parental-bias in child health outcomes. Next, we find that lower caste mothers are helped more from HYV adoption, which is consistent with poorer households benefitting more from agricultural technology adoption, relative to richer ones. Such a result also points to the role of caste in influencing access to health care services (Munshi and Rosenzweig, 2009). Furthermore, HYV impacts are greater for rural children, which is consistent with a agricultural innovation like HVY primarily assisting rural households. Another important contribution of our paper is to determine whether selective fertility by mothers can explain part of the impact of HYV adoption. We find that HYV adoption is positively correlated with mother's characteristics such as birth-order, years of education and literacy. This suggests that it is low-risk mothers who self-select into child bearing in response to HYV adoption.

The rest of the paper is organized as follows. In Section 4.2 we provide the background to our study. In particular, we document the development of the HYV of two major crops – wheat and rice – and their diffusion in India. We also postulate mechanisms that link HYV adoption to health outcomes. Section 4.3, outlines our empirical strategy. Section 4.4 describes the infant mortality data, the HYV data and the procedure we use to match the infant mortality data to the HYV data. Section 4.5 discusses our results, and Section 4.6 concludes.

4.2 Background

The Green Revolution can be credited to the cross-breeding experiments of the International Rice Research Institute (IRRI), set up in the Philippines in 1961, and its sister institution, the International Centre for Maize and Wheat Improvement (CIMMYT) that was set up in Mexico in 1967 (Gollin, Hansen, and Wingender, 2016, p. 4). In the case of rice, experiments at the IRRI in 1965 involved cross-breeding short varieties of the crop, grown in northern Asia, with the larger varieties from the tropical parts of Asia. As a consequence of a cross that was made between an Indonesian variety (Peta) and a semi-dwarf variety from Taiwan (Dee-Geo-Woo-Gen) the IR8 hybrid variety was developed (Gollin, Hansen, and Wingender, 2016, p. 8). The IR8 seed was the most productive variety to come out of research at the IRRI and was responsible for substantial improvements in rice yields.

The development of hybrid varieties of wheat happened around the same time as that of rice. Cross-breeding experiments were initiated at the Rockefeller Foundations program for wheat improvement in Mexico, the precursor of CIMMYT, and by 1961 the first semi-dwarf varieties of the crop were released worldwide. These varieties were based on a cross between the Norin10, a short variety of wheat developed in Japan in the 1930s, and an American variety called Brevor (Gollin, Hansen, and Wingender, 2016, p. 9).

Moreover, rice and wheat HYV were more successful in raising productivity than the HYV of other crops. For instance, yield increases from HYV adoption in crops such as sorghum and millet were smaller than those for rice and wheat (Estudillo and Otsuka, 2013, p. 22). This was because scientists had already developed a critical mass of knowledge about rice and wheat in particular, which did not exist for other crops (Evenson and Gollin, 2003a). Gollin, Hansen, and Wingender (2016) state that "inspite of the rapid success of the research in rice and wheat it took much longer for the green revolution to be extended to other crops, reflecting large differences in the initial stock of scientific knowledge". As shown later, the benefits of HYV adoption in terms of reducing infant mortality are also limited to households exposed to the new varieties of rice and wheat.

Once the HYV of rice and wheat were introduced in India in 1965, their adoption was fairly rapid. We consider the case of rice in North India as an example. The share of cultivated area planted to HYV of rice in North India went from an average of 11% in the period 1965-69 to an average of 82% in the period 1975-79 (Barker, Herdt, and Rose, 1985, p. 218). This represents a sudden and sharp increase in HYV adoption on historical timescales. However, such an aggregate trend masks substantial variations in adoption rates across states. In Punjab, for instance, more than 99% of the rice cultivated land was planted to HYV by the end of the first decade after introduction (Barker, Herdt, and Rose, 1985, p. 149). This was despite the state being a minor producer of rice. On the other hand, in the primarily rain-fed states of eastern India–Western Bengal, Bihar and Orissa–the share of HYV acreage averaged only around 25% at around the same time (Barker, Herdt, and Rose, 1985, p. 149). One reason behind the variable rates of HYV adoption across states was the prevalence of input factors such as irrigation systems or reliable rainfall (Evenson and Gollin, 2003a). Another was the adaptability of the HYV to location specific characteristics such as diseases, pests, and abiotic stresses (Evenson and Gollin, 2003a). Finally, factors such as income, investment, human capital, and agricultural policies also mattered for differential adoption rates (Gollin, Hansen, and Wingender, 2016, p. 11).

A number of possible mechanisms connect HYV adoption to health outcomes. First, is an increase in food production due to the higher productivity of HYV. An increase in food production decreases food prices, resulting in higher caloric intake. A higher caloric intake leads to gains in health and life expectancy (Evenson and Gollin, 2003a). These health gains are especially acute for children. Evenson and Gollin (2003a) credit the productivity gains from HYV adoption with raising the health status of between 32 to 42 million pre-school children, and with lowering infant and child mortality worldwide. Second, is an increase in agricultural incomes earned from productivity enhancements through HYV adoption. Income can affect child health in several ways. It can reduce the opportunity cost of maternal time, thereby, causing mothers to seek health care services (Bhalotra, 2010).

A positive income shock can also lower distress labour market participation[3] of mothers and improve prospects of health in early-life (Bhalotra, 2010). An increase in incomes can induce parental investments in child health outcomes either in the form of 'compensatory' or 'reinforcing' behaviour once child quality is revealed (Almond and Mazumder, 2013; Bharadwaj, Eberhard, and Neilson, 2013). The profile of mothers who give birth can be linked to income shocks in such a way so as to reduce infant mortality. In particular, a decrease in income can cause high-risk mothers to delay their fertility decisions (Dehejia, Lleras-Muney, et al., 2004). Finally, a negative income shock can cause a dramatic collapse in public expenditures on health and, thereby, adversely affect child health outcomes (Paxson and Schady, 2005; Cutler, Knaul, Lozano, Méndez, and Zurita, 2002; Maluccio et al., 2005).

[3] Distress labour market participation of mothers is defined as maternal labour supply during recessions for the purpose of consumption smoothing (Bhalotra, 2010).

4.3 Empirical strategy

In order to test for the impact of HYV adoption on infant mortality, we use ordinary least squares (OLS) to estimate the following reduced form equation:

$$Mortality_{idy} = \beta ShareHYV_{dy} + x'_{idy}\gamma + \eta_y + \delta_d + \epsilon_{idy} \tag{4.1}$$

Here, $Mortality_{idy}$ is an indicator for the death of child i in the first twelve months after birth, born in year y, whose mother is surveyed in district d. In our main results $ShareHYV_{dy}$ is the fraction of all cultivated land in district d planted to HYV in year of birth y. It measures the extent of HYV adoption in district d in the year of birth y. β is the coefficient of interest, and we expect its sign to be negative. x'_{idy} is a vector of controls that includes birth order, a dummy for whether the child born is female, a dummy for whether the child born is a multiple birth, a dummy for DHS round, mother's age in survey, mother's age in survey squared, a dummy for whether child is born in urban area, a dummy for the mother's religion, and a dummy for the mother's caste.

Additionally, we include two important sets of fixed effects. The first are district fixed effects, δ_d, that control for all time invariant characteristics of the district. For instance, if a district has lower level of HYV adoption as well as higher infant mortality due to its bad soil quality, then to obtain better estimates of the effect of technology on infant mortality we need to be able to control for the influence of the poor soils. A fixed effect at the district level would not only control for the influence of the soil quality, but would also capture all other time invariant characteristics by including a dummy variable for the district.

The second set of fixed effects we use are year of birth fixed effects, η_y, that account for any time-specific shocks such as earthquakes, flooding, disease outbreaks or dust storms that affect all districts equally in the year of birth. Finally, we cluster standard errors by (1966) district. Hence, for identification, we compare children from the same district, but whose differential exposure to HYV cannot be explained away by aggregate shocks that effect all districts in the year of birth, nor by a range of mother or child characteristics.

We also carry out several robustness exercises to further corroborate our baseline results. First, we replace the district fixed effects with more stringent village fixed effects or mother fixed effects. The inclusion of these alternative fixed effects has little impact on the baseline results. Second, in addition to the 1966 district fixed effects we also include 1966 district time trends. The inclusion of the trends, aside from reducing the magnitude of the impact of HYV adoption somewhat, does not alter the baseline results. Third, we implement an instrumental variables approach that uses the differential spread of HYV across initially rice-producing and wheat-producing districts to predict HYV adoption. The results from the instrumental variable approach are negative and significant, and confirm the baseline results. Fourth, we switch our measure of HYV adoption from being based on data in the VDSA dataset to being based on data in the IACD. The sign and significance of our baseline results are replicable when we switch the measure. Fifth, we cluster the standard errors by district in DHS or by state in DHS instead of district in 1966. Again the results remain unchanged.

It is important to note here that our paper does not include a structural model that describes the mechanism(s) for our baseline results. Therefore, we interpret our main result as a “reduced form” relationship between HYV adoption and infant mortality. We explore mechanisms later in the paper by examining heterogeneity in responses to HYV adoption, as well as other outcomes that respond to it.

4.4 Data

In this section, we describe the data sources that were used in the empirical analysis. Moreover, where necessary, we describe the construction of the main variables in the analysis.

4.4.1 Adoption of HYV

Village dynamics in south asia

We take the annual data on the area planted to HYV from the Village Dynamics in South Asia (VDSA) dataset. The VDSA dataset is a panel that covers 281 districts across nineteen states of India over the period 1966 to 2009. It includes annual district-level information on the area (in hectares) devoted to high yielding varieties of five major crops–wheat, rice, maize, sorghum and pearl millet. Additionally, it has annual information on area cultivated (in hectares) and production (in tonnes) for 5 major and 19 minor crops. Aside from the data on agricultural outcomes, the VDSA dataset also has information on socioeconomic, climate, edaphic variables and agro-ecological variables. The nineteen states covered in the dataset are Assam, Himachal Pradesh, Kerala, Chhattisgarh, Jharkhand, Uttarakhand, Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The base year for districts in the VDSA panel is 1966. This means that data from child districts formed after 1966 are given back to their respective parent districts to form a comparable sample of districts from 1966 to 2009 that is based on the 1966 district boundaries.

To compute our main explanatory variable–the adoption of HYV–we aggregate the area planted to HYV of all the major crops in each district in the year of birth. We then divide the sum by the total area cultivated in the district in the year of birth in order to compute the share of cultivated area planted to HYV.

Indian agriculture and climate

The Indian Agriculture and Climate Dataset (IACD) is a panel that covers 271 districts across thirteen states of India. Like the VDSA panel it has annual district level data on the area planted to high yielding varieties in hectares of the five major crops for the period 1957 to 1987. Since the IACD starts from 1957 this means that it has annual data on agricultural outcomes for several years before the introduction of HYV in the late 1960s. The states covered by the IACD are Haryana, Punjab, Uttar Pradesh, Gujarat, Rajasthan, Bihar, Orissa, West Bengal, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Madhya Pradesh.

We use the same procedure we followed for the VDSA dataset to compute our main explanatory variable. First, we sum the area planted to HYV of all the major crops in each district in the year of birth. Then, we divide the sum by the total area cultivated in each district in the year of birth to compute the share of cultivated area planted to HYV.

4.4.2 Demographic and health survey data

The data on our outcomes of interest come from two rounds of the Demographic Health Surveys conducted in India in 1992-93 and 1998-99, respectively.

The data in the DHS surveys come in three formats:

1. The *Individual Recodes* survey women who are aged between 15 and 49. These are nationally representative surveys that contain information on several variables that we use. These include the woman's year of birth, her level of education, whether she lives in a rural area, her age, her caste and her religion.

2. The *Births Recodes* are the complete birth histories of the women surveyed in the individual recodes. We use these data for our baseline results. Specifically, we use the child's year of birth, birth order, an indicator for a multiple birth, a dummy for female, and the length of the child's life. The recodes have births as far back as the 1950s, several years before the first year in which the data on HYV of crops starts in the VDSA dataset in 1966.

3. The *Children's Recodes* include more information on a smaller sample of children. Women are asked about births in the previous five years. There is information on early life investments such as vaccinations and breastfeeding. There is also information on prenatal investments including care from doctors and the circumstances of the child's birth. We use all of these variables in our empirical analysis.

4.4.3 Additional controls

The VDSA dataset has information on annual rainfall (in millimetres) at the district level for the period 1966 to 2009. We use this as a control in our analysis. Moreover, the IACD includes district-level normal monthly temperature (in degree celsius) for each of the twelve months of the year. We average the temperatures across the twelve months for each district and use it as a control in our analysis.

4.4.4 Matching DHS to HYV data

We use the names of the districts surveyed in the DHS to assign each child the share of HYV acreage of the district where the child was born. Where districts have split in the DHS but not in the VDSA data, children are assigned the agricultural data values from the parent district. Figure 4.1 provides a visual illustration of the matching.

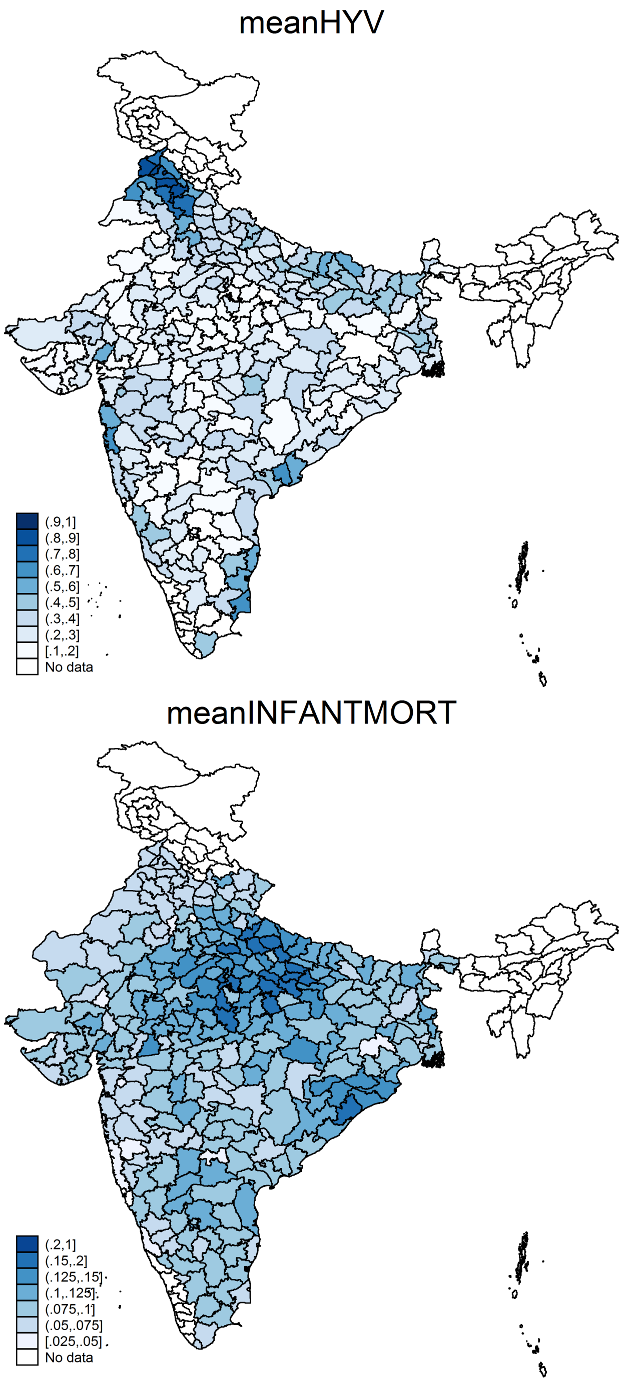
4.4.5 Summary statistics

We show the summary statistics used in this paper in Table 4.1. Infant mortality over births in our data averages 9.5%. The average for child mortality over births is higher at 13%. The share of HYV acreage over births averages 29%.[4] However, as Figure 4.1 shows there is substantial heterogeneity in HYV adoption and infant mortality across districts in our panel. Moreover, there is an inverse relationship between HYV adoption and infant mortality: districts with the lowest mean infant mortality over births are also the ones that have the highest mean shares of HYV acreage over births.

Table 4.1 also provides information on the characteristics of mothers in our sample. The average age of mothers in the sample is 34 years and the average birth order is nearly 3. Also, mothers have low levels of education (an average of 2.17 years) and tend to marry young (an average age of 16.1 years). In our baseline results we control for maternal characteristics, such as a mother's education, age, religion and caste, since they can influence infant mortality.

[4] Since the HYV and total acreage variables are reported separately in the raw data, there are a small number of cases where the computed share planted to HYV is greater than one.

Figure 4.1: HYV adoption and Infant Mortality: Heterogeneity



Notes: Shades represent mean values of the share of HYV acreage or infant mortality over births for districts in the sample, ranging from dark (highest) to light (lowest).

Additionally, Figure 4.2 shows declining infant mortality across both High and Low-HYV adoption districts over the period 1966 to 1998. The trend is indicative of there being no systematic differences in infant mortality between High and Low-HYV adoption districts prior to the introduction of HYV in the late 1960s. After these are introduced, a visible gap opens up between the infant mortality rates of the two sets of districts.

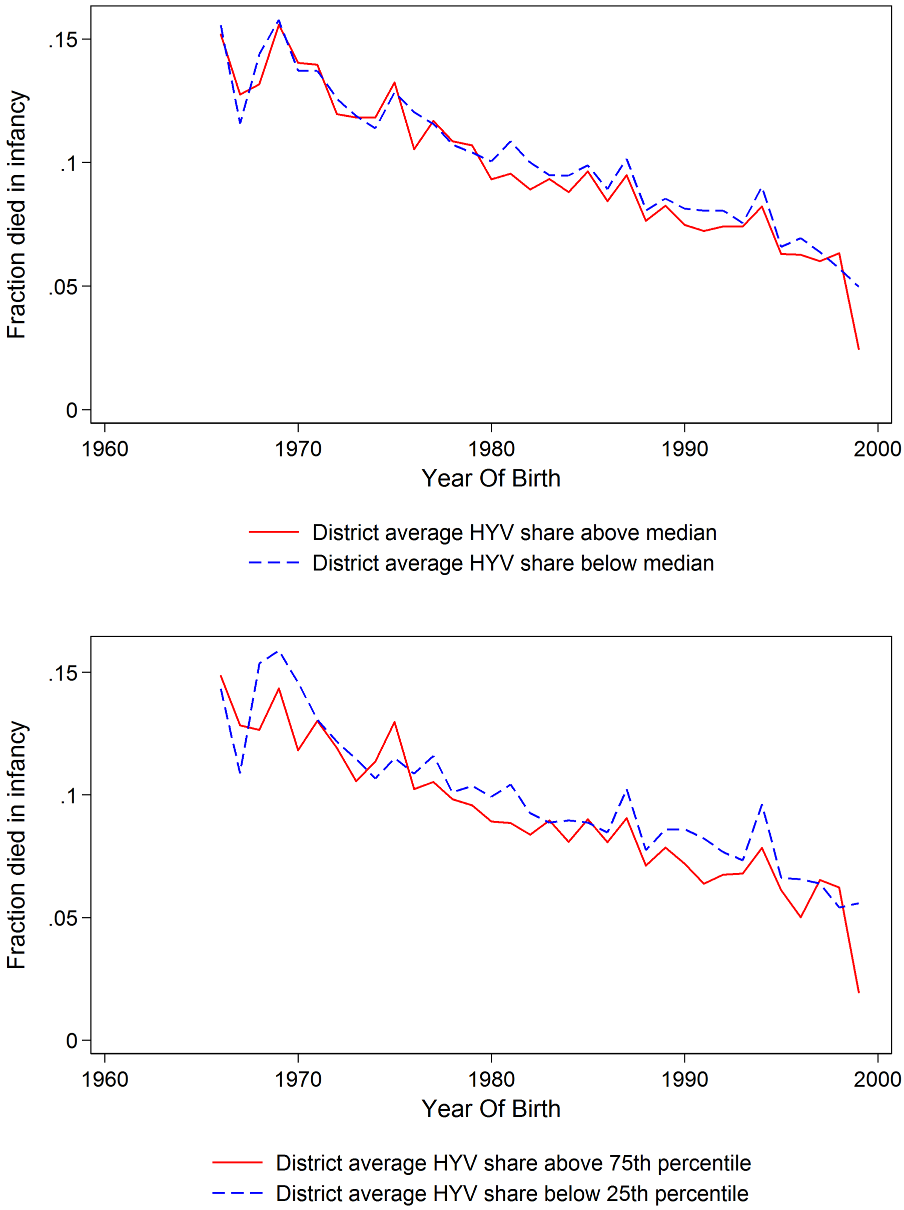
4.5 Results

In Table 4.2 we show the impact of HYV adoption on infant – within 12 months of birth – mortality. The results show a substantial and significant reduction in infant mortality from increased HYV adoption. As we move from the first to the second column, we find that including controls for the child's attributes, mother's characteristics and a dummy for DHS survey round makes almost no difference to the size and precision of the impact of HYV adoption on infant mortality. This means that it is unlikely that omitted variables correlated with HYV adoption are driving our results (Altonji, Elder, and Taber, 2005).

Interpreting the magnitude of the coefficient on HYV adoption in column 2 of Table 4.2, we find that a one standard deviation increase in HYV adoption leads to a 0.71 percentage point decrease in infant mortality, or approximately 7.5% of the mean[5]. Our magnitude is comparable to the magnitudes of other determinants of infant and child mortality found in the literature. These include the elasticity of rural infant mortality with respect to aggregate income of *-0.33* in India (Bhalotra, 2010), the long-run elasticity of infant and child mortality with respect to

[5]To arrive at this, we multiply the standard deviation of HYV adoption from Table 4.1 (0.21) by the coefficient (-0.034), and then multiply the resulting number by 100 to convert from deaths per birth to percentage points.

Figure 4.2: HYV adoption and Infant Mortality: Trends



Notes: We use two alternative definitions for distinguishing between High and Low-HYV districts. In the first we define a High (or Low) HYV district in a given year as being one where the fraction of cultivated area planted to HYV is above (or below) its median value in that year. In the second we define a High (or Low) HYV district in a given year as being one where the fraction of cultivated area planted to HYV is above its 75th percentile (or below the 25the percentile) value in that year.

per capita income of between *0.2* and *0.4* in developing countries (Pritchett and Summers, 1996), the *3.27* percent reduction in American infant mortality to due a decrease in the use of bituminous coal for heating (Barreca, Clay, Deschenes, Greenstone, and Shapiro, 2016) and the *0.51*% reduction in American infant mortality from an increase in the unemployment rate (Dehejia, Lleras-Muney, et al., 2004).

4.6 Mechanisms

Our analysis in the previous section has shown that HYV adoption reduces infant mortality across districts in India. While limitations of the available data restrict us from uncovering all possible mechanisms that explain how HYV adoption affects infant mortality, nevertheless, we use (1) heterogeneity in the effect across subgroups, (2) the behavioural response of parents in terms of investments in early-life health outcomes and (3) the response of additional childhood health outcomes to reduce the set of plausible explanations.

4.6.1 Heterogeneous effects

The use of heterogeneous treatment impacts in exploring mechanisms is prevalent in the literature on infant mortality (Bhalotra, 2010; Adhvaryu, Bharadwaj, Fenske, Nyshadham, and Stanley, 2016). In Table 4.3 we explore heterogeneity in the effect of HYV adoption on infant mortality. The first two columns of the top panel include the interaction of HYV adoption with child gender. We find that HYV adoption is more effective in reducing the infant mortality of boys relative to girls. Specifically, the impact of HYV adoption on the infant mortality for girls is only about two-thirds of that for boys. There are two possible explanations for such a result. First, since male fetuses are more fragile than their female counterparts (Gualtieri and Hicks, 1985; Kraemer, 2000) it is likely that the biological improvements caused by HYV adoption are greater for boys than for girls. That is: because boys start from a lower health endowment, the marginal return to any additional investment may be greater for them. It could also be the case that the greater reduction in infant mortality for boys is due to gender-biased parental investments in early-life health. If parents use the additional income generated from HYV adoption to invest disproportionately in the early-life health of boys then this could explain the heterogenous affect of HYV adoption across gender (Adhvaryu, Bharadwaj, Fenske, Nyshadham, and Stanley, 2016).

The second two columns of the top panel include the interaction of HYV adoption with a dummy for the child being born to a lower caste mother. The coefficient estimates on the interaction show that children from lower caste mothers benefit more from HYV adoption. The results are consistent with poorer (i.e. lower caste) mothers lacking the financial resources for undertaking investments in early-life health. They also reflect the importance of caste networks in facilitating access to health facilities (Munshi and Rosenzweig, 2009).

The last two columns of the top panel and the first two columns of the bottom panel report results for heterogeneity by two important characteristics of mothers in our sample–age and education. The results show that HYV adoption leads to a smaller decrease in infant mortality for older and more educated mothers. Conversely, younger and less educated mothers benefit more from HYV adoption. Such a result suggests that it is mothers whose observable characteristics correlate negatively with child survival who gain more from HYV adoption.

The last two columns of the bottom panel show that there is a greater reduction in infant mortality amongst rural children, relative to urban ones. Specifically, the urban effect is only one-fourth the rural effect. Such a result is not surprising as HYV are a purely agricultural innovation that mainly impacted incomes of rural households.

Most of the productivity gains from the adoption of HYV in India have been concentrated in either rice or wheat for two reasons. First, the HYV for these crops are more effective in raising productivity relative to other crops (Evenson and Gollin, 2003b) (Page: 461). As mentioned earlier, this was because scientists had developed a critical mass of knowledge about these two crops which they had not developed for other crops (Evenson and Gollin, 2003b). Second, wheat and rice are the most extensively cultivated crops in the country. Consequently, we expect HYV adoption to only impact infant mortality of households involved in wheat and rice cultivation. In Table 4.4 we test for such crop-specific heterogeneity in the impact of HYV adoption. We find a negative effect of HYV adoption on infant mortality for both wheat and rice, but no impact for the other crops: sorghum, maize and pearl millet. This confirms our prior hypothesis that HYV adoption only helped households in districts where the new varieties were wheat and rice.

4.6.2 Behavioural responses and health outcomes

In this section we investigate whether the effect of HYV adoption is mediated through greater parental investments in child health. Parental investment responses have been cited in the literature as a mechanism for other determinants of early-life health (Almond and Mazumder, 2013; Bharadwaj, Eberhard, and Neilson, 2013; Adhvaryu, Bharadwaj, Fenske, Nyshadham, and Stanley, 2016).

We would expect HYV adoption to raise parental investments in child health for two main reasons. First, an increase in agricultural incomes associated with HYV adoption could cause parental investments in health during the prenatal and neonatal stages. Second, HYV adoption could reduce the opportunity cost of maternal time, thereby, causing mothers to engage in seeking health care services (Bhalotra, 2010).

In Table 4.5 we find no obvious evidence of HYV adoption affecting investments in child health. The top two panels of Table 4.5 examine the impact of HYV adoption on neonatal investments (vaccinations) undertaken between 12 to 23 months after birth. For most investments we find no significance for the impacts. The only exception is the 'Polio 1' vaccination.

The third panel of Table 4.5 shows how pre-natal and at-birth investments respond to HYV adoption. Since such investment decisions are made before the childs birth they reflect the impact of HYV adoption on 'access' to health care services, rather than 'compensatory' investments by parents once child quality is revealed (Almond and Mazumder, 2013; Bharadwaj, Eberhard, and Neilson, 2013; Adhvaryu, Bharadwaj, Fenske, Nyshadham, and Stanley, 2016). We find that HYV adoption increases prenatal visits to the doctor, prenatal visits for pregnancy and the number of iron deficiency tablets administered to mothers giving birth. In sum, then, there is some evidence of greater prenatal care, but no evidence of greater vaccination explaining the effects that we find.

However, the fact that HYV adoption does not affect parental investments in child health, yet it leads to greater benefits in terms of infant mortality for children born to poorer (i.e. lower caste) mothers suggests that the influence of HYV could be operating through greater public expenditures on health. This is because an expansion in public health infrastructure would not be related to parental investments in child health, but would significantly improve infant mortality for the poorer sections of society.

Finally, in the bottom panel of Table 4.5 we examine the impact of HYV adoption on early childhood health outcomes beyond the infancy period. We do this to learn more about the health profile of children who survive the infancy period. If HYV adoption helped only the weakest children survive, then we would expect those children whose survival depended upon HYV adoption to have worse health outcomes. We don't find much evidence for HYV adoption being negatively associated with health outcomes of surviving children like height, weight, birth size, recent fever and recent diarrhoea, but we do find a significantly negative effect for recent coughs.

4.6.3 Selection

HYV adoption can also affect infant mortality by influencing the profile of mothers who give birth. For instance, Dehejia, Lleras-Muney, et al. (2004) and Bhalotra (2010) find that recessions cause high-risk mothers to delay their fertility decisions. In our case, if parents with both education and experience decide to have more children in response to HYV adoption, then such self-selection of parents with characteristics that predict child survival into child bearing could explain why HYV adoption reduces infant mortality. We, therefore, test for selective fertility based on either parental or child characteristics can explain the effect of HYV adoption on infant mortality (Adhvaryu, Fenske, Nyshadham, et al., 2014). To do so, we estimate equation (4.1) with parental and child characteristics as the outcome variables. Our test for selection is motivated from Buckles and Hungerman

(2013). In Table 4.6 we find that HYV adoption has a positive and significant impact on the mother's education and literacy and the child's birth-order. On the other hand we find that HYV adoption decreases the number of lower caste mothers giving birth. Together, these suggest that some part of the reduced infant mortality effect arises due to a greater selection into fertility by mothers with characteristics that correlate negatively with child mortality.

4.6.4 Robustness checks

In this section we perform several empirical exercises to show the robustness of our main result. First, in Table 4.7 we use instrumental variables to predict the agricultural productivity gains from HYV adoption in our main specification given by equation (4.1). The instruments we use are defined as follows:

$$\frac{1 + \text{Share of initial rice HYV area}}{1 + \text{Share of initial wheat HYV area}} \times (\text{Year of birth fixed effects}) \tag{4.2}$$

The intuition behind such a set of instruments is given in Foster and Rosenzweig (2003). It is based on two characteristics of HYV adoption in India. First, dissimilar climatic conditions across India create regional differences in the suitability for growing the two major crops of rice and wheat. This means that differences in land devoted to the cultivation of rice or wheat reflect differences in characteristics that predate the availability of HYV. Second, as discussed in Section 4.2 the productivity gains generated by HYV of the two crops vary substantially between them, and compared to other HYV crops. Hence, interacting the initial (i.e. 1970) ratio of land devoted to rice and wheat with year fixed effects gives us an instrument for predicting crop-specific productivity growth from HYV adoption in our panel from 1966 to 1998. Such an instrument not only predicts crop-specific productivity growth, but is also uncorrelated with omitted variables that directly impact infant mortality. Table 4.7 shows the second stage results from the instrumental variable regressions. It is clear that our causal impact of HYV adoption on infant mortality is robust to the use of an instrumental variables approach.

Second, in Table 4.8, we use alternative sets of fixed effects. Our aim is to show that despite restricting our identification to more narrowly-defined comparison groups we continue to obtain our main result of HYV adoption reducing infant mortality. In columns 1 to 4 of Table 4.8, we replace the 1966 district-specific fixed effects with more tightly defined survey cluster fixed effects or mother fixed effects. Moreover, in columns 5 to 6 show we replace the 1966 district-specific fixed effects with state $\times$ year of birth fixed effects. All the results are of the same sign as our baseline results and remain significant.

Third, in Table 4.9, we include 1966 district time trends to our baseline specification to account for any unobserved trending variables that could vary by 1966 district specific birth-cohort. The inclusion of the district time trends, aside from reducing the magnitude of the estimated coefficient on HYV adoption somewhat, does not differ significantly from the baseline estimates.

Furthermore, we perform a series of additional robustness tests in the Appendix. The results in the Appendix tables are organized in the same way as our baseline results in Table 4.2, meaning there are two columns: one for the parsimonious model without controls and the other for the model with controls.

In Appendix Table 4.A.1 we show results for three different variations of our baseline specification. Columns 1 and 2 replace infant mortality (death within 12 months of birth) with child mortality (death within five years of birth) as the outcome variable. The magnitudes of the coefficients show that HYV adoption causes a greater reduction in child mortality, relative to infant mortality, suggesting that HYV adoption is better at saving lives in the post-infancy stage. Columns 2 and 3 use an alternative HYV adoption measure that replaces the denominator with initial (1970) acreage as opposed to contemporary (in the same year) acreage. The magnitudes of the estimated coefficients on the alternative measure of HYV adoption are somewhat smaller, but the sign and the significance are the same. Columns 4 and 5 use another alternative HYV adoption measure that uses the natural logarithm of the area planted to HYV. Since we do not normalize HYV area by acreage this may be a more imprecise measure of HYV adoption. Even still, our results are still significant and have the same sign as the baseline estimates.

Next, we use Appendix Table 4.A.2 to show that our results are not dependent on the nature of the relationship between HYV adoption and infant mortality being linear. In columns 1 and 2 we use a quadratic functional form for our empirical specification where we include the square of the HYV adoption measure in addition to the HYV adoption measure. Both the magnitude and sign on the estimated coefficients of the HYV adoption measure are similar to those for our baseline specification. However, the positive sign on coefficient for the square of the HYV adoption measure is evidence for there being non-linearity in the relationship between HYV adoption and infant mortality. Columns 2 and 3 use deciles of the HYV adoption measure to show that, relative to the omitted, lowest decile, higher deciles of the HYV adoption measure reduce infant mortality more.

Additionally, Appendix Table 4.A.3 shows that our baseline results are not sensitive to the exclusion of districts with extreme values of HYV adoption or child mortality. In the top panel of Table 4.A.3 we remove from the sample those districts that have a value of child mortality that is either below the first quintile or above the fifth quintile. The magnitudes of the coefficients for HYV adoption are, again, similar to the baseline. However, the effect of HYV adoption is larger once districts that have mean child mortality below the first quintile are removed from the sample. The bottom panel of Table 4.A.3 removes from the sample districts that have mean HYV adoption that is either below the first quintile (columns 1 and 2) or above the fifth quintile (columns 3 and 4). Again, the results remain broadly similar to the baseline despite the exclusion of extreme HYV adoption values from the sample and despite the reduction in sample size. Furthermore, in Appendix Table 4.A.4 we cluster standard errors by either DHS districts or DHS survey cluster or state, instead of 1966 districts. Again, our baseline results are robust to these alternative ways of clustering.

Finally, Appendix Table 4.A.5 shows the robustness of our baseline results to the use of alternative data on HYV from the IACD. In the top panel (Panel A) we replace values for the HYV adoption measure that are missing in the VDSA data with non-missing values based on data from the IACD. In the middle panel (Panel B) we replace the missing values for the HYV adoption measure in the IACD data with non-missing values based on the VDSA data. In the bottom panel (Panel C) we take an average of the HYV adoption measure based on the data given in the VDSA and the IACD. In all cases the sign and significance of the results remain the same as our baseline estimates. Moreover, the magnitudes barely change despite the inclusion of the IACD data in our sample.

4.7 Conclusion

This paper shows that the adoption of HYV reduces infant mortality in India during the period 1966 to 1998. While there exist studies that have examined the microeconomic effects of technology adoption and identified sources of poor health outcomes in developing countries, our paper contributes to such a literature in several ways. First, by connecting agricultural productivity gains from HYV adoption with infant mortality we focus on the role played by technological change in influencing health outcomes in developing countries. Second, by restricting our study to India, we are able to compare areas that have similar political and administrative arrangements, which is not the case in cross-country studies. Third, we use heterogenous impacts of HYV adoption across various sub-groups to show that it is mothers whose characteristics predict less child survival, children born to lower caste mothers, children who are born as girls and children born in rural areas who are most advantaged by HYV adoption. Moreover, we show that the benefits of HYV adoption are concentrated in wheat and rice cultivating districts. Fourth, we show that parental investments in either early life health or the health of children who survive beyond infancy are not correlated with HYV adoption. Finally, we find evidence of selective fertility in response to HYV adoption and argue that this could be an intermediating mechanism for our results. In particular, we show that low-risk mothers self-select into child bearing in response to HYV adoption.

Table 4.1: Summary statistics

	(1) Mean	(2) s.d.	(3) Min	(4) Max	(5) N
Identifiers					
Round	32.7	9.50	23	42	388,105
Unique Mother ID	74,657	39,831	1	136,383	388,105
District ID VDSA	159	92.8	1	317	388,105
Mother Characteristics					
Current Age - Respondent	34.3	8.01	13	49	388,105
Education In Single Years	2.17	3.76	0	22	387,562
Age At First Marriage	16.1	2.79	8	48	388,105
Can Read And Write	0.20	0.40	0	1	347,035
Mother Age Squared	1,241	552	169	2,401	388,105
Completed Primary	0.31	0.46	0	1	388,105
Completed Secondary	0.17	0.37	0	1	388,105
Urban	0.25	0.43	0	1	388,105
Low Caste	0.34	0.47	0	1	386,084
Tribal	0.093	0.29	0	1	386,084
Muslim : Muslim and Hindu Sample Only	0.12	0.33	0	1	368,005
Child Characteristics					
Birth Order Number	2.87	1.88	1	16	388,105
Year Of Birth	1,984	7.75	1,966	1,999	388,105
Child Multiple	0.013	0.11	0	1	388,105
Child Female	0.48	0.50	0	1	388,105
Child Died As Infant	0.095	0.29	0	1	388,105
Child Died As Child	0.13	0.34	0	1	388,105
Green Revolution					
Total Hyv Area / Total Cultivated Area	0.29	0.21	0	3.16	331,850

Table 4.2: Impact of HYV cultivation on infant mortality

	(1)	(2)
	Child Died As Infant	
Total HYV Area / Total Cultivated Area	-0.035***	-0.034***
	(0.007)	(0.007)
Observations	331,850	330,589
1966 District FE	Yes	Yes
Birth Year FE	Yes	Yes
Controls	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

TABLE 4.3: Heterogeneous effects of HYV cultivation

	(1)	(2)	(3)	(4)	(5)	(6)
	Child Died As Infant					
Total HYV Area / Total Cultivated Area	-0.042***	-0.041***	-0.029***	-0.028***	-0.083***	-0.108***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.021)	(0.020)
Interaction	0.014***	0.014***	-0.014**	-0.018***	0.003**	0.005***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.001)	(0.001)
Observations	331,850	330,589	330,639	330,589	331,850	330,589
Interaction variable	Child female		Mother low caste		Mother age at marriage	
	Child Died As Infant					
Total HYV Area / Total Cultivated Area	-0.043***	-0.042***	-0.039***	-0.037***	-0.040***	-0.040***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Interaction	0.004***	0.004***	0.009	0.003	0.022***	0.024***
	(0.001)	(0.001)	(0.011)	(0.010)	(0.008)	(0.008)
Observations	331,363	330,102	313,236	312,037	331,850	330,589
Interaction variable	Mother education		Mother Muslim		Urban	
1966 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.4: Effects of specific crops

	(1)	(2)	(3)	(4)	(5)	(6)
	Child Died As Infant					
Crop HYV Area / Total Cultivated Area	-0.031***	-0.045***	-0.031	-0.014	0.036	0.010
	(0.010)	(0.013)	(0.022)	(0.021)	(0.040)	(0.031)
Observations	330,849	330,849	331,037	329,791	329,091	307,146
Crop	Rice	Wheat	Sorghum	Pearl Millet	Maize	Finger Millet
1966 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.5: Impact of HYV cultivation on child investments and outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
Vaccines received A:	Tetanus	Polio 0	BCG	DPT 1	Polio 1	DPT 2
Total HYV Area / Total Cultivated Area	0.125	0.032	0.034	-0.047	-0.124**	-0.004
	(0.125)	(0.073)	(0.060)	(0.058)	(0.056)	(0.062)
Observations	35,136	10,324	34,648	34,546	34,695	34,521
Vaccines received B:	Polio 2	DPT 3	Polio 3	Measles	Any	
Total HYV Area / Total Cultivated Area	-0.086	0.055	-0.030	0.035	-0.147***	
	(0.062)	(0.058)	(0.059)	(0.055)	(0.054)	
Observations	34,671	34,521	34,671	34,093	26,328	
Care received:	Pre-natal doctor	Doctor at birth	Breastfeeding duration	Pre-natal visits	Iron tablet	
Total HYV Area / Total Cultivated Area	0.113**	0.037	-1.827	0.689**	0.107**	
	(0.044)	(0.041)	(1.419)	(0.269)	(0.047)	
Observations	35,380	35,316	35,109	35,468	35,317	
Health outcome:	Birth size	Recent diarrhea	Recent fever	Recent cough	Weight	Height
Total HYV Area / Total Cultivated Area	-0.063	-0.004	-0.069	-0.100**	-0.164	-1.058
	(0.066)	(0.041)	(0.044)	(0.043)	(0.463)	(1.861)
Observations	35,116	32,614	32,617	32,620	28,400	23,192
1966 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.6: Selective fertility and survival to birth

	(1)	(2)	(3)	(4)	(5)
Mother characteristics A	Low Caste	Tribal	Age in survey	Age at first marriage	Education
Total HYV Area / Total Cultivated Area	-0.027*	-0.005	0.152	0.119	0.237*
	(0.015)	(0.007)	(0.201)	(0.120)	(0.135)
Observations	330,639	330,639	331,850	331,850	331,363
Mother characteristics B	Muslim	Completed primary	Completed secondary	Urban	Literate
Total HYV Area / Total Cultivated Area	0.013	0.027	0.018	0.006	0.032**
	(0.011)	(0.017)	(0.013)	(0.013)	(0.015)
Observations	313,236	331,850	331,850	331,850	299,718
Child characteristics	Birth order	Female	Multiple		
Total HYV Area / Total Cultivated Area	0.144*	0.008	0.003		
	(0.080)	(0.010)	(0.003)		
Observations	331,850	331,850	331,850		
1966 District FE	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	No	No

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS.

Table 4.7: Instrumental variables results

	(1)	(2)
	Child Died As Infant	
Total HYV Area / Total Cultivated Area	-0.097**	-0.074*
	(0.041)	(0.038)
Observations	331,764	330,503
KP F-Statistic	8.598	8.598
1966 District FE	Yes	Yes
Birth Year FE	Yes	Yes
Controls	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated. The excluded instruments are the ratio of one plus rice share to one plus wheat share in 1970, interacted with year fixed effects.

Table 4.8: Main results with alternative fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
	Child Died As Infant					
Total HYV Area / Total Cultivated Area	-0.030***	-0.016**	-0.033***	-0.022***	-0.026***	-0.026***
	(0.008)	(0.006)	(0.008)	(0.008)	(0.009)	(0.008)
Observations	331,850	330,589	331,850	330,589	331,850	330,589
Fixed effects	Survey cluster + year of birth		Mother ID + year of birth		State X year of birth + district	
Controls	No	Yes	No	Yes	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.9: Main results with trends for 1966 districts

	(1)	(2)
	Child Died As Infant	
Total HYV Area / Total Cultivated Area	-0.019**	-0.018**
	(0.008)	(0.007)
Observations	331,850	330,589
1966 District FE	Yes	Yes
Birth Year FE	Yes	Yes
Controls	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

4.A Appendix

Table 4.A.1: Alternative variable definitions

	(1)	(2)	(3)	(4)	(5)	(6)
	Mortality measure					
HYV Measure	-0.046***	-0.044***	-0.023***	-0.024***	-0.006***	-0.005***
	(0.009)	(0.009)	(0.007)	(0.006)	(0.001)	(0.001)
Observations	331,850	330,589	334,833	333,566	343,089	341,822
Alternative measure	LHS: Child mortality		RHS: 1970 area as denominator		RHS: ln HYV area	
1966 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.A.2: Alternative functional forms

	(1)	(2)	(3)	(4)
	Child Died As Infant			
Total Hyv Area / Total Cultivated Area	-0.068***	-0.066***		
	(0.016)	(0.015)		
Total Hyv Area / Total Cultivated Area Squared	0.040**	0.038**		
	(0.019)	(0.018)		
HYV Decile 2			-0.013***	-0.012***
			(0.004)	(0.004)
HYV Decile 3			-0.010**	-0.009**
			(0.004)	(0.004)
HYV Decile 4			-0.018***	-0.017***
			(0.004)	(0.004)
HYV Decile 5			-0.020***	-0.019***
			(0.004)	(0.004)
HYV Decile 6			-0.023***	-0.022***
			(0.004)	(0.004)
HYV Decile 7			-0.024***	-0.024***
			(0.004)	(0.004)
HYV Decile 8			-0.026***	-0.025***
			(0.005)	(0.004)
HYV Decile 9			-0.031***	-0.029***
			(0.004)	(0.004)
HYV Decile 10			-0.026***	-0.025***
			(0.005)	(0.005)
Observations	331,850	330,589	331,850	330,589
1966 District FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

TABLE 4.A.3: Results with outliers removed

	(1)	(2)	(3)	(4)
	Child Died As Infant			
Total Hyv Area / Total Cultivated Area	-0.045***	-0.043***	-0.028***	-0.028***
	(0.008)	(0.008)	(0.008)	(0.008)
Observations	261,609	260,437	268,264	267,792
Removed	Child mortality Q1		Child mortality Q5	
	Child Died As Infant			
Total Hyv Area / Total Cultivated Area	-0.017**	-0.017**	-0.056***	-0.055***
	(0.008)	(0.008)	(0.011)	(0.011)
Observations	265,476	264,462	265,495	264,529
Removed	HYV Q1		HYV Q5	
1966 District FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.A.4: Alternative clustering

	(1)	(2)
	Child Died As Infant	
Total HYV Area / Total Cultivated Area	-0.035**	-0.034**
s.e. clustered by district in DHS	(0.007)	(0.007)
s.e. clustered by state	(0.014)	(0.013)
s.e. clustered by survey cluster	(0.007)	(0.007)
Observations	331,850	330,589
1966 District FE	Yes	Yes
Birth Year FE	Yes	Yes
Controls	No	Yes

Notes: All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

Table 4.A.5: Incorporation of older World Bank data

	(1)	(2)
	Child Died As Infant	
Panel A. Missing filled using World Bank data		
Total HYV Area / Total Cultivated Area	-0.033***	-0.032***
	(0.007)	(0.007)
Observations	342,151	340,890
	Child Died As Infant	
Panel B. World Bank filled using VDSA		
Total HYV Area / Total Cultivated Area	-0.025***	-0.024***
	(0.007)	(0.007)
Observations	342,151	340,890
	Child Died As Infant	
Panel C. Average of World Bank and VDSA		
Total HYV Area / Total Cultivated Area	-0.033***	-0.031***
	(0.008)	(0.008)
Observations	342,151	340,890
1966 District FE	Yes	Yes
Birth Year FE	Yes	Yes
Controls	No	Yes

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1966 district in parentheses, unless otherwise indicated. All regressions are OLS. Controls are birth order, female, multiple, DHS round, mother's age in survey, mother's age in survey squared, urban, mother's religion, and mother's caste, unless otherwise indicated.

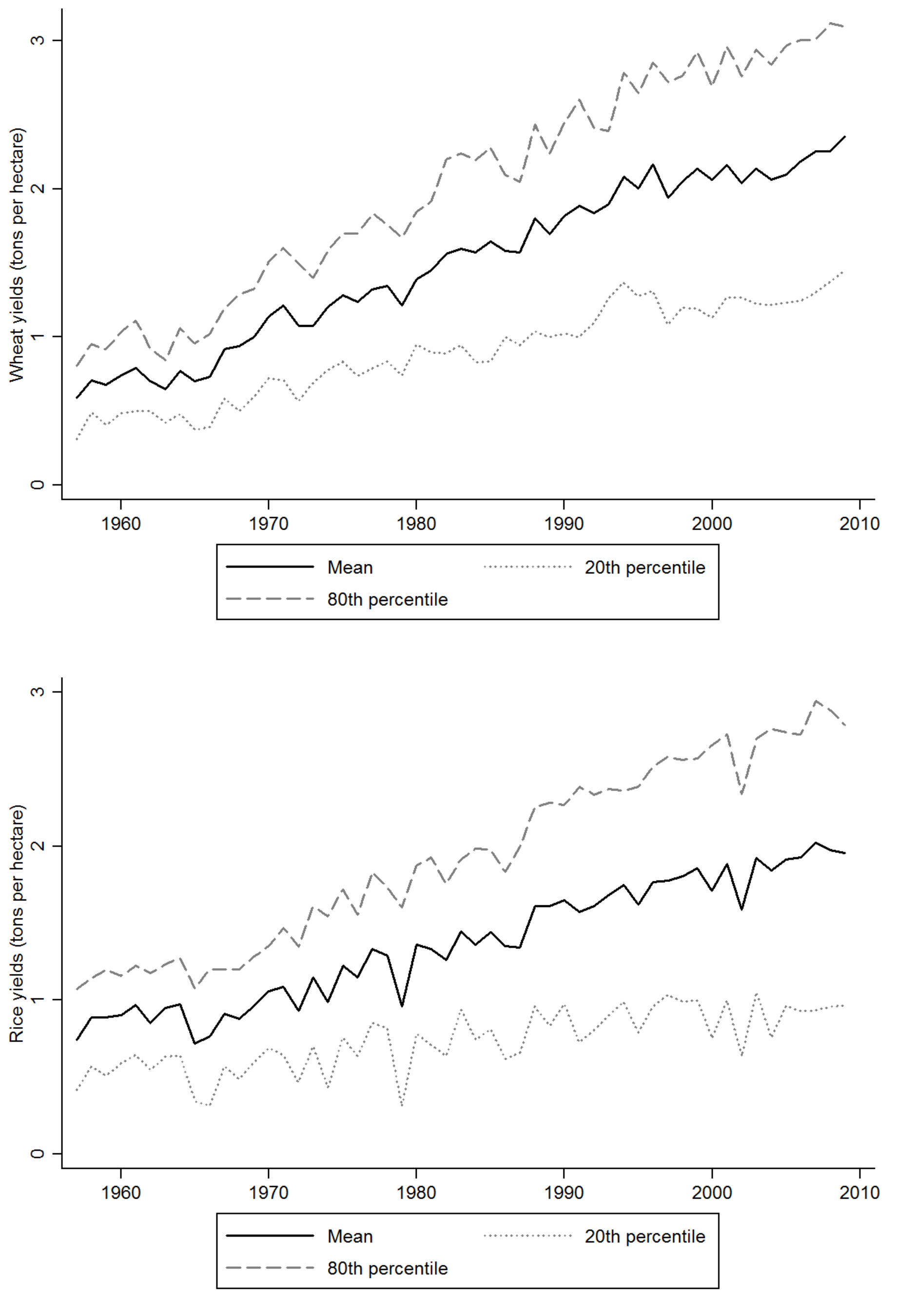
Chapter 5

Irrigation, the Green Revolution and Agricultural Development in India

5.1 Introduction

Beginning in the late 1960s, the yields for the two major crops in India, wheat and rice, rose dramatically as shown in Figure 5.1. Such a sharp rise is attributed to the introduction of high yielding varieties (HYV) of seeds of wheat and rice in the late 1960s, an event referred to as the Green Revolution. The aggregate trend, however, masks substantial variation in the evolution of yields across regions in India. A key factor behind why some regions were better able to adopt HYV and in turn accelerate their yield growth was irrigation infrastructure (Evenson and Gollin, 2003b, p. 91). This study, therefore, uses district level data from India to determine the extent to which the observed increase in wheat and rice yields after the start of the Green Revolution is associated with the existence of irrigation infrastructure prior to the start of the Green Revolution (hereafter "initial irrigation").

FIGURE 5.1: Growth in wheat and rice yields: 1957 – 2009



Notes: The line for mean gives the average yields across all districts for each year in the sample. The 20th percentile line gives the 20th percentile value of yields across all districts for each year in the sample. The 80th percentile line gives the 80th percentile value of yields across all districts for each year in the sample.

Irrigation has been identified as a crucial factor behind the adoption of HYV. To fully utilize the yield potential of HYV it is necessary to apply considerably large doses of water per unit of land, which is only possible through irrigation (Baird, 2003, p. 3). Accordingly, McGuirk and Mundlak (1991) show that availability of irrigation facilities determined the fast adoption of HYV in Punjab during the Green Revolution. Moreover, Evenson and Gollin (2003b) note that adoption rates of HYV in Punjab, Haryana and Tamil Nadu, all states with developed irrigation infrastructure, were very high less than a decade after their introduction. Finally, Barker, Herdt, and Rose (1985) observe that adoption rates for rice HYV were recorded at over 99 percent in Punjab and nearly as high in Haryana at around the same time.

The main contribution of this study is to extend such a literature by focusing on the role played by irrigation in facilitating the link between the adoption of HYV and yields. In doing so the paper will provide a systematic empirical analysis of the relationship between baseline differences in irrigation and growth in yields across districts in India after the start of the Green Revolution.

The empirical strategy I use to analyze the relationship between initial irrigation and yields after the start of the Green Revolution exploits two sources of variation. The first is the time variation arising from the introduction of HYV in India. Before the late 1960s, no HYV existed in India. However, beginning in the late 1960s, HYV of both wheat and rice were introduced as a result of the scientific efforts of the International Rice Research Institute (IRRI) and the International Center for Maize and Wheat Improvement (CIMMYT). The second source of variation is cross-sectional and arises from differences in initial irrigation across districts prior to the introduction of HYV. Accordingly, my empirical strategy, using the same logic as a difference-in-differences strategy, compares yields between districts with more initial irrigation to districts with less initial irrigation before and after the introduction of HYV. The objective is not to determine if a yield gap existed between high and low initial irrigation districts, but rather to establish if the gap widened after the start of the Green Revolution.

Once the HYV are introduced, it is expected that districts with more initial irrigation will be better able to adopt HYV and thereby raise their yields even more. Consistent with such an expectation, I find that districts with more initial irrigation are indeed associated with greater increases in wheat and rice yields after the start of the Green Revolution. In particular, using the first year in which HYV acreage goes above 0% as the start of the Green Revolution, a 10 percentage point increase in initial irrigation is associated with a 0.0466 tons per hectare increase in wheat yields on average after the start of the Green Revolution. The equivalent result for rice yields is a 0.0765 tons per hectare increase on average. As shown in Section 5.5, both increases are substantial relative to the mean of wheat and rice yields in the sample.

To explore the mechanisms that connect initial irrigation with yields after the start of the Green Revolution I employ two strategies. First, I use a fully flexible estimating equation to uncover heterogeneity in the relationship between initial irrigation and yields across wheat and rice over time. I find that for wheat, more initial irrigation is associated with greater increases in yields immediately after the start of the Green Revolution, however, in subsequent periods the gap between areas with high and low initial irrigation closes up. For rice, more initial irrigation is associated with additional growth in yields throughout all of the period after the start of the Green Revolution period. The heterogeneity in the relationships reflects differences in the development of HYV in wheat and rice. While for wheat the later generation of HYV improved yields in non-irrigated areas, the later generation of rice varieties improved yields even more in already irrigated areas.

Second, I use historical data on canal irrigation to determine whether the relationship between initial irrigation and yields in the baseline results originates in the colonial period. By replacing the measure of initial irrigation in my baseline specification with a measure of colonial canal irrigation I show that the positive association between initial irrigation and yields after the start of the Green Revolution extends back to the colonial period. Given that impacts of historical investments in public infrastructure have been shown to persist in Africa (Huillery, 2009), Asia (Chaudhary and Garg, 2015; Donaldson, 2010)[1] and Latin America (Dell, 2010), my results are a validation of some of the other findings in the literature.

My empirical strategy addresses the standard empirical concerns that can arise in analyzing the relationship between initial irrigation and yields after the start of the Green Revolution. For instance, districts in India could have geographical characteristics that influence the extent of their initial irrigation. If the geographical characteristics of districts that are associated with initial irrigation also affect yields, then this could introduce a bias into the estimates. I address such a concern by including in the baseline specification district fixed effects that absorb all time-invariant characteristics of the district which are associated with initial irrigation and also affect yields. Another potential concern could be a time-specific shock, aside from the Green Revolution, that affects all states equally – recession, earthquake or flooding – driving part of the correlation between initial irrigation and yields. By including year fixed effects in the baseline specification I control

[1] Chaudhary and Garg (2015) show persistence of colonial investments in education only until 1971, after which they provide evidence for the post-1971 state sponsored expansion of public education overturning the effect of colonial investments

for any such time-specific shock. I also cluster the standard errors in the baseline specification by district.

Additionally, I carry out a series of empirical tests to show the robustness of the relationship between initial irrigation and yields after the start of the Green Revolution. First, I show that replacing the outcome variable with yields of less water intensive crops altogether eliminates the association between initial irrigation and yields after the start of the Green Revolution. Second, I show that the baseline results are robust to replacing district fixed effects with state fixed effects. Next, I include agricultural region-specific linear time trends to account for any broad secular trends at the level of the agricultural region influencing the baseline results. India is divided into six agricultural regions – Eastern Himalaya, Western Himalaya, Northern Dry, Eastern Wet, Western Wet and Southern. Areas within each of these regions have certain degree of similarity in terms of relief, soil type, climatic conditions, farming practices, crops produced and crop association. For instance, the Northern Dry region consists of areas that have low rainfall and where the soil is alluvial and sandy. The region also has wheat, maize and cotton as its chief crops. Again, the results remain positive and significant despite the inclusion of the trends. I also show that the results remain stable even after dropping districts with extreme values of initial irrigation from the sample. Finally, I show that my results are robust to clustering standard errors by state rather than by district.

5.1.1 Contribution

Literature exists that examines the relationship between the Green Revolution and yields. For instance, HYV adoption in the late 1960s is shown to cause substantial increases in wheat and rice yields across the developing world (Evenson and Gollin, 2003a). The adoption of HYV, in addition to increasing yields, is also shown to reduce their variability across a broad range of developing countries (Byerlee and Moya, 1993).

Related literature also exists that stresses the importance of irrigation in HYV adoption. It has been found to be 'by far the most important factor affecting' the adoption of HYV in Asia (Estudillo and Otsuka, 2013). In particular, for both wheat and rice, pre-exiting irrigation has been identified as one of the main drivers behind the adoption of HYV (Gollin, Hansen, and Wingender, 2016). While the earliest HYV were especially developed to enhance yields under irrigated environments (Evenson and Gollin, 2003a), the later generations of rice and wheat varieties responded differently to irrigation (Byerlee and Moya, 1993; Barker, Herdt, and Rose, 1985).

Finally, there is literature that focuses on the role of irrigation in facilitating agricultural development through HYV adoption (Rozelle, Jin, Huang, and Hu, 2003; McGuirk and Mundlak, 1991; Baird, 2003). This study contributes to such a literature by statistically documenting the relationship between initial irrigation and yields after the introduction of HYV across districts in India. Moreover, by examining the evolution of the relationship over a long period of time, stretching from 1957 to 2009, it offers additional insights into how later generations of HYV respond to initial irrigation.

Another contribution this paper makes is to the broader literature on the impacts of large-scale public infrastructure investments on development outcomes. The expansion of the rail network during the colonial era has been shown to increase real incomes and the volume of trade while at the same time reducing trade costs and risk of famines in India (Donaldson, 2010; Burgess and Donaldson, 2012). Furthermore, dam construction during the post-independence period has been found to reduce poverty in downstream areas and increase poverty in upstream areas (Duflo and Pande, 2005). More relevant to this paper are two major studies on the impact of canal irrigation in colonial India that reach different conclusions. One of the studies shows that canal irrigation shifted production away from staple food crops towards commercial crops, which caused environmental problems such as water-logging, salinity of soil and increased malaria incidence (Whitcombe, 1995). On the other hand, a later study finds that canal irrigation raised agricultural productivity and increased incomes (Stone, 2002).

The lack of consensus between the studies as to the effects of canal irrigation is because neither study provides a systematic empirical investigation into the relationship between canal irrigation and agricultural outcomes. This paper, by providing a systematic analysis of the relationship between irrigation and yields, fills such a gap in the literature.

Finally, by focusing on India this paper examines the relationship between irrigation and yields across areas with similar administrative and political institutions – an advantage that is not present in cross-country empirical studies.

The remainder of the paper is organized as follows. Section 5.2 highlights the role irrigation played in the diffusion of the rice and wheat high yielding varieties in India. It also provides a review of the development of irrigation in India. Section 5.3, provides an outline of the empirical strategy. Section 5.4 describes the data sources and explains the construction of the main variables used in the empirical analysis. Section 5.5 discusses the results and the robustness checks.

The mechanisms behind the results are also explored in the same section. Finally, Section 5.6 concludes.

5.2 The Green Revolution and Irrigation

5.2.1 Irrigation and HYV adoption

Irrigation was an important factor in the adoption of the high yielding varieties of both rice and wheat. This is evidenced by the high adoption of the rice and wheat varieties in 'tropical and subtropical regions with good irrigation systems' (Evenson and Gollin, 2003a, p. 758). However, despite the importance of irrigation the rate of adoption of the varieties differed over time in India. The first-generation wheat varieties were adopted fairly quickly in irrigated and favourable rain-fed areas (Munshi, 2004, p. 189). Their success was because of the more or less uniform agro-climatic conditions under which wheat is grown in India (Munshi, 2004, p. 187). It was also because of the varieties being robust to pests and diseases that were local to the wheat areas (Munshi, 2004, p. 187). On the other hand the first-generation rice varieties failed to penetrate the rice growing areas. The failure of the early rice varieties was due to their lack of resistance to local pests and diseases and the varied agro-climatic conditions of the rice growing regions (Munshi, 2004, p. 190).

Unlike the early varieties, the later generation of rice and wheat varieties responded differently to irrigation. For rice, the later varieties increased the rate of adoption from around 35% to around 80% on irrigated or favourable rain-fed land (Evenson and Gollin, 2003a, p. 759). Meanwhile, the later generation of wheat varieties, having already penetrated irrigated and favourable rain-fed areas, made substantial headway into less favourable rain-fed areas (Byerlee and Moya, 1993).

The widespread adoption of the later rice varieties was due to breeding efforts aimed at developing location-specific traits within those areas (Evenson and Gollin, 2003a, p. 759). The later varieties were also resistant to the pests and diseases that had been a major cause behind the failure of the first-generation varieties. On the other, the later wheat varieties were bred for incorporating 'resistance to serious disease problems in rain-fed areas' (Byerlee and Moya, 1993, p. 13). Such differences in the focus of later breeding programs caused irrigation to decrease in importance for wheat and increase in importance for rice.

5.2.2 Development of Irrigation

The foundations of an extensive irrigation network were laid during the colonial era. At first, under the rule of the East India Company, irrigation projects were the domain of the army's engineering department. Later, when power was handed over to the British Crown, the responsibility for expanding irrigation was entrusted to the colonial Public Works Department. From very early on, however, colonial irrigation policy made a distinction between projects for famine relief called 'protective works' and projects for agricultural production called 'productive works' (Roy et al., 2011). The projects were either financed from the revenues of the colonial government or through loans raised from private investors in London. Beginning in the 1880s large canal irrigation projects were undertaken in the Indus plain in Sind and in the arid interfluves of Punjab (also called *doabs*) (Ali, 2004, p. 134). As a consequence of the projects 'the canal irrigated area in Punjab, excluding the princely states, increased from less then three million to around 14 million acres' between 1885 and 1947 (Banerjee, 1999, p. 36). Most of the increase in canal irrigated land took place in the canal colonies (Banerjee, 1999, p. 36). The canal colonies were extensive land settlement schemes that were initiated by the colonial authorities on the new canal irrigated tracts (Ali, 2004, p. 134). The canals made an immediate contribution towards agriculture. They converted the virtual deserts of Punjab and Sind into arable land, thereby, producing large gains in terms of net agricultural output (Stone, 2002, p. 4).

For British India as a whole the expanding irrigation network increased gross irrigated area as a proportion of net sown area from around 17% in 1886-95 to around 20% in 1935-36 (Chaudhary, Gupta, Roy, and Swamy, 2015, p. 105). During this period, some 28 million acres of irrigated area was added to the British India (Chaudhary, Gupta, Roy, and Swamy, 2015, p. 105). As discussed earlier, it was canal projects that made the largest contribution to the addition in irrigated area during this period. For instance, in 1936 almost 46% of the total area irrigated was fed through government canals, which is by far the highest contribution compared to any of the other sources (Chaudhary, Gupta, Roy, and Swamy, 2015, p. 105). However, the extent of canal irrigation outside of Punjab and Sind was limited.

As a consequence, the Partition gave most of British India's irrigated land to Pakistan. For instance, at the time of Partition nearly 8.8 million hectares out of a total of 28.2 million hectares of British India's irrigated area went to Pakistan (NCA, 1976b, p. 14). Recognizing the dearth of irrigated area the post-independence Indian state substantially expanded the irrigation infrastructure built during the colonial era. A number of new large canal irrigation projects 'like the Bhakra-Nangal, the Damodar Valley and the Hirakud' were taken up in the period immediately after Independence (NCA, 1976b, p. 14). An important feature of such an expansion was that irrigation development was uneven across states with historically canal irrigated states experiencing significant growth in irrigated area and other states lagging behind.

However, beginning in the late 1960s with the advent of the Green Revolution more minor irrigation projects were undertaken to rapidly expand irrigation beyond the historically canal irrigated states. The expansion came in the shape of minor irrigation works based on electrified tubewells (Rud, 2012, p. 353). Such minor works were categorised as high priority from the end of the third Five Year Plan onwards – the third Five Year Plan ended in 1965-66. There were several reasons behind the shift of focus towards electrified tubewells and away from canals. One was their ability to provide timely and adequate water supplies that was crucial for the introduction of HYV during the Green Revolution (NCA, 1976b, p. 20). Another, was their cost effectiveness which made them particularly attractive for small and medium sized farmers in areas without canal irrigation. The state financed extension of the electricity network across rural India and provision of credit to farmers were also factors behind the spread of electricity powered tubewells in particular (NCA, 1976b, p. 20).

Despite their importance to the Indian agricultural economy, only two major studies examine the impact of canals. One study argues that the construction of canals generated negative externalities such as water-logging, increased water salinity, reduced self-sufficiency in food and higher incidence of malaria (Whitcombe, 1995). However, the other study finds that canals increased yields, reduced adverse harvest fluctuations and raised average living standards (Stone, 2002). With a focus on the colonial era, neither study examines whether the influence of canals persists into the post-independence period.

5.3 Empirical strategy

The estimation strategy I use follows the same logic as a standard difference-in-differences approach. I compare the relative change in yields in the period after the start of the Green Revolution, relative to the pre Green Revolution period, between those areas that had more initial irrigation and those that had less. The main difference between my estimates and a standard difference-in-differences strategy is that I use a continuous measure for the intensity of treatment (i.e. initial irrigation) that allows me to capture more variation in the data.

In accordance with such a strategy, I use the following estimating equation to statistically document the relationship between initial irrigation and yields after the start of the Green Revolution:

$$\begin{aligned} yield_{cit} = \beta ProportionIrrigated_{i1957} \cdot I_t^{Post} + X_i' \cdot I_t^{Post} \phi \\ + \zeta Rainfall_{it} + \sum_a \gamma_a I_i^a + \sum_{j=1958}^{2009} \rho_j I_t^j + \epsilon_{cit}. \end{aligned} \tag{5.1}$$

Where, $yield_{cit}$ is the yield of crop c (wheat or rice), in district i, in year t. Moreover, $ProportionIrrigated_{i1957}$ is the proportion of cultivated area in district i that is irrigated in 1957. It measures the extent of initial irrigation in district i prior to the Green Revolution. I_t^{Post}, is an indicator variable that defines a single date for the onset of the Green Revolution across all districts. It is important to note that the literature does not precisely identify such a date. Therefore I estimate equation (5.1) separately using three alternative indicator variables to signify the onset of the Green Revolution. The reason for estimating equation (5.1) separately for the different start dates is to show that the relationship between initial irrigation and post Green Revolution yields is not dependent on any specific date for the Green Revolution. As such a date does not exist. The construction of each of the three indicator variables is explained in Section 5.4.2.

Furthermore, $X_i' \cdot I_t^{Post}$ are district-specific characteristics interacted with the post Green Revolution indicator. They control for factors at the district level that are correlated with initial irrigation. The characteristics included are altitude, the number of displaced persons per capita after the partition of British India in 1947, topsoil depth indicators, soil alkalinity indicators and aquifier indicators.

Moreover, I include measures of topsoil depth as controls because they contribute toward the productivity of the land and, therefore, influence irrigation. This is because topsoil is the outermost layer of soil that has the highest concentration of organic matter and micro-organisms crucial for plant growth. Specifically, a higher topsoil depth is positively correlated with crop yields and as a consequence reduces the water needs of the land.

I include measures of soil alkalinity to control for the fact that they influence irrigation and also have a direct impact on crop yields. Akaline soils reduce the infiltration capacity of the soil and, as a consequence, require copious amounts of irrigated water for plant growth[2].

Finally, I include measures of aquifier depth to account for the fact that they are a source of irrigation and also directly influence crop yields. Aquifiers are underground layers of water that at lower depths can be used for irrigation purposes.

The coefficient of interest in equation (5.1) is β, which is the estimated relationship between irrigation in 1957 and yields after the start of the Green Revolution. In particular, a positive value for β indicates that districts with more initial irri-

[2]Infiltration capacity is the process by which water on the ground surface manages to enter into the soil. It measures the rate at which soil is able to absorb water either through rainfall or irrigation.

gation are associated with a greater increases in yields after the start of the Green Revolution relative to before the Green Revolution.

I also include annual rainfall, $Rainfall_{it}$, as a control. The reason for including rainfall as a control is because it is strongly correlated with irrigation and also directly impacts crop yields. If there is sufficient rainfall in an area to cover the water needs of crops then irrigation is not required. On the other hand if rainfall is insufficient then water requirements need to be fulfilled through irrigation. Finally, irrigation is also used in some areas to supplement rain water.

Additionally, the main estimating equation also includes two important sets of fixed effects. The first are district fixed effects, $\sum_a \gamma_a I_i^a$, that control for all time invariant characteristics of the district. For instance, if a district has a rugged terrain that limits its irrigation network as well as lowers its crop yields, then to be able to get more precise estimates of the positive association between irrigation and post Green Revolution yields one needs to be able to control for the influence of the rugged terrain. A fixed effect at the district level not only controls for the influence of the rugged terrain, but also captures all other time-invariant characteristics by including a dummy variable for the district. The second set of fixed effects are year fixed effects, $\sum_{j=1958}^{2009} \rho_j I_t^j$, that control for any time-specific shocks such as earthquakes, flooding, land slides or dust storms that influence all districts equally in any particular year. Finally, I cluster standard errors by district.

Note that this paper only presents evidence that is consistent with more initial irrigation causing additional growth in yields after the start of the Green Revolution, and does not explicitly claim a causal relationship between the two variables.

Hence, its results should be considered as suggestive, but ultimately lacking a causal interpretation.

Furthermore, I carry out a series of robustness exercises to corroborate the results from the main estimating equation. First, I estimate the relationship between initial irrigation and two other major crops – sorghum and pulse – that are not water intensive. Since irrigation is not as effective at raising the yields of crops that have a lower water footprint, the results from such an estimation can be interpreted as a placebo experiment. I find that initial irrigation is not systematically related to post Green Revolution yields for either sorghum or pulse. Second, I replace the district fixed effects with state fixed effects. Third, in addition to the district fixed effects I also include agricultural region-specific time trends to account for any unobserved trending variables that may vary by the agricultural region. Fourth, I remove extreme values of initial irrigation from the dataset and re-estimate the relationship between initial irrigation and post Green Revolution yields. Finally, I show that the results are robust to clustering the standard errors by state rather than by district.

5.4 Data

In this section, I describe the data sources that are used in the empirical analysis. Moreover, where appropriate, I describe the construction of the main variables used in the analysis.

5.4.1 Irrigation and Crop Yields

The data on crop yields comes from the Indian Agriculture and Climate Dataset (IACD) and the Village Dynamics in South Asia dataset (VDSA). Both the IACD and the VDSA provide annual district level information on the area planted in hectares and output produced in tons for each of the five major crops – wheat, rice, maize, sorghum and millet – and also other non-major crops. The IACD covers 271 districts across thirteen states and the VDSA covers 281 districts across nineteen states. The panel I construct uses districts that appear consistently in both the IACD and the VDSA. I divide the output produced by the area planted to compute the district level yields in tons per hectare of the crops used in my empirical analysis.

The data on initial irrigation (i.e. 1957) comes from the IACD. The IACD provides annual information on irrigated area and cultivated area at the district level for the period 1957 to 1987. I use the proportion of cultivated area that is irrigated in 1957 as a measure for initial irrigation of districts prior to the Green Revolution.

5.4.2 Post Green Revolution Indicator Variable

To construct the indicator variable signalling the start of the Green Revolution I use annual district level data on the area planted to HYV of the five major crops of wheat, rice, maize, sorghum and pearl millet given in both the IACD and the VDSA. I first aggregate the area planted to HYV over all districts in each year to compute the annual area planted to HYV for all of India. I then aggregate the cultivated area over all districts in each year to compute the annual area cultivated for all of India. I then divide the annual area planted to HYV with the annual area cultivated to compute the annual share of cultivated area that is devoted to HYV for all of India.

Finally, I use the shares to construct three different indicator variables, each signifying a different date for the start of the Green Revolution. The first indicator variable equals one from the first year in which the share of cultivated area that is devoted to HYV in India goes above 0%, and zero otherwise. The second equals one from the first year in which the share goes above 2%, and zero otherwise. Finally, the third takes on a value of one from the first year in which the share goes above 4%, and zero otherwise.

5.4.3 Colonial Canal Irrigation

I use the Agricultural Statistics Reports of British India to construct the variable for historical canal irrigation. The reports were published on an annual basis by the Department of Revenue and Agriculture of the Colonial government. They contain annual information at the district level for area irrigated through government canals and the net area sown. I divide the area irrigated through government canals for 1931 by the net area sown in 1931 to compute the proportion of net sown area that is irrigated through government canals in 1931. My choice of 1931 as the date to measure historical canal irrigation is driven by the fact that by the 1930s the expansion of the irrigation infrastructure during the colonial period had been more or less completed.

5.4.4 Additional controls

The annual data on rainfall (in millimetres) at the district level comes from the VDSA (1966 to 2009) and the Indian Meteorological Department (1957 to 1965).

Additionally, the IACD includes information on the mean altitude (in metres) of the geographic centre of districts, five dummy variables representing different ranges of top soil depth in centimetres, five dummy variables giving different ranges of soil alkalinity in pH and three dummy variables giving different ranges of aquifier thickness in metres. I include the interaction of all such district specific characteristics with the Green Revolution dummy as controls in the baseline specification. Finally, I interact the number of displaced persons per capita at the district level from the 1951 census with the post Green Revolution dummy and include it as a control in my analysis.

5.4.5 Matching Historical Data to Post-Independence Data

The mapping procedure I use to match the 1931 data on historical canal irrigation with the post-independence data on agricultural outcomes given in the IACD and VDSA datasets includes the following steps: First, I superimpose the shapefile for 1931 district level administrative map of India over the shapefile for 1953 district level administrative map of India using the ARC-GIS software. I then used the 'UNION' function with the 'Use Ratio Policy' option in ARC-GIS to combine the polygons in the two shapefiles. The resulting output in the attributes table gives the areas of 1953 district that were linked to different districts in 1931. I then divide the areas by the total area of the 1953 district to compute the proportion of 1953 district areas that are linked to different districts in 1931. Finally, I use the proportions to come up with values for the data given IACD and VDSA datasets based on the 1931 district boundaries.

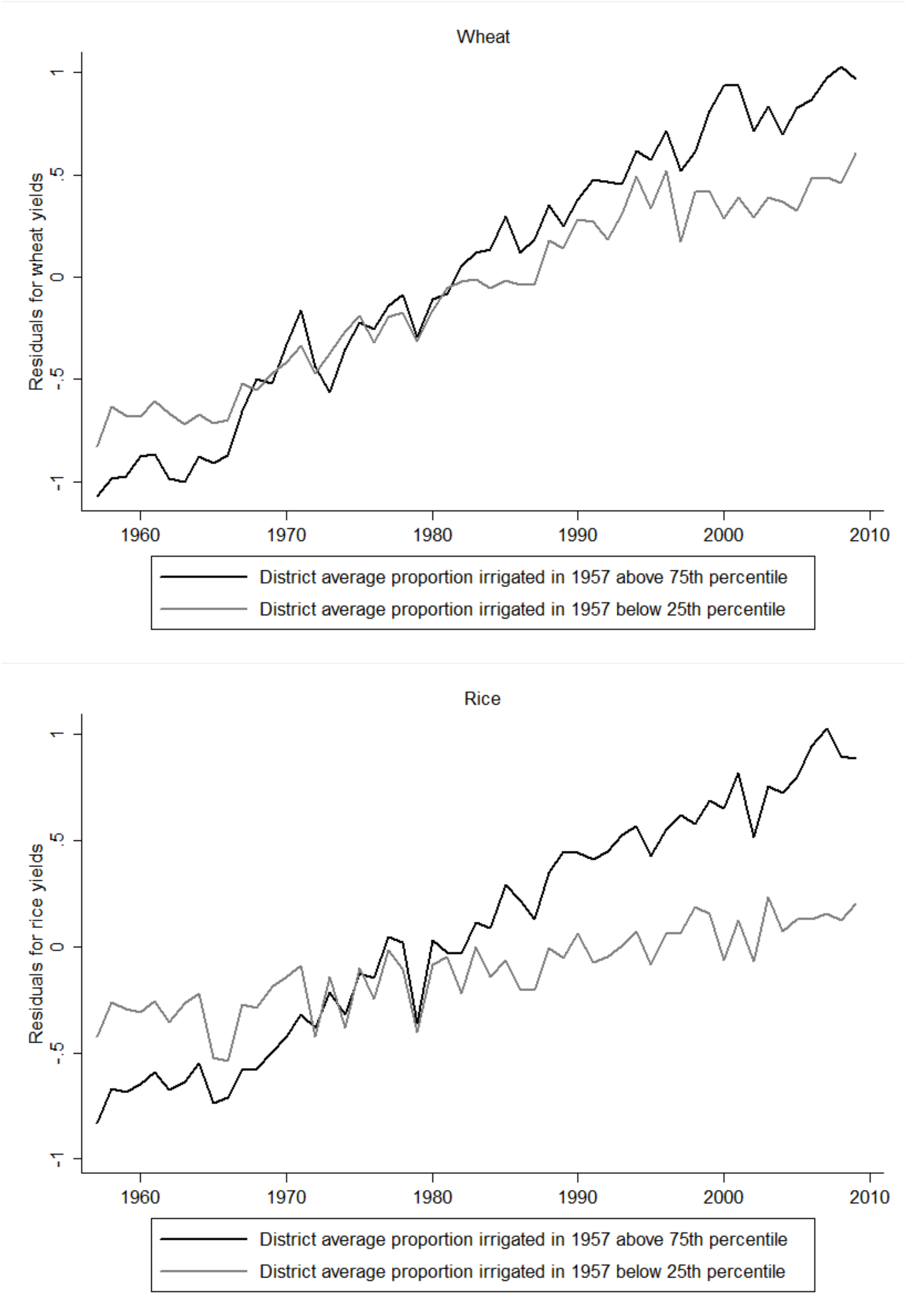
5.4.6 Summary statistics

I show the summary statistics used in this paper in Table 5.1. District level wheat and rice yields in the panel average 1.490 and 1.361 tons per hectare, respectively. The initial (i.e. 1957) district level proportion of cultivated area that is irrigated averages 18.4%. Figure 5.2 shows the relationship between initial irrigation and rice and wheat yields for the period from 1957 to 2009. For wheat, districts with high initial irrigation experienced an increase in yields relative to low initial irrigation districts during the period immediately after the start of the Green Revolution. Then, from the mid 1970s onwards, yields between districts with high and low levels of initial irrigation remain broadly similar. In the case of rice, though, the trend is different. Rice yields of high initial irrigation districts diverge from those of low initial irrigation districts in the late 1970s and keep on diverging from then on until 2009.

Additionally, Figure 5.2 shows that the trends in average wheat and rice yields are similar between high and low initial irrigation districts for the period between 1957 and the late 1960s. Since the late 1960s coincides with the Green Revolution, such a trend is indicative of no systematic difference in yields between high and low initial irrigation districts prior to the Green Revolution.

Table 5.1 also provides information on a series of characteristics of districts in the sample. The average altitude across districts is 353 metres. The average annual rainfall at the district level is 1028 millimetres. The average number of displaced persons per capita in 1951 at the district level is 0.02. Of the total districts in the sample, 23% have a high count for their soil alkalinity that is between 4.5 pH and 5.5 pH; 45% have a topsoil depth that is above 300 centimetres; and 8.2% have an

Figure 5.2: Initial Irrigation and Yields: Trends



Notes: A High (or Low) irrigation district is defined as one where the proportion of cultivated area that is irrigated is above the 75th percentile (or below the 25th percentile) value based on the sample of districts in 1957.

aquifier depth above 150 metres. The baseline results control for all these district specific characteristics.

5.5 Results

Table 5.2 presents the results from estimating equation (5.1) for three alternative start dates of the Green Revolution. The reason for using three alternatives dates is to show that the results are not driven by any specific start date of the Green Revolution. Although literature suggests that the Green Revolution in India started in the late 1960s, the exact date of its start is not identified.

Columns (1) and (2) report the estimated coefficients for the correlation between initial irrigation and post Green Revolution yields using an indicator for Green Revolution that takes on a value of one from the first year in which HYV acreage in India goes above 0% (i.e. 1966). Columns (3) and (4) use a post Green Revolution indicator that equals one from the first year in which HYV acreage in India goes above 2% (i.e. 1967). Finally, columns (5) and (6) use a post Green Revolution indicator that equals one from the first year in which HYV acreage in India goes above 4% (i.e. 1968). Panel (A) shows the results for wheat yields and Panel (B) shows the results for rice yields. In all cases results are presented for models with and without the additional controls discussed in Section 5.4. Including the controls reduces the magnitude of the estimated coefficients but does not make much of a difference to their significance levels.

The estimated coefficients of the interaction term, $ProportionIrrigated_{i1957} \cdot I_t^{Post}$, show that districts with more initial irrigation are associated with greater increases in rice and wheat yields on average after the start of the Green Revolution. Specifically, the coefficient in column (2) of Panel (A) shows that a 10-percentage point increase in the proportion of cultivated land that is irrigated in 1957 is associated with a 0.0466 tons per hectare increase in wheat yields on average after the start of the Green Revolution.[3] Since 0.0466 is 3.2% of the mean wheat yields of 1.456 tons per hectare based on the regression sample, it represents a substantial increase. Moreover, the coefficient in column (2) of Panel (B) shows that a 10-percentage point increase in the proportion of cultivated area that is irrigated in 1957 is associated with a 0.0765 tons per hectare increase in rice yields on average after the start of the Green Revolution.[4] As 0.0765 is 5.8% of the mean rice yields of 1.331 tons per hectare based on the regression sample, again, it represents a substantial increase.

The baseline results can be put in the context of the impacts found for other public infrastructure projects examined in the literature. Specifically, these include the *0.33* increase in number of hectares planted to HYV from a 100 rupee increase in irrigation investment found in villages across India during the Green Revolution (Baird, 2003), the *0.34*% increase in agricultural production and the *0.19*% increase in yields found in downstream districts from the construction of dams in India (Duflo and Pande, 2005) and the *16*% increase in agricultural income found in an average district of India from the arrival of railroads (Donaldson, 2010).

5.6 Mechanisms

The analysis in the previous section documents the statistical relationship between irrigation prior to the Green Revolution and yields after the start of the Green

[3] To arrive at this I multiply the coefficient estimate of 0.466 from column (2) of Panel (A) by 0.1 which gives 0.0466.

[4] To arrive at this I multiply the coefficient estimate of 0.765 from column (2) of Panel (B) by 0.1 which gives 0.0765.

Revolution across districts in India. A number of possible mechanisms explain the association between initial irrigation and post Green Revolution yields. While it would be ideal to uncover all possible mechanisms, data limitations mean that this is not possible. Therefore, this Section uses (1) heterogeneity in the relationship between initial irrigation and post Green Revolution yields across crops and over time, and (2) historical data on canal irrigation to reduce the set of plausible mechanisms.

5.6.1 Effects over time and across crops

Having established a positive relationship between initial irrigation and post Green Revolution yields for both wheat and rice, I now exploit the fact that my data spans 52 years, between 1957 – 2009, to explore how the relationships have changed over time. The following fully flexible estimating equation is used to analyze how the relationships evolve over time:

$$\begin{aligned} yield_{cit} = & \sum_{j=1958}^{2009} \beta_j ProportionIrrigated_{i1957} \cdot I_t^j + \sum_{j=1958}^{2009} X_i' I_t^j \phi_j \\ & + \zeta Rainfall_{cit} + \sum_a \gamma_a I_i^a + \sum_{j=1958}^{2009} \rho_j I_t^j + \epsilon_{cit}. \end{aligned} \tag{5.2}$$

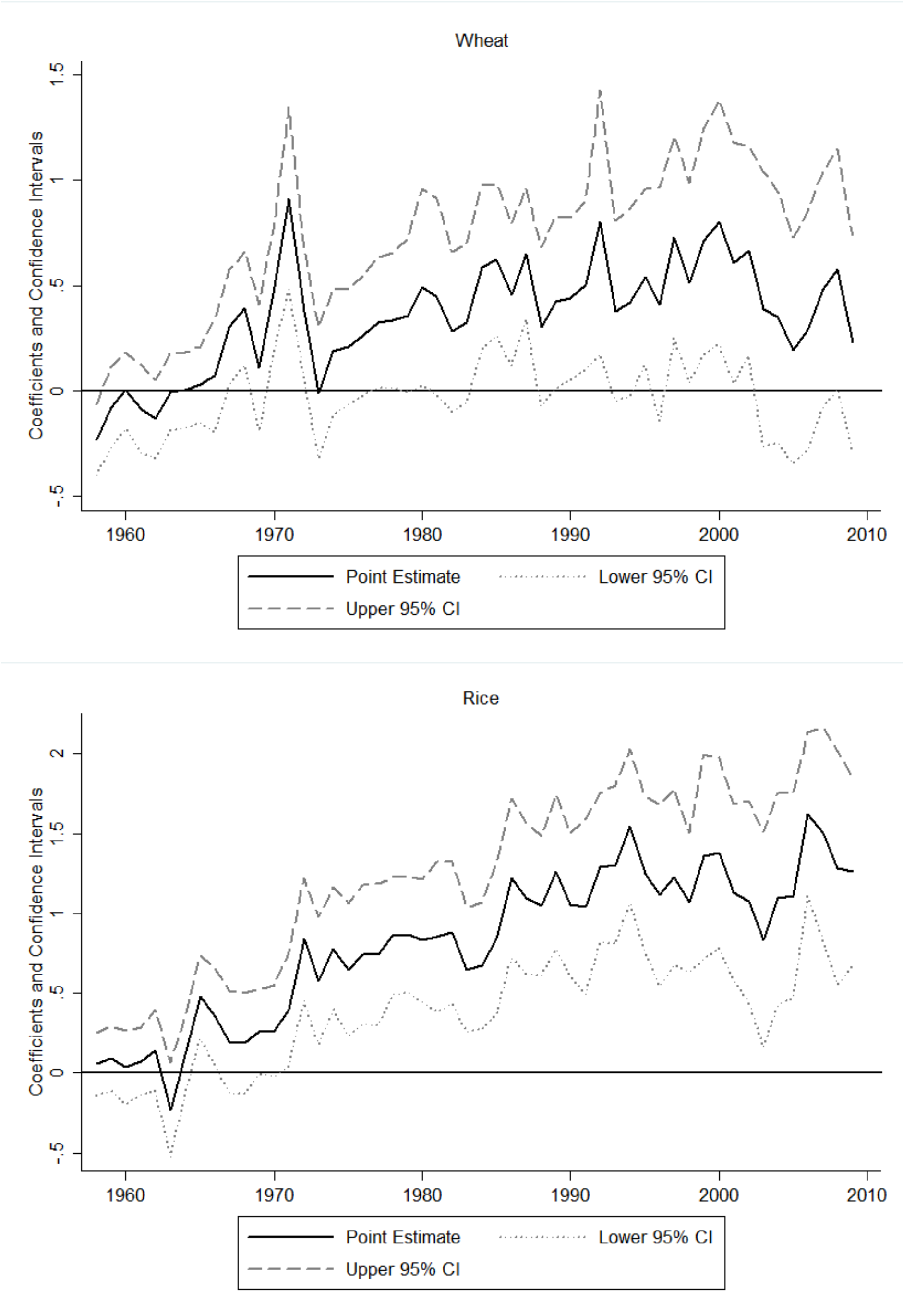
Where there are two differences from equation (5.1). First, in equation (5.2), rather than interacting the initial irrigation measure, $ProportionIrrigated_{i1957}$, with the post Green Revolution indicator variable, I interact it with each of the year fixed effects. The second difference is that rather than interacting the district specific characteristics, X_i', with the post Green Revolution indicator variable, I interact them with each of the year fixed effects. The estimated β_j's then give the estimated relationship between initial irrigation and yields at the district level in each year of the sample.

If for instance, the Green Revolution is associated with an immediate increase in yields in irrigated districts, then the estimated β_js would be more or less stable over the years prior to the introduction of HYV and would increase in magnitude around the time of the Green Revolution. Furthermore, depending on how later generations of HYV respond to irrigation, the estimated β_js would either increase or decrease over time. I estimate equation (5.2) separately for wheat and rice to explore the heterogeneity in the relationship between initial irrigation and yields both across crops, as well as over time.

Figure 5.3 plots the estimated β_js from regressing the fully flexible estimating equation (5.2) for both wheat and rice. Different patterns emerge for wheat and rice over time. For wheat, the relationship between initial irrigation and yields increases in magnitude around the time of the Green Revolution in the late 1960s. Then, we see that areas with low initial irrigation catch up with areas with high initial irrigation relatively quickly and remain similar until 2009. For rice, the positive association between initial irrigation and yields increases in magnitude around the time of the Green Revolution. However, unlike in the case of wheat, areas with low initial irrigation do not manage to catch up later on. Instead, the positive yield gap between high and low initial irrigation areas continues to widen until 2009.

The patterns reflect differences between the later generation of rice and wheat varieties that were developed after the start of the Green Revolution. While for wheat the later varieties were adopted in rain-fed areas that were deficient in irrigation infrastructure, the adoption of later generation rice varieties was difficult

Figure 5.3: Effects of initial irrigation over time: wheat and rice



Notes: The figure shows flexible estimates of the relationship between the proportion of land irrigated in 1957 (i.e. initial irrigation) and wheat or rice yields over time.

in rain-fed areas. During the period from 1977 to 1990, most of the increase in the area of HYV of wheat occurred in rain-fed areas in contrast to the earlier period, which was spearheaded by the adoption of HYV in irrigated areas (Byerlee and Moya, 1993, p. xi). On the other hand, the 'uncertainty of adequate moisture' and the 'flooded conditions' made adopting later generation of rice varieties difficult for farmers in rain-fed areas (Barker, Herdt, and Rose, 1985, p. 6). Instead, the newer rice varieties improved yields substantially in already irrigated areas, thereby increasing the importance of irrigation (Barker, Herdt, and Rose, 1985, p. 6).

5.6.2 Persistence of Colonial Irrigation

A growing literature delves deeper into the colonial roots of under-development in India. In particular, the public infrastructure and institutions established during the colonial period have been shown to persist into the post-colonial period and explain regional differences in contemporary development outcomes (Banerjee and Iyer, 2008; Acemoglu, Johnson, and Robinson, 2000; Engerman and Sokoloff, 1997). Irrigation is a public infrastructure whose foundations were laid during the colonial period. Its relevance in explaining differences in yields after the start of the Green Revolution makes it important to ask whether its influence is rooted in investments made during that time.

During the colonial era, irrigated area as a proportion of total cropped area increased from around 5-6% in the early nineteenth century to 22% in 1938 (Roy et al., 2011, p. 3). It was large scale government canals that were responsible for around 60% of the total addition in irrigated area during that period (Roy et al., 2011, p. 3). The irrigation network constructed during the colonial era was expanded by the post-independence state in the period following the partition. However, it was not until after the start of the Green Revolution, in the late 1960s, when it became apparent that irrigation was crucial to HYV adoption, that there was an acceleration in the expansion of the irrigation network (Fitzgerald-Moore and Parai, 1996, p. 4). This meant that there was a high level of persistence between colonial irrigation and post-independence irrigation prior to the Green Revolution. However, once the expansion of the irrigation network picked up pace after the start of the Green Revolution, the influence of colonial irrigation started to decline.

I present two pieces of evidence that are consistent with such a trend. First, as Figure 5.4 shows, there is a strong positive correlation between colonial canal irrigation and the post-independence measure of irrigation from 1957 used in the baseline results.

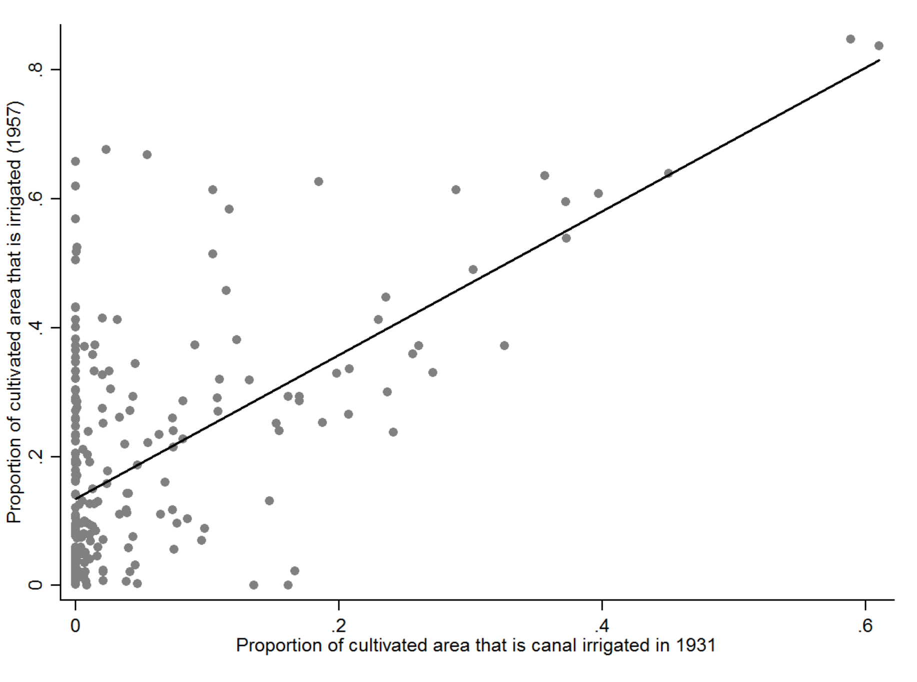
Next, I exploit the fact that I have annual data on irrigation from 1957 to 2009 to explore how the influence of colonial canals shown by Figure 5.4 evolves over time. To do so, I estimate equation (5.3) below. The β_ts give the estimated relationships between colonial canals and irrigation in each year of the period from 1957 to 2009.

$$ProportionIrrigated_{it} = \beta_t ProportionIrrigated_{i1931} + \sum_a \gamma_a I_i^a + X_i'\phi + \epsilon_{it} \quad (5.3)$$

Figure 5.5 plots the 95% confidence intervals of the estimated β_ts over time. This Figure shows that prior to the Green Revolution in the late 1960s, the influence of colonial canals over irrigation remains stable, but starts to decline in the period after the start of the Green Revolution from the 1970s onward.

Having provided evidence for persistence between colonial canals and post independence irrigation prior to the Green Revolution, I now examine whether it was

FIGURE 5.4: Relationship between colonial and post-independence irrigation: I

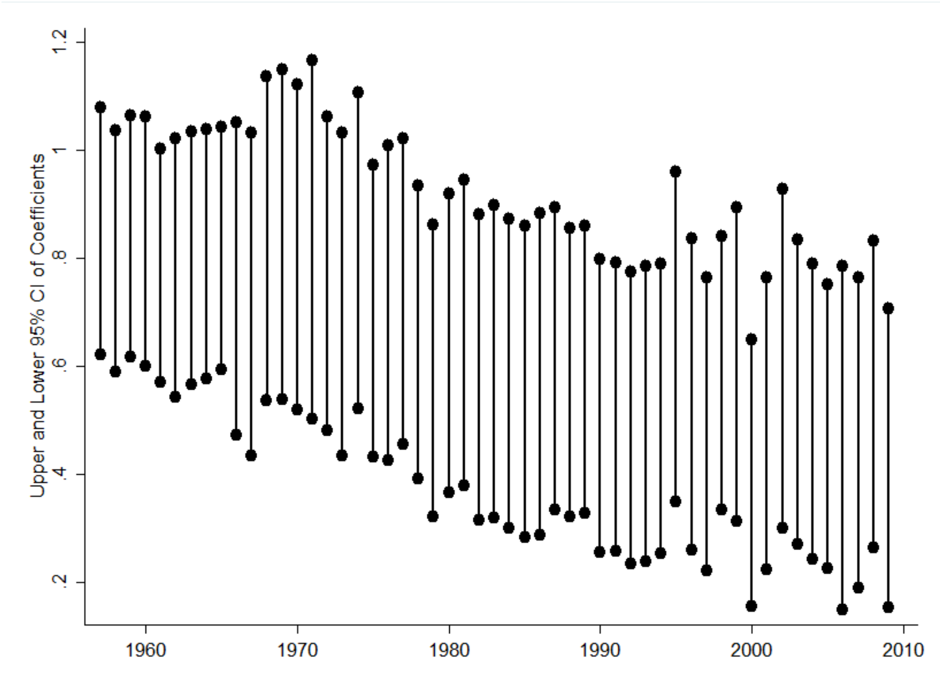


Notes: The linear trend shown in the figure holds even after dropping extreme values from the sample.

colonial canals that were responsible for the positive relationships shown in the baseline results. Accordingly, Table 5.3 replaces the interaction between the initial irrigation measure and post Green Revolution dummy used in the baseline specification with the interaction between the colonial canal irrigation measure from 1931 and post Green Revolution dummy. The results show that colonial canal irrigation is positively associated with increases in both rice and wheat yields after the start of the Green Revolution.

The results offer two important insights into the positive relationships between irrigation and yields. First, they provide evidence that it was districts with greater historical investments in canals that were better able to adopt HYV and raise their yields after the start of the Green Revolution. Given that the impacts of colonial investments in public infrastructure persist into the post colonial period,

FIGURE 5.5: Relationship between colonial and post-independence irrigation: II



Notes: Equation (5.3) is estimated separately for each year and the confidence intervals for the coefficients on $ProportionIrrigated_{i1931}$ are plotted.

my results are a validation of other findings in the literature. Second, they suggest that from the different sources of irrigation such as canals, tubewells and tanks, investments in canals was key to long-term influence over yields.

5.6.3 Robustness checks

The baseline results in Table 5.2 show that areas with more irrigation prior to the Green Revolution witnessed faster increases in yields for both wheat and rice after the start of the Green Revolution. The results were obtained after controlling for district fixed effects, year fixed effects, annual rainfall at the district level and a baseline set of district characteristics interacted with year fixed effects. In this section, I carry out a series of empirical exercises to further reinforce the baseline results.

First, Table 5.4 shows the relationship between initial irrigation and post Green Revolution yields for two other crops aside from wheat and rice that have lower water requirements. The crops are sorghum and pulse. If the positive associations shown in the baseline results are attributable to irrigation, then they should not hold for crops that are not water intensive. Sorghum is generally grown under 'dryland conditions' (Evenson and Gollin, 2003a, p. 758) 'with limited water resources and usually without application of any fertilizers or other inputs' (F.A.O, 1995), and so is one such crop. Moreover, pulse that is 'well adapted to semi-arid regions', uses 'less water' and is 'drought tolerant' (ICRISAT, 2016) is another example of a crop with a low water footprint. As the results in Panel (A) and (B) of Table 5.4 show, irrigation prior to the Green Revolution is not correlated with post Green Revolution yields for either sorghum or pulse, further reaffirming the baseline results.

Second, in Table 5.5 I show that the baseline results are robust to the use of alternative fixed effects at the state level. The objective is to show that examining the relationship for alternatively defined comparison groups (i.e. states) continues to obtain the positive association between initial irrigation and post Green Revolution yields shown in the baseline estimates. Hence, in all columns of Panel (A) and (B) of Table 5.5 I replace district fixed effects with state fixed effects. The results are broadly similar to the baseline estimates.

Third, in Table 5.6 I account for the possibility of any unobserved linear trends at the level of the agricultural region influencing the relationship between initial irrigation and post Green Revolution yields in the baseline specification. Accordingly, columns 1 to 9 of Panels (A) and (B) include the interaction between the agricultural region dummy and the post Green Revolution dummy. The inclusion of the trends does not substantially alter the baseline results.

Next, in Table 5.7 I show that the positive association between initial irrigation and post Green Revolution yields does not depend on extreme values of the initial irrigation measure used in the baseline specification. Accordingly, I drop districts that have a value for the initial irrigation measure that is either below the 10th percentile (top Panel) or above the 90th percentile (bottom Panel). The estimated relationship remains positive and significant for both wheat and rice yields despite the exclusion of the extreme values.

Finally, in Table 5.8 I show the robustness of the baseline results to clustering standard errors by state rather than by districts in the sample. The clustering of standard errors by state accounts for any serial dependence across observations within states. As is clear from Table 5.8, the standard errors clustered by state are very similar to the standard clustered by district in the baseline.

5.7 Conclusion

This paper shows that districts with an advantage in irrigation infrastructure prior to the Green Revolution experienced greater increases in rice and wheat yields after the start of the Green Revolution in India. While studies exist that examine the role of irrigation in influencing both the adoption of HYV and crop yields, this paper contributes to such a literature in several ways. First, it examines the relationship between initial irrigation and yields separately for wheat and rice and shows that the influence of initial irrigation differed across the two crops over time. While for wheat initial irrigation is positively associated with increases in yields immediately following the Green Revolution, its influence decreases in subsequent periods. On the other hand, initial irrigation is positively associated with increases in rice yields throughout the period post the Green Revolution. Second, by focusing on India, the paper is able to analyze the relationship between irrigation and crop yields amongst areas that have similar political and administrative arrangements, which is not the case with cross-country studies. Finally, this paper shows that the positive relationships between initial irrigation and post Green Revolution yields shown in the baseline results originate from investments in canal infrastructure made during the colonial period.

Table 5.1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
A.Dependent Variables					
Wheat Yields (tons per hectare)	12754	1.49	0.89	0	5.16
Rice Yields (tons per hectare)	13441	1.36	0.82	0	5.54
B.Irrigation Variables					
Net irrigated area (1000s hectares)	12479	146.29	141.41	0	1012.64
Cultivated area (1000s hectares)	12479	497.63	263.05	0.5	1701.79
Proportion of cultivated area irrigated	12479	0.31	0.26	0	1
Proportion of cultivated area irrigated in 1957	270	0.18	0.18	0	0.84752
Proportion of cultivated area canal irrigated in 1931	256	0.05	0.10	0	0.61
C.Green Revolution Variables					
Area planted to HYV of major crops (000s hectares)	11196	116.12	155.73	0	1292.14
Proportion of cultivated area planted to HYV of major	11196	0.21	0.23	0	1
D.Geography and Climate Variables					
Annual Rainfall (millimeters)	13981	1027.79	584.37	8	5399
Altitude (m)	270	353.32	139.47	33	906
Top Soil Depth (thickness> 300 cm)	269	0.46	0.50	0	1
Soil strongly alkali (4.5<pH<5.5)	270	0.23	0.42	0	1
Aquifier (thickness> 150 m)	269	0.082	0.275	0	1
E.Other Control Variables					
Proportion of displaced persons in 1951	269	0.02	0.06	0	0.37

Notes: The unit of observation is a district and year.

Table 5.2: Initial irrigation and wheat & rice yields with alternative definitions of post GR

	1957-1965; Post=1966-2009		1957-1966; Post=1967-2009		1957-1967; Post=1968-2009	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Wheat					
Proportion irrigated (1957) x Post	1.193***	0.466***	1.178***	0.464***	1.153***	0.438***
	(0.178)	(0.121)	(0.173)	(0.119)	(0.171)	(0.117)
Observations	12508	12126	12508	12126	12508	12126
Mean of dependent variable	1.484	1.456	1.484	1.456	1.484	1.456
	Panel B: Rice					
Proportion irrigated (1957) x Post	1.268***	0.765***	1.258***	0.757***	1.278***	0.771***
	(0.186)	(0.153)	(0.184)	(0.149)	(0.185)	(0.150)
Observations	13120	12720	13120	12720	13120	12720
Mean of dependent variable	1.349	1.331	1.349	1.331	1.349	1.331
1961 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: In columns 1 to 2 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. In columns 3 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 2%, and zero otherwise. Finally, in columns 5 to 6 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 4%, and zero otherwise. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

Table 5.3: Colonial canal irrigation and wheat & rice yields with alternative definitions of post GR

	1957-1965; Post=1966-2009		1957-1966; Post=1967-2009		1957-1967; Post=1968-2009	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Wheat					
Proportion canal irrigated (1931) x Post	2.806***	1.112***	2.768***	1.116***	2.724***	1.074***
	(0.248)	(0.241)	(0.250)	(0.241)	(0.246)	(0.234)
Observations	11935	11609	11935	11609	11935	11609
Mean of dependent variable	1.477	1.451	1.477	1.451	1.477	1.451
	Panel B: Rice					
Proportion canal irrigated (1931) x Post	1.973***	0.723**	1.929***	0.672**	1.961***	0.702***
	(0.388)	(0.302)	(0.385)	(0.295)	(0.388)	(0.302)
Observations	12464	12107	12464	12107	12464	12107
Mean of dependent variable	1.356	1.337	1.356	1.337	1.356	1.337
1961 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: In columns 1 to 2 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. In columns 3 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 2%, and zero otherwise. Finally, in columns 5 to 6 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 4%, and zero otherwise. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

Table 5.4: Initial irrigation and yields of other crops with alternative definitions of post GR

	1957-1965; Post=1966-2009		1957-1966; Post=1967-2009		1957-1967; Post=1968-2009	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Sorghum					
Proportion irrigated (1957) x Post	0.114	0.184	0.071	0.148	0.075	0.148
	(0.108)	(0.118)	(0.107)	(0.119)	(0.106)	(0.121)
Observations	11745	11371	11745	11371	11745	11371
Mean of dependent variable	0.708	0.704	0.708	0.704	0.708	0.704
	Panel B: Pulse					
Proportion irrigated (1957) x Post	0.068	-0.141*	0.027	-0.091	0.015	-0.051
	(0.069)	(0.077)	(0.062)	(0.074)	(0.058)	(0.075)
Observations	12082	11701	12082	11701	12082	11701
Mean of dependent variable	0.564	0.556	0.564	0.556	0.564	0.556
1961 District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: In columns 1 to 2 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. In columns 3 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 2%, and zero otherwise. Finally, in columns 5 to 6 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 4%, and zero otherwise. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

Table 5.5: Alternative fixed effects

	1957-1965; Post=1966-2009		1957-1966; Post=1967-2009		1957-1967; Post=1968-2009	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Wheat					
Proportion irrigated (1957) x Post	0.744***	0.642***	0.764***	0.650***	0.781***	0.652***
	(0.147)	(0.120)	(0.147)	(0.120)	(0.148)	(0.121)
Observations	12508	12126	12508	12126	12508	12126
Mean of dependent variable	1.484	1.456	1.484	1.456	1.484	1.456
	Panel B: Rice					
Proportion irrigated (1957) x Post	0.789***	0.609***	0.813***	0.623***	0.845***	0.645***
	(0.133)	(0.136)	(0.134)	(0.137)	(0.136)	(0.139)
Observations	13120	12720	13120	12720	13120	12720
Mean of dependent variable	1.349	1.331	1.349	1.331	1.349	1.331
1961 State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: In columns 1 to 2 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. In columns 3 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 2%, and zero otherwise. Finally, in columns 5 to 6 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 4%, and zero otherwise. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

Table 5.6: Including agricultural region-specific time trends

	1957-1965; Post=1966-2009			1957-1966; Post=1967-2009			1957-1967; Post=1968-2009		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Panel A: Wheat								
Proportion irrigated (1957) x Post	0.449***	0.299**	0.140	0.434***	0.295**	0.136	0.408***	0.268**	0.108
	(0.138)	(0.131)	(0.111)	(0.136)	(0.130)	(0.112)	(0.136)	(0.127)	(0.110)
Observations	12508	12179	12126	12508	12179	12126	12508	12179	12126
Mean of dependent variable	1.484	1.458	1.456	1.484	1.458	1.456	1.484	1.458	1.456
	Panel B: Rice								
Proportion irrigated (1957) x Post	0.896***	0.708***	0.634***	0.889***	0.703***	0.628***	0.914***	0.720***	0.642***
	(0.173)	(0.161)	(0.149)	(0.171)	(0.160)	(0.146)	(0.171)	(0.160)	(0.146)
Observations	13120	12773	12720	13120	12773	12720	13120	12773	12720
Mean of dependent variable	1.350	1.333	1.331	1.350	1.333	1.331	1.350	1.333	1.331
1961 District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls 1	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls 2	No	No	Yes	No	No	Yes	No	No	Yes

Notes: In columns 1 to 2 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. In columns 3 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 2%, and zero otherwise. Finally, in columns 5 to 6 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 4%, and zero otherwise. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls 1 are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy. Controls 2 are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

TABLE 5.7: Results with outliers removed

	Wheat		Rice	
	(1)	(2)	(3)	(4)
	Drop Highest 1957 Irrigation Decile Districts			
Proportion irrigated (1957) x Post	0.960***	0.306*	1.541***	1.172***
	(0.230)	(0.171)	(0.226)	(0.199)
Observations	11657	11319	11966	11622
	Drop Lowest 1957 Irrigation Decile Districts			
Proportion irrigated (1957) x Post	1.093***	0.396***	1.188***	0.698***
	(0.192)	(0.131)	(0.196)	(0.161)
Observations	11184	10805	11884	11484
1961 District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Notes: In columns 1 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. The results from other definitions of of the Post dummy (not presented here) are similar. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifer dummies interacted with post dummy.

Table 5.8: Alternative clustering

	Wheat		Rice	
	(1)	(2)	(3)	(4)
Proportion irrigated (1957) x	1.193**	0.466**	1.268***	0.765***
s.e. clustered by 1961 state	(0.443)	(0.157)	(0.413)	(0.227)
s.e. clustered by 1961 district	(0.178)	(0.121)	(0.186)	(0.153)
Observations	12508	12126	13120	12720
Mean of dependent variable	1.484	1.456	1.349	1.331
1961 District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Notes: In columns 1 to 4 the Post dummy takes a value one from the first year in which the share of HYV acreage in India goes above 0%, and zero otherwise. The results from other definitions of of the Post dummy (not presented here) are similar. ***Significant at 1%, **Significant at 5%, *Significant at 10%. Standard errors clustered by 1961 district in parentheses. Yields are measured in tons per hectare. All regressions are OLS. Controls are annual rainfall, altitude interacted with post dummy, proportion of displaced persons in 1951 interacted with post dummy, 5 topsoil depth dummies interacted with post dummy, 5 soil alkalinity dummies interacted with post dummy and 3 aquifier dummies interacted with post dummy.

Chapter 6

Religion, Land and Politics: Shrines and Literacy in Punjab

6.1 Introduction

It is a well-received wisdom that human capital is a key determinant of the wealth of a nation. In fact, long-term prosperity is unthinkable without an educated population. A large body of theoretical and empirical research has examined the role of human capital in advancing development (Klenow and Rodriguez-Clare, 2005; Glaeser, La Porta, Lopez-de Silanes, and Shleifer, 2004; Gennaioli, Porta, Lopez-de Silanes, and Shleifer, 2011). This begs the question: What explains the substantial variation in literacy rates across and within developing countries? And, why some countries are condemned to persistently low levels of literacy? In thinking about constraints to human capital development, the earlier literature emphasized largely proximate explanations focusing on the role of expenditures, inputs and adverse resource endowments. But, as the growing literature on political economy argues, determinants of development are often deep, rooted in the underlying structure of economic and political inequality (Acemoglu and Robinson, 2012). This applies equally to education: schooling differences across countries are grounded in history and political economy (Gallego, 2010; Acemoglu, Gallego, and Robinson, 2014).

Taking a cue from this literature, we investigate how the initial configuration of economic, political and religious power might have shaped patterns of literacy across Pakistani Punjab. Specifically, we examine the role played by the confluence of land inequality, concentration of religious shrines and political power. Our main argument is that religious power, measured by the concentration of shrines, only matters for literacy when these shrines own more land and exercise greater political power manifested through direct electoral participation. We argue that this interplay between religion, land and politics constitutes a powerful structural inequality with potentially adverse consequences for development.

Why should religious power matter for development outcomes? The shrines of great sufi mystics, who played a leading role in spreading Islam, occupy a prominent place in the religious, cultural and political life of South Asia. They were also immersed in the local rural economy, and acted as important nodes of political power. They are often structurally positioned within the prevailing economic and political systems. Shrine caretakers *sajjada nashins* command tremendous respect and influence among their vast network of devotees. The unquestionable allegiance of their followers converts them into important intermediaries between, not just God and man, but also between the state and its subjects. This power of intermediation is particularly important in peripheral regions, where, due to weak power of the central state, rulers had greater dependence on local elites for political support. Shrine elites have traditionally acted as brokers of centralized power throughout history – from Mughal rule and the Sikh interregnum to colonial India and post-partition Pakistan.

While the state, its functionaries and non-religious local elites seek legitimacy from these shrine families, the guardians of these shrines, in turn, use this dependence to access state patronage and other privileges that help them to consolidate their power. In a sense, the power and influence enjoyed by shrine families resembled those of local chiefs and notables of Punjab. In line with Peter Brown's description of Christian saints as "patrons par excellence", the shrine guardians serve as a crucial link between the rural populace and the state, binding the *pirs* (Sufi saints centred at shrines) and their followers, known as *murids*, in a patron-client relationship. Over time, continued state patronage has made prominent shrine families into large landowners. In many areas of Punjab they are both spiritual and feudal masters, appropriately termed as *pir-zamindars*.

This linkage between piety and privilege has profound implications for prosperity. The power of the *pir* is reinforced in a hierarchical society that is based on loyalty, obedience and superstition. The *pir* often acts as the overlord of an exploitative structure, where any material and human uplift is viewed as a threat. As Sir Malcolm Darling presciently observed in his seminal work, *The Punjab Peasant*:

> "Worst of all, both landlord and pir are instinctively opposed to the two movements from which the ordinary cultivator has most to hope. Neither education nor cooperation has their sympathy, for both strike at the regime which it is their one object to maintain" (Lyall, 1928, p. 100).

A more recent assessment on Pakistan by Anatol Lieven echoes the same concern: "in practice the *pirs* and their families cannot genuinely advance either local education or local democracy, as this would strike directly at the cultural and social bases of their own power" (Lieven, 2011, p. 138). In fact, the literature is replete with references to the *pir's* resistance to educational progress. To famous historian, K. K. Aziz, this is unsurprising. “How could a *pir*”, he asks, “countenance any prospect for the education of the masses when his supremacy, status and income depended on their ignorance and superstition?” (Aziz, 2001, p. 27). He goes on to argue:

> “The *pir-zamindar*, in order to protect his supremacy against any plebeian questioning and to retain intact the loyalty of his followers, discourages the spread of education in his area. Even the most superficial and inferior kind of public instruction and the ensuing rents in the veil of ignorance might push some of his spiritual slaves out of their prison of superstition and unthinking obedience. Education is a plague which he does not want his flock to catch” (Aziz, 2001, p. 159).

While prior literature has commented on the possible impact of shrines on local development, this paper conducts a first systematic enquiry into the subject. We empirically examine whether the presence of shrines explains regional variation in literacy rates across Punjab. Our focus on Punjab is guided not just by a pragmatic concern – the availability of data on literacy by *tehsils* – but the central role of Punjab in the transmission of Islam's mystical influence in South Asia. Interspersed between Central Asia and the heartlands of India, Punjab is home to some of the oldest sufi orders of India. It has a rich tradition of saintly presence: tombs of famous saints have traditionally been important meeting points for religious, economic and political exchange. Shrines are a constitutive element of local political economy. In fact, it is impossible to map Punjab's rural power structure without accounting for the interaction between sufi saints and state power.

To explore the impact of shrines on literacy, we compile three unique complementary databases on shrines across the 115 *tehsils* of Punjab (lowest available geographic unit): a database mapping the universe of shrines across of Punjab; a mapping of their political influence over time; and a historical database consisting of shrines mentioned in colonial district gazetteers. To our knowledge, this is the first such detailed compilation of shrine-related records in Punjab. We then construct an indicator, shrines per capita, that is used in regression models of literacy rate. An additional contribution of the paper is the construction of a new indicator of land inequality.

Since shrines vary in both size and significance, we do not expect a simple association between the concentration of shrines and literacy. Instead, we are interested in the interplay between religion, land and politics. A key empirical claim of this paper is that such a nexus is best captured in regions where shrines have a direct political influence, measured through success of shrine guardians in electoral politics. Our empirical results lend support to this. The presence of shrines matters for literacy only in regions where shrine families have entered into politics. The adverse influence of shrines on literacy is obtained after controlling for land inequality, which itself is a powerful negative correlate of literacy. Our results are robust to controlling for a variety of historical and geographic factors. We interpret this evidence to suggest that shrines influence literacy largely through their bearing on local political economy.

Probing the political dimension further, we investigate the determinants of political selection. We demonstrate that the religious and material power exercised through shrines is historically embedded: regions where a greater number of shrines were mentioned in British colonial documents are also more likely to have politically influential shrines today. Representing the interplay between religion, land and politics, political shrines enshrine a powerful structural inequality with important consequences for development. To our knowledge, this is the first systematic empirical assessment of the relationship between shrines and development.

The remainder of this paper is structured as follows. Section 6.2 briefly discusses the related literature and develops a broad historical narrative on shrines and development. Section 6.3 describes the data and sets out the paper's empirical strategy. The main empirical results are discussed in section 6.4. Section 6.5 probes the political dimension in greater detail and section 6.6 offers supporting qualitative evidence. Finally, section 6.7 concludes.

6.2 Shrines and Development

6.2.1 Related Literature

Apart from enriching the existing literature on the determinants of literacy, our study feeds into several inter-related strands of literature. Firstly, it adds to the growing discourse on religion and development (Barro and McCleary, 2003; Guiso, Sapienza, and Zingales, 2003; Noland, 2005). A parallel literature in political science links religion with democracy, investigating the role of religious beliefs and world view on attitudes towards democracy. Religion is shown to have contrasting effects on democracy. By fostering conservative attitudes religiosity can undermine democracy. At the same time, religiosity can encourage trust and engagement with civic institutions, thereby promoting democratic participation (Bloom and Arikan, 2013b, 2012).

Existing literature that links religion with democratization and development is largely focused on the role of "beliefs, behaviour and belonging". Empirical studies rely on large-N analysis and cross-country survey data. Past literature has paid limited attention to studying religion's role in its specific context. It has also largely ignored the underlying social and institutional structures in which religion is usually embedded. There is an important omission. As Iyer (2008) argues in her wide-ranging review of the field: "The role of religion in economic development warrants a nuanced perspective that integrates economic theory with an understanding of socio-political structures". Our emphasis on understanding religion as part of historically embedded structural inequality precisely underscores that spirit. Development is often characterized by feedback effects. The interplay between education, inequality and politics is central to major debates on democracy and development.

This study also informs the discourse on Islam and politics. Like the religion and democratization literature, it is also largely focused on political orientations and attitudes and ignores the structures through which the impact of religion could be mediated. Specifically, we also make a direct contribution to an influential literature at the intersection of Islamic studies and history that throws light on the spiritual and political ecosystem associated with shrines. Studies in this tradition have considered the impact of shrines on nationalism (Gilmartin, 1979, 1988), systems of political control (Ansari, 1992; Aziz, 2001) and moral authority (Gilmartin, 1984; Metcalf, 1984). None of this work has broached the development dimension in much detail. Our paper makes a first systematic effort at probing the relationship between shrines and development. Finally, this study contributes to a smaller, more localized literature, focusing on explaining regional variation in Punjab's development outcomes (Cheema, Khalid, Patnam, et al., 2008). While this empirical literature is largely concerned with proximate explanations, this paper lays emphasis on relatively deep determinants of literacy.

6.2.2 Historical Background

This section develops a broader historical narrative on shrines and development. We argue that this relationship is primarily shaped by local political economy. Although the influence of shrines is built on "sacred genealogies", their material power is shaped by the negotiation between the sacred and the secular or, what David Gilmartin describes as, the interface between the "universal and the particular". Given this emphasis on political economy, our focus is on the "this-worldly" influence of shrines. The ensuing discussion extensively relies on detailed archival evidence from colonial District Gazetteers and various historical monographs.

The discussion below is organized around three inter-connected themes: dependence, privilege and persistence. Central to the intermediary role of shrines is the dialectic of dependence. Both the state and the subject are dependent, in their respective constituencies, on shrine guardians. Such dependence translates into material privilege that is consolidated through politics. A recurring theme in this discourse is one of persistence: the power of notable shrines is historically embedded and has persisted through time.

Dependence:

Since times immemorial shrines have played an important role in the religious culture and political economy of Punjab. The great sufi mystics from Baba Fariduddin Ganj-i-Shakar of Pakpattan and Shaikh Bahawal Haq Zakariyya of Multan to Sayyid Jalaluddin Bokhari of Uch have dominated the popular imaginary of Punjab. Sufi saints served as important conduits of religious transmission. As Gilmartin notes, "many rural Punjabi tribes have traced their conversion [to Islam] to these medieval saints" (Gilmartin, 1988, p. 40). The physically imposing shrines dotted along Punjab are not only architectural masterpieces but also shape the lived reality of citizens. The tombs of saints are revered for their inclusive approach and social services. People from all walks of life, irrespective of caste, creed or religion, regularly pay their homage to these holy sites. For the seeker the shrine provides not just a sight of spiritual devotion but also a temporary refuge from a precarious existence. It provides food to the poor, house to the homeless and traveller, medicine to the ill, and solace to the depressed.

This popular culture of respect and reverence is solidified through a rich tradition of annual festivals and fairs, where pilgrims congregate, markets are formed and networks are consolidated. Major religious festivals often coincide with key agricultural seasons, and an elaborate bazaar economy thrives at the footsteps of these shrines. Such movement of people and resources has continued for generations. Attendance at these festivals (*urs*) can sometimes run into hundreds of thousands. Even in colonial times some shrines received 50,000 people or more on an annual *urs*. Shrines receive public offerings that sometimes run into millions of rupees. These festivals have "marked many shrines as important centres of rural economic and political power" (Gilmartin, 1988, p. 43). Central to this is the distributive function of shrines, whereby offerings of land, livestock and produce are collected as alms and partially redistributed amongst the local population.

Importantly, shrines are embedded, not just in the local welfare economy, but are also sometimes part of extractive institutions. Aided by superstition, ill-health and economic deprivation many shrine subjects are tied in a vicious cycle of dependence. Numerous accounts of this can be found in Lyall (1928). Speaking of the well-known connection between shrines and health, Darling notes that "superstitions are rife and the evil eye is universally dreaded. Since medicine has no power over the latter, medical aid is little sought, and those who are ill prefer to pay their hereditary *pir* large sums in order to invoke his supernatural powers"[1]. Being more prone to superstition and illiteracy, women are particularly attracted to shrines. Given their greater concern for family problems in matters of income, birth and death, women are more drawn to the spiritual support system offered by shrines[2].

For men shrines offer a domain of both allegiance and obedience. In the true spirit of *Taqlid*, *murids* uphold the "unquestioned authority" of the *sajjada nashins*. The world of shrines is one of tightly bound networks of devotees that sometimes extend to neighbouring villages, towns, districts and even provinces. As suggested below, such undisputed loyalty of devotees serves as a crucial political resource that paves the way for a shrine family's entry into politics. Guardians of influential shrines, much like tribal chieftains, routinely deploy the tools of patronage and control. Their power blends with local structures of control that are adept at enframing captive subjects.

This can reduce the life of the poor to one of virtual serfdom. The ordinary cultivator of Punjab, we learn, is triply bound by three scourges: the landlord, *pir*, and *kirar* (money lender). Each, according to Darling, "contributes to their fetter" (Lyall, 1928, p. 101). On another instance, he observes: "The poor man pays blackmail for his cattle to these local chieftains and for his soul to his *pir*, who may or may not live in his neighbourhood, but visits his followers to receive his dues" (Lyall, 1928, p. 99). Reinforcing this message, Aziz (2001) argues that, "as lords of the shrine they commanded both the body and the soul of the poor villager" (Aziz, 2001, p. 31). Even females are vulnerable to exploitation.

[1]The account pertains to Attock District (Lyall, 1928, p. 107)

[2]Popular accounts, journalistic as well as literary, and District Gazetteers are often replete with references to the greater pull of shrines for females. As Aziz (2001) argues, this is also true for urban regions: The women of the urban middle class have exactly the same mentality and attitude towards religion and family problems as their rustic sisters (Aziz, 2001, 129).

Instances of sexual harassment and rape are a common occurrence, and routinely become the subject of press reports and literary caricatures.

This regime of coercion is facilitated through control of resources. The *pirs* are often caricatured as leading a rich and extravagant life. Donations from *urs* are a key source[3]. But their real power is derived through state patronage.

Privilege:

In their search for legitimacy, local intermediation and peace in the countryside, rulers have often turned to the *pirs*. Neither Mughal or Sikh nor the British could have ruled without their administrative support. With dependence comes privilege. The Mughals and Sikhs rewarded the loyalty of *pirs* through land grants, a practice that continued in British rule and complemented with other forms of appeasement, such as honours and appointments. Given "their hereditary bases of power" the *pirs* resembled tribal leaders "who were readily susceptible to the common forms of state political control" (Gilmartin, 1979, 488). As a class the *pirs* of Punjab are known for their opportunism and political expediency. As defenders of status–quo, they have always supported men in power.

The British found in them ready allies. The leading *pir* families supported the British in overthrowing Sikh rule and quelling the 1857 uprising in Punjab. Later, in early twentieth century, they conveniently distanced themselves from the anti-British *Khilafat* Movement, a precursor to the Indian independence movement[4]. They aided the colonial administration in its War effort, contributing both men and resources. Such services were amply rewarded. Instances of colonial patronage

[3] As defined before, *urs* refers to the annual religious festival.

[4] The *Khilafat* Movement was a broader protest, led mainly by the Muslims of India but also supported by Gandhi, against the breakup of Ottoman Caliphate.

to shrine guardians are extensively documented in the historical literature. The 1904 Gazetteer of the Bahawalpur State, for example, contains several records of landed estates (*jagirs*) and wells being awarded to *pirs*[5].

Shrine caretakers in Multan, Montgommery, Muzaffargarh, and Dera Ghazi Khan, among others, were given *jagirs* (grants in perpetuity). Supplementary grants were offered in the form of revenue free gardens, orchids and vegetable farms. When the crown wasteland was brought under canal irrigation, *pirs* were given preferential access to colony land. Occasional references to these can be found in the historical literature. The *pir* of a "powerful shrine in Attock District", for example, "was given a personal landed gentry grant of ten rectangles in 1916, along with the lease of 15,000 acres of rakh land in his home district"(Ali, 1988, p. 106). In Multan, 19,751 acres of land was reserved for religious shrines, with 99% of these grants allocated to Muslim shrines[6]. Other prominent shrines that received land grants included: Sultan Bahu and Uch Gul Imam Shah from Jhang; Shergarh and Pakpattan Sharif from Montgomery District; Shah Gardez, Musa Pak Shahid and Shaikh Kabir Qureshi from Multan; and Dera Din Panah from Muzaffargarh District[7]. Several other shrines received maintenance grants and life *muafis* (revenue-free assignments). These included the shrine of Bhai Pheru and Mohammad Ghaus in Montgomery District. Life *muafis* were also assigned to shrines in Mianpur, Ghaunspur and Baghdad in Khanewal District[8].

[5]Some details are as follows: The *sajjada nashin* of the Salih Muhammad Ujjan shrine in the Sadiqabad tehsil enjoyed an inam of 500 bighas of land from the state; the *sajjada nashins* of the Jetha-Bhutta shrine in Khanpur tehsil were assigned 500 *bighas* of land under the pretext of *tel charag*; the *mutawalli* of the Bhindwala Sahib shrine enjoyed an inam of 1.5 wells from the state authorities; the *sajjada nashins* of the Chachran Sharif shrine were granted the village of Waghuan in jagir which yielded an income of over Rs.20,000 annually.

[6]49 grants were made to Muslim shrines; only 10 were reserved for Hindu shrines. See, *Gazetteer of the Multan District, 1923-24*.

[7]These selected land grants are noted in footnote 111 in (Ali, 1988, p. 106).

[8]Settlement Reports for Montgomery and Khanewal provide more precise information on these assignments.

If the recipients were incapable, due to death or indebtedness, of managing their estates, their land were temporarily taken over by the state under the Court of Wards, restored to a profitable condition and subsequently returned to the awardee[9]. Leading religious families who benefited from this facility included the *pir* of Makhad (Attock), Makhdoom of Shah Jewana (Jhang) and Syeds of Jalalpur Pirwala and Musa Pak Shahid (Multan)[10]. The former held, in proprietary rights, more than 34 thousand acres of agricultural land – see Appendix Table 6.A.2. Leading *pir* families were also incorporated into officialdom through appointments in provincial *darbars*, legislative councils, district boards and assemblies[11]. Others became Honorary Magistrates, Extra Assistant Commissioners and revenue collectors (*zaildars*). Recognizing the de facto power of local chiefs, the *zaildari* system selected men of influence as tax collectors. In many regions, prominent shrine families were natural contenders for this role. The access of shrine families to high office and valuable economic resources was significant in that it prepared them for a subsequent role in politics.

PERSISTENCE:

When the British opened the political arena the *pirs*, as spiritual and feudal lords, were natural contenders for power. They enjoyed access to both divine and po-

[9]In the event of death the state took responsibility for education of the young ward. Appreciating the education arrangements for the young son of a shrine guardian, the Deputy Commissioner noted that, "He promises to become an enlightened *Sajjada Nashin* as well as an intelligent *zamindar*". The Court of Wards thus preserved the union between religious and dominant landed classes. See Report on Final Settlement of the Jhang District.

[10]The estate of Makhdum Abdul Sattar Shah of Bilot Sharif in Dera Ismail Khan was also taken over under Court of Wards. Although, presently in Khyber-Pakhtoonwa Province, the shrine still commands a significant following among the shias of Pakki Shah Mardan in Mianwali, Punjab.

[11]The guardian of the shrine of great sufi mystic, Baba Fariduddin Ganj-i-Shakkar, was a leading provincial *darbari* in the colonial administration. Pir Mohammad Hussain of shergarh, Dipalpur tehsil, was also a Divisional Darbari. See Gilmartin (1979) for more examples.

litical favour. The combination of religious and landed power, in particular, is a vital political asset in a milieu where, in the words of Anatol Lieven, "it is not wealth alone, but wealth plus either kinship or spiritual prestige, or both, that gives political power" (Lieven, 2011, p. 137). A shrine, in this regard, provides an ideal platform:

> "Medium-size shrine makes him a small landowner and a local squire. The big shrine gives him an entrée into the zamindar club and makes a magnate of him. A leading shrine is a gold mine, which catapults him into the aristocratic category and brings him riches large enough to ... enter politics directly at the highest level" (Aziz, 2001, p. 109).

There is a long-standing connection between *pirs* and politics. In the 1920 and 1946 provincial elections roughly 19 percent of total rural Muslim constituencies were represented by *pirs* (Aziz, 2001, p. 39)[12]. When an alliance of Punjabs landed aristocracy was formed under the banner of Unionist Party the *pirs* became its core members. The 1937 and 1946 elections in British India saw many prominent religious families from Punjab taking part in them. When the demand for Pakistan gained strength, religious families readily joined the ranks of Muslim League and mobilized support for the cause. Whether military or civilian rule, *sajjada nashins* have been a permanent fixture of politics in post–independence Pakistan[13]. Although the country's first military ruler, Ayub Khan, attempted to exert greater control over shrine affairs, political pragmatism demanded a more

[12]The ratio for 1946 elections was calculated by authors.

[13]Tombs of prominent saints are also regularly frequented by top government functionaries and political leaders.

lenient approach towards influential shrines whose support, like any past ruler, was crucial for him[14].

From Zulfiqar Ali Bhutto to Nawaz Sharif, political governments have come and gone but the sun has never set on the political power of *pirs*. They are an omnipresent reality in every political dispensation, whether a political party is ideologically on the left or right or whether a military ruler supported "Islamization" or "enlightened moderation". While a noted protagonist of Islamization, General Zia-ul-Haq reached out to noted shrine families and inducted them into his *Majlis-e-shura* (consultative assembly). Some of the same *pirs* joined General Pervez Musharraf's cabinet two decades later, this time for undoing Zia's legacy[15]. The *pirs* truly transcend traditional party lines. They are adept at shifting political loyalties, which partly explains the persistence of priestly power in politics.

Another reason why the *pir's* power easily translates into political dynasties is the instrument of hereditary succession, which spreads religious power across several generations. Table 6.1 provides a snapshot of the persistence of leading *pir* families in politics. Although just a selective representation, Table 6.1 displays the remarkable overlap between spiritual and political dynasties, with some shrine families preserving their political turf since the pre-independence period. In the 2013 National Assembly there are some 43 *sajjada nashins*, which is equivalent to 16% of the house – a figure not very different from their representation in the 1920 provincial assembly in British India.

[14] Ayub Khan tried to regulate the finance, upkeep and activities of shrines through the establishment of a Waqf Department under a separate ordinance. However, it is worth mentioning that Khan was himself a self-professed murid of the *Pir* of Dewal Sharif. See (Ewing, 1983).

[15] General Pervez Musharraf patronized the notion of "enlightened moderation" to counter religious extremism.

The lure of spiritual network is especially powerful in constituencies where political parties are weakly penetrated and dependent on local notables. The blessing of a *pir* is deemed critical here for winning an election, since it can complement party vote bank. With their army of obedient *murids*, the *pirs* have a stable constituency of followers – a captive vote bank of sorts – that makes them electable even in an uncertain political game. Some constituencies are completely dominated by religious families. Political parties are pretty much dependent here on *pir's* support. In the 2013 elections all the top four candidates for NA-194, Rahimyar Khan III, belonged to prominent religious families; the winner was an independent candidate[16]. In other constituencies where the *pir's* network alone is insufficient for electoral victory he is dependent on party support. This creates a relationship of mutual dependence between parties and *pirs*. The influence of some *pirs* stretches beyond their own constituency, which makes them a vital asset for building and sustaining regional political alliances. This dense network of power and privilege is further consolidated through nuptial bonds with other landed and *pirs* families[17].

To this narrative on shrines and development we must add two further nuances: their differential importance across regions and "structural transformations" in the property rights regime during the colonial era. Both of these are critical for understanding the impact of shrines on present day development outcomes.

[16]The four candidates were: Makhdoom Khusro Bakhtiar (Independent), Makhdoom Shahab ud Din (PPP), Makhdoom Moin ud Din Hashmi (PML-N), and Makhdoom Imad ud Din Hashmi (PTI). All advocates for political change, including the PTI, had to field their candidate from a religious party.

[17]The Gillani Syeds of Multan, for instance, are related through family marriages with the *Pirs* of Makhad in Attock, Mukhdoom Hassan Mehmoods family in Rahimyar Khan, and *Pir* Pagaras family in Sind.

Varying Influence:

It is important to recognize that not all shrines are equal in size and significance. While shrines are spread all across Punjab, some have had a more enduring impact on local political economy. While the more noted shrines of great *sufi* mystics in Pakpattan, Taunsa, Multan, and Jhang continue to have a profound influence, there are other shrines "dedicated to lesser known saints" and "had only the most localized significance" (Gilmartin, 1988, p. 41). The colonial era District Gazetteers of Punjab provide some indication of the varying power and influence of shrines. A detailed reading of these Gazetteers reveals that shrines in north Punjab were generally more localized in influence. Several extracts corroborate this. The 1904 Gazetteer of the Northern Chenab Colony District reports that "there are no shrines of any note in the Colony"[18]. In Rawalpindi division the Kahuta *tehsil* is shown to have "a number of small fairs, which take place at various intervals, but none of them are of great importance", while "there are no fairs of any importance" in Murree *tehsil*[19].

Saintly presence is relatively insignificant in many central districts as well. Gujranwala was noted to have "very few religious fairs", with "people attending do not exceed a few hundred in number and they are local men"[20]. Gujrat was described as having "numerous small shrines". However, "[T]here are no large fairs in the district, though there are certain local shrines at which people congregate ... that may be an occasion on which friends may meet, there is no merriment"[21]. Shrines gain prominence in south and western parts of Punjab. Multan "is thickly dotted

[18]See p.62 of the 1904 Gazetteer of the Chenab Colony

[19]See p.102-3 of the 1907 Gazetteer of the Rawalpindi District

[20]See p.93 of part A of the 1935 Gazetteer of the Gujranwala District

[21]See p.54 and 63 of part A of the 1921 Gazetteer of the Gujrat District

with shrines of various degrees of age and sanctity"[22]. The Muzaffargarh Gazetteer observes: "shrines of the district are very numerous, and the more important are frequented by pilgrims from Dera Ghazi Khan, Multan and Bahawalpur"[23].

Significance of shrines increases as we move further west and south in Punjab. The Gazetteer notes that "[F]rom the number of shrines scattered about the Dera Ghazi Khan district it would appear to have been in the by-gone days a favourite resort of saints"[24]. Shrines are most deeply penetrated in the local political economy of south Punjab. The former Bahawalpur State was particularly noted for its number and influence of shrines. As per the above quotes, the south-western parts of Punjab contain more significant shrines. In line with this varying significance, colonial patronage was largely reserved for influential shrines. Indeed, as Ali (1988) notes, even if "no comprehensive list exists of allotments to shrines, it is clear that the recipients were largely confined to the western Punjab, and were predominantly Muslim" (Ali, 1988, p. 106).

However, the "sacred geography" of shrines defies a crude distinction between north and south Punjab. Several shrines in north and central Punjab are sometimes considered as important as those in south Punjab. These include, among others, shrines in: Attock, Sargodha, Pakpattan and Kasur. There is also a significant urban presence of shrines – from Lahore's Data Darbar to Islamabad's Barri Latif Shah[25]. We aim to exploit some of this variation in shrine influence in our empirical analysis (Clearly, this variation cannot be captured through the inclusion of regional dummy variables alone). As we discuss further below, information from District Gazetteers provides a useful starting point for such analysis.

[22]See p.138 of part A of the 1923-24 Gazetteer of the Multan District

[23]See p.81 of part A of the 1929 Gazetteer of the Muzaffargarh District

[24]See p.51 of the 1883-84 Gazetteer of the Dera Ghazi Khan District. Revised Edition.

[25]As the Rawalpindi Gazetteer noted, "About 20,000 persons attend the fair (of Barri Latif Shah) annually". Punjab District Gazetteers: Rawalpindi. part A. 1907. p. 102-103.

Significance of riverine shrines:

A key challenge in mapping the relationship between shrines and development is that shrines vary in both size and influence. Simply looking at shrine concentration is unlikely to be helpful. Taunsa in west Punjab, for example, has fewer shrines than many *tehsils* in north Punjab, but its influence on local political economy is far more enduring. One measure of influence is attendance at shrine fairs. But collecting this information for nearly 600 shrines in Punjab is both costly and time consuming. Although the Gazetteers provide scattered information on attendance, it is highly selective. In thinking about shrines and development, one potential source of variation is ecology. Shrines situated in riverine *tehsils*, for instance, can have a differential impact on development than those distant from river.

Some of the oldest and prominent shrines are situated along the river bank. In his article on "The Muhammadan Saints of the Western Punjab", Major Aubrey O'Brien noticed how the Indus River is "dotted" with shrines (O'Brien, 1911). Further down the Indus, in the Sind province, Alice Albinia found shrines so commonplace that she described their guardians as "River Saints" (Alice, 2008, p. 79). She poignantly observed that, for many Pakistanis, "the power of the Indus and the power of Islam coexist" (Alice, 2008, p. 107). We argue in this paper that it is also a domain where local power is configured and preserved.

There is a sense in which the political economy of riverine shrines is radically different from their more distant peers. Firstly, there has historically been a greater concentration of Muslim populace along the river. It was a core spiritual constituency. As Darling notes, "it is a curious feature of riverine tracts that they are mainly inhabited by Muhammedans" (Lyall, 1928, p. 62). Apart from settled communities, the riverine regions have also traditionally attracted Punjab's nomadic and pastoral communities who move to riverine regions in between seasons.

Access to river also expanded the spiritual constituency by affording greater mobility of people, especially in an age when other means of communication were underdeveloped, and many river crossing points served as important logistic nodes. Riverine tracts also have some of the most productive agricultural conditions, especially "when wells were few and canals not at all, the low-lying lands along the river were best, and greedily seized by the invader" (Lyall, 1928, p. 63). Superior agricultural possibilities in riverine tracts made them a preferred destination for earlier saints, since they usually preferred cultivation over wage employment. Importantly, in regions where access to river made it possible to bypass the insecurity of rain-fed agriculture, land became a prized economic asset. As Darling notes, "all down the Indus ... the landlord is common" (Lyall, 1928, p. 98). A similar tendency is observed by Albinia: "lands along the river bank are the domain of powerful landlords" (Alice, 2008, p. 107). It is therefore easy to understand that shrines in such regions are often controllers of both religious and material resources. With economic power comes political influence. The political brokerage of landed shrines can set them apart from other shrines. It is this confluence between religion, land and politics that is likely to be consequential for development and which, we argue, is best captured by riverine shrines.

Structural transformations during the British Era:

Given their "intermediary" position, prominent shrines have been patronized by all past rulers. In fact, "[N]o major ruler passed by the area without showing deference to" their "spiritual power" (Eaton, 1984, p. 247). While colonial patronage for shrines is part of this long tradition, its reward structure was more systematized and associated with significant legal and institutional changes that arguably led to greater elite entrenchment. A key turning point in the British era was the establishment of formal property rights. Absolute property rights did not exist before the British. Prior to the British, "*jagirs* and pensions offered by the state ... were non-portable and at the mercy of the government" (Roseberry, 1987, p. 81). While land grants by Mughal rulers could easily revert back to the ruler upon the death of the *sajjada nashin*, they were preserved under the British through a formal property rights regime[26]. Shrine properties were now also subject to state adjudication of property law. Though the British officially disavowed government interference into the operation of shrines in the 19th century, the fact that shrines controlled property meant that courts became a venue in which legitimate authority at shrines was adjudicated. Though property characterized as personal might be divided among heirs, endowed property passed on intact to the successor. In such cases, there was usually no accepted law of primogeniture[27]. All of this made hereditary succession of shrines a powerful economic proposition.

While the Punjab Land Alienation Act of 1900 forbade the sale of land to non-agrarian castes, Muslim religious elites, such as Syeds, Sheikhs and Qureshis, were considered as "agrarian castes" and deemed eligible for landed gentry grants, in spite of the fact that colonial documents described Syeds and Qureshis as "of no great usefulness in the capacity of colony landlords" and taking "little personal interest" in agriculture[28]. As Talbot argues, "[T]he Punjab government's recognition

[26]We were informed in an interview with the present guardian of the Makhdum Rashid shrine in Multan that the shrine had received a land grant by the Mughals but it reverted back to the ruler after the caretaker's death.

[27]There was some variation in this pattern since the British, in such matters, gave precedence to prior customary practices at the shrine.

[28]Jhang District Gazetteer 1883-84. It was also noted that, in lands controlled by religious families, "*khudkasht* (i.e. owner cultivator) is practically unknown".

of the Syeds who were generally *pirs* ... as agriculturists and eligible for 'landed gentry' status possessed profound political repercussions. It gave them common interests with other controllers of land" (Talbot, 1991, p. 211). Although not typically known as agrarian castes, religious families "had to be incorporated into the British system of social control" in the canal colonies (Talbot, 1991, p. 213). This systematic absorption of religious elites cemented the nexus between religion and land from an early period.

6.3 Data and empirical strategy

In this section we describe the core variables used in our empirical analysis, along with their data sources. We subsequently set out the empirical strategy for this paper. Our dependent variable is the total literacy rate measured for household members aged 10 or above (or 15 and above). Literacy is defined as being able, with understanding, to both read and write in any language[29]. The source for the literacy data is the Multiple Indicators Cluster Survey (MICS, 2007/8 Round) that provides information at a sufficiently disaggregate level, *tehsil*[30]. The right hand side controls include a range of explanatory variables (historical, contemporary and geographic in nature). These shall be described in the course of our analysis. In this section, we restrict our discussion to describing variables that measure two principal dimensions: concentration of shrines and land inequality.

[29]This excludes Quranic reading, if this was the only response.

[30]MICS is an international household survey programme developed by UNICEF. The MICS Punjab provides up-to date information on the situation of children and women and measures key indicators that allow countries to monitor progress towards the Millennium Development Goals (MDGs) and other internationally agreed upon commitments. Additional information on the global MICS project may be obtained from www.childinfo.org.

6.3.1 Data on Shrines

To capture the influence of shrines on literacy we compiled a unique database documenting the number of shrines in every *tehsil* of Punjab. This involved a detailed and laborious effort involving several field researchers, interaction with various departments and consultation of eclectic data sources, both published and unpublished. It resulted in three complimentary databases on shrines that capture both historical and contemporary information on the presence and significance of shrines. These databases and the multiple sources used to compile them are separately described below.

The Auqaf List

The primary source for our database on shrines is the Punjab *Auqaf* Department. Established in 1959 the *Auqaf* Department was originally made responsible for the administration, construction, decoration and management of shrines. To fulfil these functions it maintains a detailed list of shrines across different regions of Punjab. These lists provide information both on shrine names and their location. Shrines are categorized, however, by 'circles' that sometimes contain several overlapping district and *tehsil* boundaries. The first challenge was to slot each shrine to its contemporary *tehsil* boundary. The *Auqaf* lists are an old compilation; several *tehsil* and district boundaries have changed since the list was first compiled. However, information on sub-*tehsil* units (*Moza*) and Union Councils was frequently available, which together with files from the National Reconstruction Bureau (NRB), allowed us to assign each shrine to its relevant *tehsil.* Shrines with missing or incomplete location details were separately treated through specialized interviews with informed respondents in each district circle.

Although an exhaustive list, the resulting database largely covers small and medium-sized shrines that came under *Auqaf* administration and depended on it for their sustenance and upkeep[31]. The *Auqaf* only maintained a list of shrines that came under its administration. Many influential shrines in rural areas that functioned with the blessings of powerful religious families were allowed to retain their independence. Only few of these were taken over by the *Auqaf* Department[32]. Despite this omission, the *Auqaf* list provides a convenient building block for a shrines database, especially since smaller less noted shrines are more difficult to map. The *Auqaf* lists were supplemented through information from the following sources:

> *Government of Punjab websites*: The website of the *Auqaf* and Religious Affairs Department lists 'important' shrines, which also includes shrines not currently under its administration. Websites of various TMAs (Town and Municipal Authority) also display names of prominent shrines in the area[33]. All TMA websites were systematically consulted for this purpose.
>
> *Google and other web resources*: Generalized Google searches were carried out using combinations of district and *tehsil* names with words, such as "shrine" or "*Darbar*"[34]. Shrines thus identified were reconciled with *Auqaf* lists, with additional names added to the database. A complimentary source was Google Maps, which usually highlights key shrines in the area. Separate Wikipedia pages for different districts and

[31]Several prominent shrines were not part of the Auqaf list. For example, Darbar Hazrat Syyad Abdullah Shah Gillani of Pindigheb and Darbar Bibi Pak Daman of Lahore were excluded from the list.

[32]These were mostly in Sind.

[33]These are usually contained in the section: "Important places".

[34]The word Darbar denotes a *sufi* hospice.

tehsils also highlight influential shrines. We used these web resources to supplement the shrines database.

District-level interviews: After exhausting all resources we ran our shrines list for each district with a knowledgeable resource person on that district (typically a shrine caretaker). Any major errors or omissions were likely to be identified and corrected at this stage. This consistency check tried to ensure that no shrine worth a mention is excluded from the district list.

Historical Database

Drawing upon information from the Punjab District Gazetteers (PDG), our second complimentary database is largely historical in nature. Periodically issued during the colonial era, the District Gazetteers contained vital information on major shrines and their guardians, and mapped their spiritual and material influence. Such information was typically documented in a separate sub-section entitled, "Religious fairs and festivals". Occasionally, attendance rates at shrines and size of public offerings were also recorded. As noted in section 6.2, the Gazetteers also commented on whether or not a particular region was noted for its saints and shrines. They are a critical historical resource for our project, since we get a concrete indication of shrines considered as influential in the colonial period. It is unlikely that any prominent shrine would have missed the Gazetteer's attention. Importantly, shrines recognized as more influential by colonial administrators were also more likely to have received official patronage.

All shrines mentioned in District Gazetteers were separately recorded and consolidated with our original database. This required mapping each historical shrine to the contemporary *tehsil* where it is located. A total of 146 shrines across Punjab were mentioned in PDGs, with 47 *tehsils* containing at least one shrine mention. Ahmadpur East in Bahawalpur had the maximum number of shrines (15) mentioned in PDG. In fact, the Bahawalpur Gazetteer devoted 13 pages to the subject. Based on this historical information, we define two categorical variables at the *tehsil*-level: number of shrines mentioned in PDGs and a dummy variable coded as one when the *tehsil* had a shrine mentioned in PDGs.

Politics Database

Our final database mapped the direct participation of shrine families in electoral politics. Using electoral records from varied sources we developed a detailed and systematic compilation of shrines-politics linkage across Punjab. Specifically, we relied on 15 waves of election results since 1937 to identify all shrine families that directly participated in electoral politics and entered in national or provincial assemblies[35]. Results for National Assembly elections (1970-2008) were obtained from FAFEN (2010)[36]. The 1962 and 1965 results were compiled using Gazette notifications available at the National Assembly library. Pre-partition election results (1937 and 1946) were obtained from various monographs published in Urdu (Anjum, 1995; Jafri, 2007). Finally, Punjab Provincial Assembly results were directly retrieved from the websites of ECP and Punjab Assembly.

The next challenge was to identify shrine-related families in the electoral database. In many constituencies, shrine caretakers enter the electoral race with names that

[35]The following election rounds were considered: 1937, 1946, 1950/51, 1962, 1965, 1970, 1977, 1985, 1988, 1990, 1993, 1997, 2002, 2008 and 2013. Moreover, we only considered families that were successful in winning at least one election. The patron-client dimension requires that we only consider families that had electoral success and, as a result, could have directly influenced public goods provision.

[36]Results for 2013 elections were obtained from the website of ECP (Election Commission of Pakistan).

have "*pir*" or "*Makhdum*" attached as an honorific title. Since 2002 election results are available with the winners' address details, which usually contain name of the shrine complex[37]. A final useful resource for mapping shrine families was the Urdu literature on political dynasties. The detailed district-level mapping of political families in Anjum (1990, 1995) and Jafri (2007) served as useful references. Like the *Auqaf* lists the electoral connection of shrines was verified with district resource persons[38]. We were able to identify 64 shrines with a direct political connection, in the sense that their caretakers were elected into various national or provincial parliaments. In 42 *tehsils* there was at least one politically influential shrine. The highest number of political shrines in our sample was 3 (these *tehsils* were: Khairpur Tamewalli, Chishtian, Multan and Okara). A dummy variable was then constructed to identify *tehsils* with at least one politically-linked shrine.

Together, these three databases (*Auqaf*, historical and political lists) were consolidated to form the master database on shrines, which contains a total of 598 shrines. Lahore has the largest number of shrines (73), followed by Multan (20) and Rawalpindi (17). Although some small-time shrines might be omitted from the list, our database provides a comprehensive coverage of any shrine of significance or note. Using this database we constructed our main variable of interest, shrines per capita, which is defined as the number of shrines per 10,000 persons in a *tehsil*. Contrary to popular belief, there is no marked difference in shrine density between northern and southern regions of Punjab. Shrines are not an exclusively rural phenomenon either. In fact, major urban centres tend to have

[37]This is particularly important in *tehsils* in central Punjab that are relatively less known for political shrines, especially compared to their peers in south Punjab. An example is Syed Iftikhar-ul-Hassan, a 2013 MNA from Daska (Sialkot), His postal address on the National Assembly records contains the shrine name, "Allo Mahar Sharif"

[38]For conflicting cases we also directly contacted candidates using the telephone numbers provided on the National Assembly database. We also interviewed at least three *sajjada nashins* who have extensive knowledge of regional political influence of shrines.

greater concentration of shrines. Finally, several shrines are situated in *tehsils* along the river.

Some of the key shrine statistics are presented in Appendix Table 6.A.1. Dividing Punjab across three geographic zones – north, central and south-west Punjab – we do not find huge variation in the presence of shrines. In fact, all three regions have surprisingly similar ratio of shrines per capita. However, there is a discernible variation in other shrine attributes. A greater number of shrines in south-west Punjab were mentioned in District Gazetteers and selected into politics. This is hardly surprising: south Punjab is known as the land of shrines. Perhaps more importantly, a significantly large number of shrines (25) have a direct electoral linkage in central Punjab. About 39 percent of politically influential shrines are situated in central Punjab. Delineating the geography of poverty in Punjab, Cheema, Khalid, Patnam, et al. (2008) observed that, while south-west Punjab has a greater incidence of poverty relative to north Punjab, poverty outcomes are more variable in *tehsils* of central Punjab. We hope that shrine concentration can explain part of this variation.

6.3.2 Land Inequality

Given the above discussion, a core dimension that warrants inclusion in our analysis is land inequality. We are interested in estimating the impact of shrines on literacy over and above any possible role of land inequality. There is a real dearth, however, of credible land inequality measures in Pakistan[39]. Although land inequality can be measured using data from the Agricultural Census or Household

[39] This is, in part, due to the strength of landed elites and their ready access to the corridors of power. Successive governments in Pakistan have shown little interest in compiling detailed data on land inequality.

Surveys, data is only available at higher levels of geographic aggregation (district). One contribution of this paper is to construct a new dataset on land inequality at the *tehsil* level. Using a unique database on identity registration covering 96 million records, we compute the proportion of identity card holders that self-identify them as *Muzaara* (sharecroppers)[40]. In Pakistan's agricultural context *Muzaaras* are typically landless tenants that are tied to landlords. The ratio was calculated for identity registrations completed till 2007-08.

The identity database maintained by NADRA is the most extensive repository of citizen data covering the far corners of Pakistan[41]. With its near universal coverage of citizens and regions, the Proportion *Muzaara* provides a relatively precise, albeit indirect, proxy for land inequality. A possible limitation of this indicator is its reliance on self-identified data on occupations. It is possible that fewer people register for an identity card in regions with high poverty and land inequality, since they are less likely to require it for jobs, travel or exchange. While a legitimate concern, the NADRA database covers 94% of citizens[42].

[40]Applicants for the identity card are required to select a profession from a detailed list of occupational categories. There are more than 200 professions on the list. Since researchers do not have access to the database, NADRA's Analytics Department was requested to compute the ratio for all tehsils of Punjab.

[41]NADRA stands for National Database and Registration Authority.

[42]This extensive coverage is partly attributable to the extensive reach and promise of cash transfer programmes, and the fact that only identity cardholders are eligible for support directed at households affected by poverty or disaster. Specifically, identity cards were required to claim support from flood or disaster relief programmes, and to be eligible for Benazir Income Support Programme (BISP).

6.3.3 Empirical strategy

To explore these relationships, we initially propose the following empirical specification:

$$L_i = \beta_1 S_i + \beta_2 River_i + \beta_3 (River_i \cdot S_i) + \beta_4 Geo_i + \beta_5 X_i + \epsilon_i \tag{6.1}$$

Where L_i is the contemporary literacy rate for *tehsil* (i), S_i denotes our shrines per capita measure (as defined earlier), and $River_i$ is the distance of the *Tehsil* (i) from the nearest river. The term, ($River_i \cdot S_i$), is an interaction between the distance from river and shrine per capita; Geo_i is a vector of geographic controls, consisting of latitude, longitude and elevation; X_i represents other historical and contemporary correlates of literacy; and ϵ_i is an error term.

Our main parameter of interest in equation (6.1) is β_1, the estimated relationship between shrines pc and current literacy rate. Given our initial interest in the impact of riverine shrines, this has to be interpreted together with the coefficient on shrine-river interaction (β_3). Although we do not ascribe a causal interpretation to our parameter of interest at this stage, it is useful to point out that the shrines measure is historically pre-determined. The shrine-river interaction, in particular, tracks the effect of historically more important shrines that are likely to be proximate to river[43]. Ultimately, however, we are interested in exploring specifications that contain interactions between shrine pc and political variables. We will revert to identification issues later in the paper.

[43] This can address the concern that a small percentage of shrines might have witnessed changing fortunes over time. For example, *Pir* Mehr Ali Shah resuscitated the influence of Golra Sharif and the *Pir* of Ghamkol Sharif established his influence in the Frontier Province back in early 1950s. Most of the riverine shrines, however, are of an ancient pedigree.

We will be careful not to ascribe a strictly causal interpretation to our results. While the establishment of shrines pre-dates the period over which literacy rates are determined, potential selection bias cannot be ruled out. The concern is whether holy men were more likely to settle down in poorer regions that were subsequently pre-disposed to lower literacy rates? Historical literature on religious transmission in South Asia tends to negate this. In fact, sufis were as likely to make a prosperous surrounding or an urban centre their permanent abode as a poor or rural neighbourhood. The spiritual demands of a particular *silsila* (sufi order) were often a more crucial determinant of shrine location (Nizami, 1953). However, given the limitations of our research design, it is not possible to claim strict exogeneity of the shrines measure. In particular, our measure of political shrines contains contemporary information and likely to be endogenous with respect to local development. Shrines that entered into politics after independence could have been influenced by local development characteristics, making them lucrative in the first place.

6.4 Evidence on Shrines and Literacy

This section presents the basic patterns of association between shrines and literacy. Our specification consists of models of literacy measured at the level of *tehsils*, and our initial variable of interest is the indicator of shrines per capita interacted with the distance from river. Our prior is that the effect of shrines on literacy can systematically vary depending on whether they are situated in a *tehsil* that is closer or distant from river. The estimations are based on a sample of 115 *tehsils*. The initial set of results is documented in Table 6.2. The dependent variable is the total literacy rate for years 10 and above (results are very similar for literacy rate for years 15 and above, and therefore not presented).

Column (1) explores the non-linear impact of shrines by including the shrines indicator on its own as well as its interaction with the distance from river. To ensure that the effect of the shrine interaction is not driven by other geographic attributes, we also control for the latitude, longitude and elevation measured at the *tehsil* level. As expected, the coefficient on shrines per capita (*shrines pc*), capturing the impact of riverine shrines, is negative and statistically significant. The coefficient on the interaction term, on the other hand, is also statistically significant[44]. Given the inclusion of both the shrine measure and its interaction term the parameter estimates on the two terms need to be interpreted together. Evaluated at the mean distance from river, the impact of shrines on literacy is negative and statistically significant[45]. Overall, the results strongly support the suggestion that the impact of riverine shrines on literacy, captured by *shrine pc*, is significantly different from that of shrines situated in *tehsils* relatively distant from river. It is worth noting that the coefficient on elevation is positive and statistically significant at the 1% level. Apart from capturing specific geographic features, the elevation measure is likely to pick up the impact of other development dimensions, such as rainfall patterns, soil quality and land inequality, with which it is highly correlated[46].

[44]When separately included, in the absence of the interaction term, the coefficient on distance from river is statistically insignificant.

[45]The precise size of the impact can be calculated as: -2.697 + 0.114 x (21.155).

[46]Geographically the average altitude falls as we move from North to South Punjab. Both rainfall and land inequality follow a similar pattern.

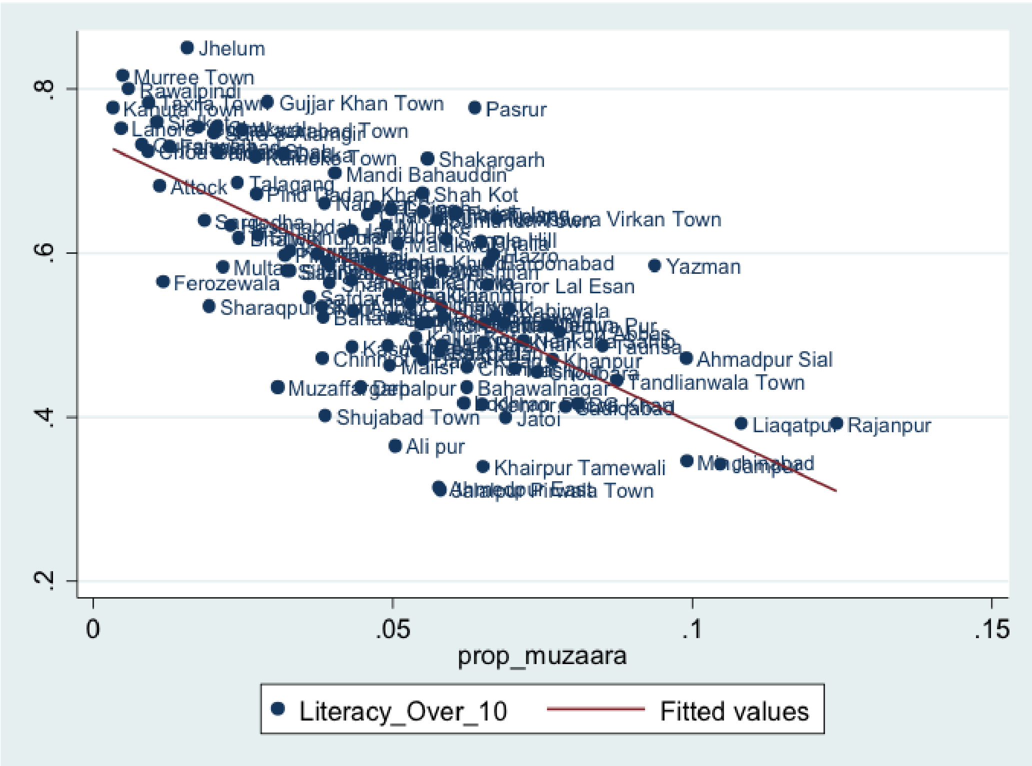
6.4.1 Extended Specifications

We next explore extended specifications to ascertain the strength of these empirical patterns. A key challenge in reduced form specifications is to ensure that the results are not contaminated by omitted variables. One crucial dimension in this regard is land inequality. To what extent, we might ask, is the effect of riverine shrines simply acting as a proxy for inequitable land distribution? The fact that most *pirs* in riverine regions are also landowners further heightens this concern. As Figure 6.1 shows there is an unusually strong correlation between one proxy for land inequality (the proportion of share-croppers, *Muzaara*, who are usually landless) and literacy rate. The principal challenge then is to ascertain whether shrines have an effect on literacy over and above the role of land inequality.

We do this in column (2) by adding a proxy for land inequality, the proportion of *Muzaara* (landless tenants). As expected, the results indicate a very strong negative association between land inequality and literacy. This is consistent with the argument that landlessness combined with productive agriculture is associated with illiteracy. Measured at the end of the sample period, the negative effect of *Muzaara* suggests that land inequality and literacy are jointly determined. Importantly, however, the impact of riverine shrines remains robust to the inclusion of this powerful correlate of literacy.

It is important to ensure that the shrines effect is not simply driven by systematic differences in regional development across Punjab. As suggested by Cheema, Khalid, Patnam, et al. (2008), the south and western parts of Punjab are considerably more underdeveloped than the rest of Punjab. Coincidentally, these regions are also home to some of the politically most influential shrines. To ensure that the shrines effect is not conflated by these regional differences, we include in column 3

FIGURE 6.1: Land inequality and literacy rate



Notes: The y–axis has the contemporary *tehsil* level literacy rates for persons over 10 years of age and the x-axis has the proportion of persons in a *tehsil* who are classified as a *Muzaara*. Each dot in the scatter plot represents a *tehsil*.

three dummy variables for north, central and south Punjab (with west Punjab as the base category). Coefficients on neither of these regional dummy variables are statistically significant, whilst the impact of riverine shrines and land inequality remain negative and significant.

A related concern arises if the settlement patterns of *sufi* saints were determined by ecological endowments and these, in turn, shaped the long-term conditions for literacy. If saints were more likely to settle down in riverine regions and the riverine tracts were more backward, the shrine-river interaction would just pick up these generalized development effects independent of the influence of shrines. To control for this possibility we include a commonly used proxy for income, mean rainfall over the period, 1960-2008. The result is presented in column 4. As expected, rainfall is a strong predictor of literacy: its coefficient is positive and significant at 1% level. Apart from being associated with land inequality, rainfall captures many unobserved dimensions of income and development[47]. It is reassuring, however, that the negative impact of riverine shrines, captured by the coefficient on shrines pc, continues to be robust.

Some previous work on Punjab has also controlled for distance from Lahore to reflect core-periphery dynamics in development. Other studies have sometimes controlled for distance from the GT (Grand Trunk) road[48]. It is possible that *tehsils* with characteristics least favourable to literacy were also remote from the historical centre of power and, consequently, suffered from a substantial power vacuum that was filled by shrines. Shrines would then simply capture the impact of remoteness. Columns 5 and 7 control for these dimensions (given its significance we

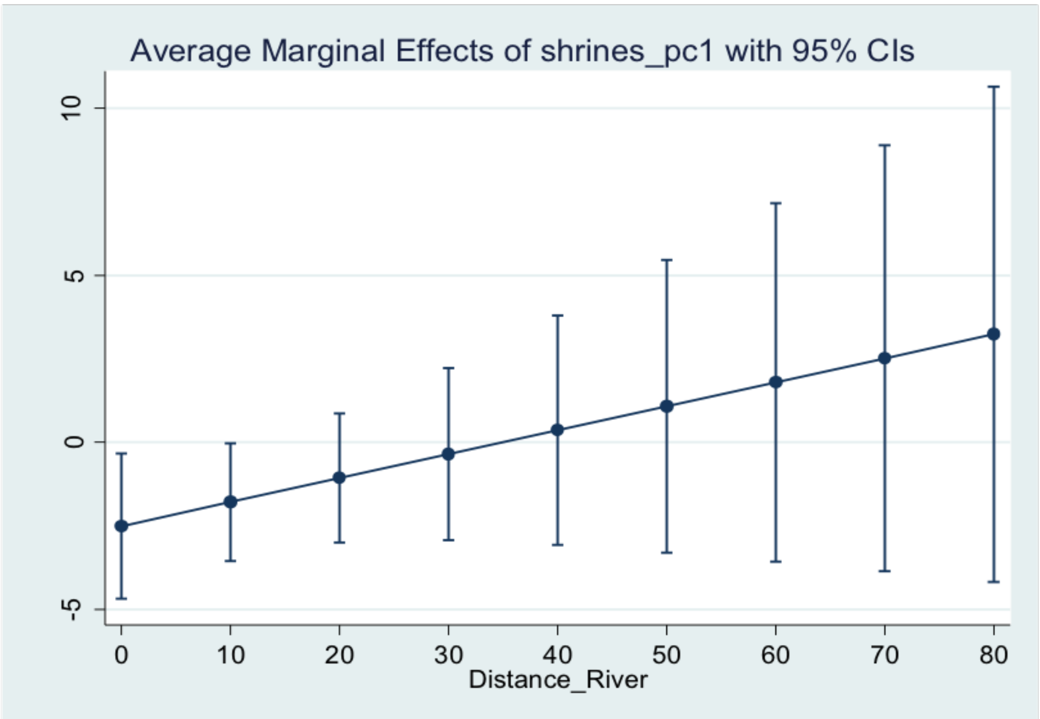
[47]There is a strong negative correlation between rainfall and land inequality. Land is more unequally distributed in low-rainfall regions.

[48]GT Road stands for Grand Trunk Road, a major road artery connecting Central Asia with eastern and western parts of the Indian subcontinent. We use the natural log of the variable.

retain average rainfall in the model). Neither of these have additional explanatory power. Finally, column 6 assesses the importance of spatial dimensions in mapping shrine influence. The influence of major shrines usually extends beyond the *tehsils* where they are situated. Religious festivals organized around prominent shrines typically attract devotees from far flung areas as well. To account for shrines in neighbouring regions, we constructed a new variable, neighbouring shrines per capita, by adding up the total number of shrines in the contiguous *tehsils* and weighting it by total population of these *tehsils*. Its inclusion does not alter our main results, however. The models presented above explain 59 to 69 percent of the total variation in literacy rates.

Overall, these multivariate regressions suggest a robust pattern of association between shrines and contemporary literacy. Specifically, shrine concentration is negatively correlated with literacy only in *tehsils* that are proximate to river. Figure 6.2 shows the average marginal effects of shrines pc at various distance ranges from river. As the plot shows, shrines have a negative effect on literacy only in *tehsils* situated at less than 10km from river. And, this effect of shrines in riverine regions remains robust to controlling for other powerful correlates of literacy, including land inequality and average rainfall. A similar pattern of results holds when we investigate the impact of shrines on a more direct measure of public goods provision: distance from public and private schools for both boys and girls. Results, presented in Appendix Table 6.A.5 suggest that a greater concentration of shrines in riverine regions is associated with a more defective physical access to schools. We next turn to our principal line of investigation relating to the political economy of riverine shrines.

Figure 6.2: Average marginal effects of shrines per capita



Notes: The figure plots the average marginal effects of shrines per capita on literacy over different values for the distance of *tehsils* from the river.

6.4.2 Is Politics the Primary Influence of Shrines

To what extent does the effect of riverine shrines reflect deeper political economy forces related to political and landed power? Table 6.3 explores this by considering models that simultaneously investigate the impact of riverine shrines with our two competing explanations: politics and land. To do so, we define three separate dummy variables: River, *Muzaara* and Politics. The River dummy picks out *tehsils* that are proximate to the river, characterized as *tehsils* situated at a distance of 9km or less from the main river. The interaction between this dummy variable and shrines pc allows the coefficient on the latter to be different for riverine and non-riverine shrines[49]. The usual geographic effects (latitude, longitude and elevation) are included in all specifications.

Beginning with results in column 1, the coefficient on the interaction term between shrines pc and River dummy is negative and statistically significant. This is consistent with our earlier finding that the negative impact of shrines on literacy is mainly driven by riverine shrines[50]. To explore whether this effect is primarily driven by *tehsils* where shrines have a direct link with electoral politics, we introduce an interaction between the Politics dummy and shrine indicator. The Politics dummy equals 1 in *tehsils* where a shrine-related family has a direct connection with politics through participation in general elections, either at the provincial or national level. The results are instructive. Inclusion of the politics interaction renders the coefficient on our main interactive term between shrines pc and the River dummy statistically insignificant. Instead, the Politics interaction now has

[49]The term, riverine, is loosely used to denote shrines that are proximate to the river as classified by the dummy variable above.

[50]A similar result is obtained if were to define the River dummy on the basis of the top 25th percentile of the overall distribution of the distance from river variable.

a negative and statistically significant coefficient, supporting our hypothesis that the shrine effect is principally mediated through politics.

The model in column 3 imposes a more stringent test by including all three dimensions together (River, *Muzaara* and Politics). This allows us to estimate the differential impact of shrines per capita across the three categories defined above. We introduce a dummy variable, *Muzaara*, that takes a value of one in *tehsils* where the proportion of *Muzaara* is greater than or equal to the 75th percentile of the variables distribution; zero otherwise[51]. The interaction of *Muzaara* dummy with shrines indicator effectively allows the coefficient on shrines pc to be different for *tehsils* with high and low levels of land inequality. The shrines-politics interaction still has a robust negative and statistically significant impact on literacy. There is no additional impact of *Muzaara* or its interaction with shrines. Adding average rainfall in column 4 slightly weakens the impact of politics, but it still remains negative and statistically significant at 10 percent level. The coefficient on *Muzaara* dummy itself is now negative and weakly significant. The inclusion of regional dummy variables in column 5 keeps the results unchanged. In column 6 we drop the river and *Muzaara* interactions and explore a specification with Proportion *Muzaara*. Despite the inclusion of two powerful correlates of literacy, rainfall and *Muzaara*, the politics interaction continues to exert a negative and significant impact.

Additionally, Table 6.4 replicates the initial set of results shown in Table 6.2 using a restricted sample of *tehsils* in which shrines have no links with politics. If riverine shrines affect literacy through the channel of politics then restricting the sample to *tehsils* with no shrine-politics linkage should remove the significance of the coefficient on the shrines per capita (*shrines pc*) variable in Table 6.2. Table 6.4

[51] The 75th percentile of the Proportion Muzaara is equivalent to 0.0636.

shows that this is indeed the case. Once *tehsils* with political shrines are dropped from the regressions the coefficient on shrines per capita (*shrines pc*) becomes statistically insignificant for all models.

Together, these results are consistent with the suggestion that the impact of riverine shrines is primarily mediated through politics. As the narrative in section 6.2 argues, prominent shrines dotted along rivers of Punjab have traditionally acted as important nodes of power, where structures of religious and political authority have been historically co-determined. Through their control of the three critical resources – religion, land and politics – they are a key constitutive element of the local power structure. This is confirmed by eyeballing the data on shrine-related political families and matching it with selective interviews and qualitative data. Invariably, politically linked shrines have either direct or indirect control over vast tracts of agricultural land. Caretakers of these shrines are therefore not simply *pirs*, but *pir-zamindars*. Today, nearly all leading *pir* families own substantial tracts of land[52]. Their landed power is largely hereditary. Thus, politically influential shrines encapsulate the impact of both landed and political power. However, the effect of political shrines is over and above any direct role of land inequality measured through the *Muzaara* variable.

Overall, these results provide first-cut evidence on the empirical relationship between shrines, politics and development. Since our results are based only on direct evidence of a shrine family's entry into politics, they understate the true relationship between shrines and politics. Even if a shrine lacks direct electoral representation, it can play a crucial indirect role by garnering support for election

[52]The *pirs* also consolidate their power through strategic marital alliances with large landowners. Urban shrines have also continuously added to their existing land holdings. For example, the *Pir* of Golra Sharif has sizeable landholdings in and around Islamabad. Even shrines with more limited economic fortunes tend to function with the patronage and support of local landlords.

candidates. A relevant example is the shrine of Shaikh Fazil in Burewala that is better known for its indirect political brokerage than direct electoral contest, and has an impressive political footprint on multiple constituencies of Punjab[53]. Support of the shrine of Golra Sharif is similarly deemed critical for candidates from many neighbouring constituencies in Islamabad and Rawalpindi.

6.5 Shrines and Politics

In this section, we probe the political dimension in greater detail by considering rival historical explanations and investigating the determinants of political selection. A key challenge is that initial *tehsil* characteristics might determine the extent to which shrines had an influence over literacy, and that these characteristics may either persist affecting literacy today, or that they might have influenced development outcomes in the past through channels other than the influence of shrines. One crucial dimension that could conflate the impact of political shrines is the historical literacy rate. It is a well-established fact that literacy rates display considerable persistence over time. This has important implications for our results. If regions with political shrines had historically lower literacy rates to begin with then their negative impact on literacy could simply capture these adverse initial conditions. The exclusion of other historically determined *tehsil* characteristics from our model poses a similar challenge. We try to address these concerns by re-estimating our model on the sample of colonial *tehsils* and including historically pre-determined characteristics in the model. This requires that we fix *tehsil* boundaries at 1931, the census year for which historical data is readily available. Data on 115 contemporary *tehsils* were therefore collapsed into data for 61 colonial

[53] As a regular election ritual, candidates from neighbouring constituencies queue up in Shaikh Fazil to seek spiritual and political support.

tehsils. Our strategy for doing so comprised of the following three steps. First, we identify the historical parent *tehsils* of each of the 115 contemporary *tehsils*. Then, we calculate the proportion of the areas of each of the contemporary *tehsils* that were carved out from the historical parent *tehsils*. Finally, we use these proportions to compute the area–weighted averages of the data from contemporary *tehsils* based on the historical parent *tehsil* boundaries.

Results for this exercise are presented in Table 6.5. Our historical sample, consisting of 61 colonial *tehsils*, is dictated by data availability[54]. Several historical variables were compiled from district gazetteers and Census Reports. We first assess the robustness of our final explanation, the political influence of shrines, on the historical sample. Column 1 includes the Politics dummy variable and its interaction with our main variable of interest, shrines pc. The usual set of geographic controls, including average rainfall measured for 1923, is also included. Consistent with our argument, greater concentration of shrines in *tehsils* where shrine families have a direct political presence have systematically lower literacy rates. Results on the historical sample confirm that the presence of shrines is harmful for literacy only in *tehsils* where shrines have a manifestly political role. As expected, rainfall is a strong and positive predictor of literacy. The statistically significant coefficient on regional dummy for north Punjab suggests an unexplained literacy differential between north and west Punjab.

We then control for historical land inequality in column 2. To measure land inequality we use detailed information on land tenure contracts from various editions of district gazetteers compiled by the British colonial administration. Typically, district gazetteers divided land tenure contracts into four categories: *zamindari*,

[54]The sample size reduced from 69 to 61 *tehsils* due to unavailability was dictated by data availability.

pattidari, *bhayachara*, imperfect *bhayachara* and Government-owned lands. Our main interest is in the proportion of the total number of villages governed by zamindari contracts[55]. Land held in *zamindari* contracts recognized proprietary rights of individual owners and entailed a direct payment[56]. Effectively, the contracts recognized the de facto ownership and influence of large landlords. Adding the *zamindari* variable in column (2) results in a weakly significant coefficient and suggests a negative impact of historical land inequality on contemporary literacy. Importantly, however, the interaction between shrines and politics retains its explanatory power.

The inclusion of historical literacy rate, compiled from the 1931 Punjab Census Report, does not change the results. Its own coefficient is not significantly different from zero (see column 2). The next column adds literacy rate in 1951 of migrants who crossed over from India in the wake of the 1947 partition. If *tehsils* with riverine shrines attracted relatively less literate migrants than this could be a potential confounding factor. Results in column 3 dispel this concern: the migrant literacy rate enters with a statistically insignificant coefficient. Together, these results suggest that our findings are not driven by the exclusion of historical literacy rate.

We experimented with a range of other historical characteristics that might have a bearing on contemporary literacy and compete with our political explanation.

[55]Ideally it would be more appropriate to estimate the total area under *zamindari* contracts, rather than counting the number of villages. However, the coverage of data on land tenures by area is very sparse.

[56]In *pattidari*, both the land and revenue were divided in accordance with ancestral or customary shares as per the laws of inheritance. Under *bhayachara* contracts, possession was the measure of right of land. Through both *Pattidari* and *bhayachara* the *de facto* land tenure arrangements that pre–existed the British rule were recognized. Another category, imperfect *bhayachara* and *pattidari*, denoted a situation where the land was held partly in severalty and partly in common; the measure of right in common land was the amount of the share or the extent of land held in severalty.

Prominent amongst these are: the share of total public spending dedicated to education in 1911 (col. 4); the proportion of total cultivated area that is irrigated (col. 5); and military recruitment as a percentage of total men of military age (col. 6). Apart from military recruitment, which has beneficial impact on contemporary literacy, none of the other dimensions were significant. Interestingly, with the addition of military recruitment, the dummy variable for north Punjab becomes unimportant. This is easy to reconcile: north Punjab has historically been a recruitment centre for the British and, later, Pakistani military[57]. We experimented with a range of other variables, neither of which had a statistically significant impact (not reported for shortage of space); these included measures of religious diversity; and the number of *zaildars* per capita (local revenue collectors)[58]. Overall, models estimated on the historical sample explain around 70 percent of the variation in literacy rate. Importantly, our emphasis on the political economy of shrines is maintained even after controlling for a variety of historical explanations. The coefficient on shrines-politics interaction is statistically significant at 5 percent level in all specifications.

6.5.1 Determinants of Political Selection

If the impact of riverine shrines on literacy is mediated through politics, it is worth asking: What factors determine the selection of shrines into politics? Which *tehsils* are more likely to have political shrines? As argued in section 6.2, the local influence of *pirs*, their capacity to act as intermediaries and their control of landed

[57]The role of military recruitment in human capital accumulation in colonial Punjab has been discussed in greater detail in Eynde (2015).

[58]The variable for religious diversity combines census information on the proportion of population identified as Muslim, Hindu, and Sikh. Moreover, *zaildars* were effectively village headmen in charge of tax collection from their respective *zails* (revenue extraction units usually a collection of villages). Typically, *zaildars* were locally influential landlords

property act as crucial political assets. The *pirs* established an early foothold into politics, dating back the pre-partition era when noted shrine families participated in the 1937 and 1946 elections. As Table 6.1 shows, many of these families have persisted in electoral politics after independence.

In probing the determinants of political selection, we emphasize factors embedded in the political history of colonial Punjab. Our main prior is that shrines that enjoyed greater influence in the colonial era are more likely to have entered into politics in post-partition Punjab. To capture this, we draw upon the historical database described in section 6.3 that records the number of shrines in a *tehsil* that were mentioned in District Gazetteers. Typically, the Gazetteers recorded shrines that wielded greater influence over local political economy. These shrines were more likely, in turn, to receive colonial patronage and enter into electoral politics.

Drawing on these two unique databases, we now examine our claim that historically important shrines are more likely to select into electoral politics in post-independence Punjab. To investigate this we run probit models for the dichotomous dependent variable, coded one for *tehsils* where shrines have a direct electoral linkage, zero otherwise (see section 6.3 for a detailed discussion of the politics database). Our main explanatory variable for political selection is a dummy variable selecting *tehsils* containing at least one shrine mentioned in the historical District Gazetteer. We find that all across Punjab there is evidence of historically influential shrines, but south-western parts of Punjab have a greater concentration of such shrines. There is also a larger presence of politically influential shrines in south-west Punjab.

Table 6.6 presents results for this investigation. For ease of interpretation, we report marginal probability effects for different variables[59]. Column 1 provides an initial test of our prediction. As expected, the coefficient on the binary PDG variable is positive and statistically significant at the 1 percent level. This suggests that as the variable for shrines mentioned in PDG takes the value 1, the probability that a *tehsil* has politically affiliated shrine(s) increases by 31 percentage points. Column 2 includes the usual set of geographic controls: latitude, longitude, elevation, and distance from river[60]. While the coefficient on the log of elevation is negative and significant, the effect of our historical shrine variable remains fairly robust. This impact also holds up to the inclusion of regional fixed effects in column 3; the coefficients on central and south Punjab are positive and statistically significant. If the dummy variable for central Punjab takes the value one, the probability that the *tehsil* has a politically affiliated shrine increases by 44 percentage points relative to western Punjab. The inclusion of average rainfall (column 4) does not alter the results.

It is possible that shrines have a greater political role in *tehsils* with a more unequal land distribution. We checked this by entering Proportion *Muzaara* in the model (results not shown). It was neither significant on its own nor did it dislodge the impact of historical shrine measure[61]. The preceding analysis provides strong support for our argument that the likelihood of a *tehsil* containing a politically linked shrine increases if it as the average number of shrines mentioned in PDGs

[59] Marginal probability effects are the partial effects of each explanatory variable on the probability that the observed dependent variable equals 1. These are estimated at the sample mean values of regressors.

[60] The last three variables are expressed in natural log.

[61] Experimenting with an alternative, district-level, measure of land inequality (the proportion of total cultivated area in a district that is 25 acres and above, obtained from the Agricultural Census of Pakistan) yields a slightly more informative result. While the coefficient on this alternative land inequality measure was positive and significant at 10% level, the PDG variable retained its robust influence, indicating that it is not simply capturing underlying land inequality.

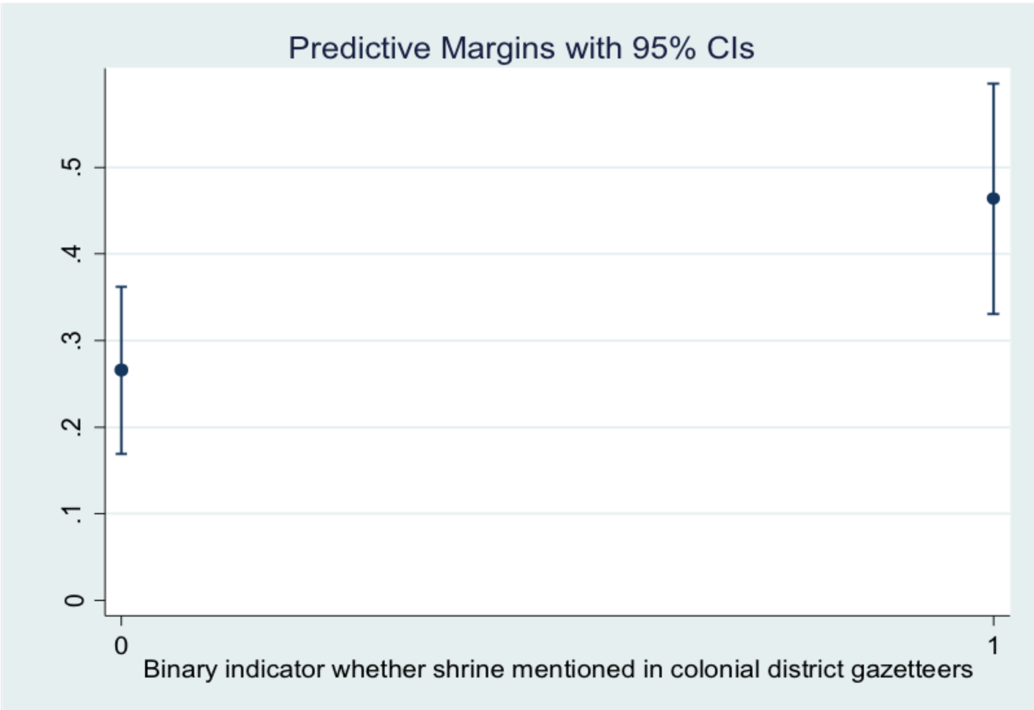
rises. What it does not test, however, is the role of historical literacy rate on the probability of political selection. This may be important to control, since *tehsils* with a historically lower literacy rate may also have a greater concentration of PDG shrines. We test this possibility in columns 5-6 that report probit estimates on the historical sample consisting of 69 *tehsils*.

The initial pattern of results also holds in the historical sample. Replicating the model in column 4 on the historical sample preserves the basic pattern of results. In column 6 we add the historical literacy rate (based on the 1931 census of Punjab), which has a statistically significant negative impact. Calculated at the mean values of control variables, a small increase in the average historical literacy rate decreases the probability that a *tehsil* has a political shrine by 57 percent[62]. Importantly, however, the coefficient on the PDG dummy variable is still positive and statistically significant at 1 percent level. This means that if the PDG dummy changes from zero to one, the probability that a *tehsil* has a political shrine increases by 42 percentage points (see Figure 6.3). The diagnostic chi-square tests suggest that our model fits the data reasonably well[63]. In short, *tehsils* with shrines considered as historically important, as measured by their mention in historical district gazetteers, predict their selection into politics in post-independence Punjab. Importantly, the underlying pattern is not simply driven by lower initial historical literacy rates in such *tehsils* or regional fixed effects. Taken together, the above results indicate a strong pattern of persistence.

[62] Including a measure of historic land inequality (the proportion of *zamindari* villages) together with the 1931 total literacy rate doesn't alter the results.

[63] The Pearson chi-square test is a test of the observed against expected number of responses using cells defined by covariate patterns.

Figure 6.3: Persistence of shrine influence



Notes: The figure plots the predictive margins from the probit regression of a binary dependent variable for the political linkage of a shrine on another binary variable indicating whether the shrine is historically significant or not.

6.5.2 The Political Economy of Schooling

Given the primacy of politics in our empirical analysis, it is worth probing how politics might shape literacy in Punjab. Globally, there is a well-established literature on the political economy of public service provision. Recent empirical evidence has also highlighted the relevance of politics in explaining both variation in educational outcomes and administrative arrangements for educational provision (Ansell and Lindvall, 2013; Gallego, 2010). Given that literacy also serves as a political resource, there can be multiple pathways linking politics to education. This section furnishes some pertinent evidence from Punjab. For brevity, we focus only on two inter-related dimensions: the modes of governance affecting the educational sector and the mechanisms behind elite capture of resources for schooling.

Punjab's political elites have historically enjoyed significant control over public policy and administrative structures for education. Whether administered through the centre, province or a decentralized dispensation, educational provision has largely remained a centralized affair, where interests of political elites are routinely accommodated. Since colonial rule institutional arrangements for public provision of education have privileged the role of local elites and the bureaucratic class. Under the British, education was administered by local governments: district boards in rural areas and municipal committees in urban centres[64]. Local governments were usually composed of members that were elected, nominated or appointed. The nominated members were typically drawn from the locally influential elite who owed their allegiance to colonial authorities. Appointed members were officers of the colonial bureaucracy, such as the District Commissioner or the

[64] Local governments were responsible for financing the construction of new schools and the maintenance and supervision of existing schools.

Magistrate. Elected members usually consisted of middle class professionals (e.g. lawyers and doctors) primarily belonging to major towns of the district.

In this milieu, the attitude of the political class towards education was of considerable import. From the three types of members mentioned above, elected members from towns were likely to be more responsive to the local demand for schooling. In contrast, nominated members were typically drawn from the local gentry who were considered as the 'yes men' of the colonial bureaucracy (embodied in the person of the District Commissioner), and were either indifferent or hostile to mass schooling. Mass education has been traditionally viewed by these elites as a threat to the local power structure. While in other provinces of British India elected members usually held greater sway on matters of local development, in Western Punjab, the nominated and appointed members in local governments outnumbered elected ones. Here, the local gentry usually formed a nexus with appointed members to steer the course of local development, which included public provision of education.

This partnership between political and bureaucratic intermediaries was further consolidated through the direct appointment of District Commissioners as chairmen of the District Boards and Municipal Committees. As Tinker and Hailey (1954) noted, this centralized bureaucratic management of education was peculiar to Punjab:

> "in Punjab the district boards continued to be presided over by the district officers, while all boards continued to lean heavily upon the advice of the education department inspectorate, so that educational development was much more a partnership between officials and non-officials than in most provinces". (Tinker and Hailey, 1954, p. 256)

This alliance between political and bureaucratic classes persisted after independence even if the institutional arrangements for public goods provision underwent some change. Substantively, educational administration remained "hierarchical and centralized" (Gazdar, 1999). Even though military rulers – who ruled over half of the country's independent history – promoted local governance, this was primarily used to centralize power and bypass mainstream political parties. Usually held on a non-party basis, local government elections have often re-cycled local elites with little stake in the promotion of literacy. The Basic Democracy system introduced by Ayub Khan, Pakistan's first military ruler, preserved the colonial practice of retaining a mix of elected and appointed members. Appointed members belonged to the civil bureaucracy and had the power to override decisions of elected members. Essentially, this maintained the centralized decision making that existed before partition.

Abolishing direct bureaucratic representation in local governments, subsequent military rulers gave more voice to elected members. Under Pervez Musharraf, greater fiscal responsibility was devolved to local representatives. However, elections have been centrally managed to extend the military regime's control over masses. Public policy on education remained vulnerable to elite capture, since historically entrenched elites were inherently advantaged in elections held on a non-party basis Cheema, Khalid, Patnam, et al. (2008). Ironically, the resumption of democratic politics was usually accompanied with a scale back of local governments. Dominated by influential political brokers who are loathed to seeing the emergence of new leadership from the grassroots, political parties have remained hesitant to share power with local representatives. Even as a provincial subject, educational administration remained centralized. As Gazdar (1999) notes: "Decision-making is largely concentrated at the provincial level, and the job of the directorates and the district offices is to implement these directives and policies, and to report back to the top" (Gazdar, 1999, p. 26).

Preserving the historical alliance between bureaucrats and elected politicians, this centralized structure gives politicians considerable sway in identifying and sanctioning development schemes. Since the 1980s they have also exercised growing control over the disbursement of development expenditures in their respective constituencies. In this milieu, as political overlords, shrine guardians are well-placed to shape both the quantity and quality of school provision. As argued before, *pirs* have strong incentives to oppose mass schooling. Next, we describe the mechanisms for elite capture.

6.5.3 Mechanisms of Elite Capture

Punjab's landed gentry has historically shown little interest or commitment for schooling. Typically caricatured as opposing the construction of new schools, the attitude of Punjab's rural elites has changed overtime from an outright obstruction to one where they actively compete for government resources on education. In both cases, the result is the same: a defective and broken system of education. Faced with a historic deficit in social sector spending, the 1980s saw a new resolution among policymakers to channel greater resources towards education. With the help of international donors, various political governments in the 1990s launched a multi-million initiative, the Social Action Programme (SAP). The programme was subjected to such widespread political abuse that the World Bank ended up describing it as a 'failure'. An independent evaluation for the Bank concluded that "politicians used staff recruitment, construction contracts, and site selection for schools and clinics to enrich their kith and kin" (Birdsall, Malik, and Vaishnav, 2005, p. 26).

The failure of SAP was emblematic of the deeper malaise affecting the education sector; it represented a large scale political capture of public resources. For politicians the construction of new schools offered lucrative contracts for distribution to cronies. As one of the largest provincial departments, the education sector offers plentiful opportunities for distributing employment to favoured constituents. Teacher appointments are managed centrally at the provincial level. As Gazdar (1999) noted:

> "The appointment of primary teachers was, formerly, the responsibility of the DEO. Over the years, however, these appointments have become 'politicised' in the sense that local members of National and Provincial Assemblies (MNAa and MPAs) exert a great deal of influence on teacher appointments. The DEOs discretionary power has been replaced in recent years by an appointment committee consisting of officials and 'notables' in a district, but in practice, the DEO and, above him or her, the political representatives remain in control." (Gazdar, 1999, p. 26).

Such non-merit appointments create negative externalities for the wider system. Politically appointed teachers are difficult to monitor or hold accountable. They also affect the morale of other teachers. Schools are plagued by teacher absenteeism. In single-teacher schools in far-flung regions, such absenteeism results in school closure. Political patrons also use transfers of teaching staff to punish or reward their constituents. Over the last two decades, plentiful evidence has emerged on the existence of 'ghost schools' that exist on government papers but are inaccessible to students. Yet, administrative overheads, including teacher salaries, are regularly paid for, resulting in a significant pilferage of scarce resources. A remote location can make schools practically inaccessible to students, especially females, and allows local notables to divert them for private use as private residences, cattle-sheds or stables.

Political interference also distorts the composition and quality of spending. Given the potential for rent capture, brick and mortar investments are privileged over recurring expenditures on maintenance, resulting in the poor quality of the schooling infrastructure. As recent evidence shows that around 60 percent of primary schools do not have electricity, 36 percent lack any drinking facility, 42 percent have no washrooms, and 30 percent have only a single teacher (GOP, 2014). The empirical and contextual evidence in this paper has demonstrated that the crisis is partly political. While donors have frequently lamented the "lack of political will", our analysis underscores the need to understand the stable and historically-embedded conditions from which this absence of political will emanates.

6.6 Conclusion

This paper has shed light on how structural inequality – defined by the powerful configuration of religion, land and politics – shapes contemporary development outcomes in Pakistani Punjab. We have argued that considering ways in which religious shrines in riverine regions influence literacy can provide a critical window into the subject. Drawing on a unique compilation of data on shrines capturing their contemporary, historical and political dimensions, we demonstrate that a greater concentration of shrines in riverine *tehsils* is associated with lower literacy rates on average. The result is robust to controlling for a variety of controls, including land inequality, which is itself one of the most significant correlates of literacy. Another contribution of this paper is its focus on possible channels of transmission. We show that the impact of riverine shrines on literacy is principally mediated through their influence on politics. The impact of shrines is largely driven by *tehsils* where prominent shrine families have directly entered into electoral politics.

Given that the connection between *pirs* and politics is often consummated through large landholdings, these findings testify to the importance of the interplay between religious, landed and political power. Going a step further, we also probe the determinants of political selection, and discover that shrines considered as historically important, as reflected in their recognition and patronage from British colonial authorities, were more likely to select into politics in post-colonial Punjab. While colonial patronage for shrines was part of a long-standing tradition of rewarding shrine guardians, it was accompanied, under British rule, with "structural transformations" in the property rights regime through introduction of the 1900 Land Alienation Act. Cementing the nexus between religious and landed elites of Punjab, colonial rule led to a significant entrenchment and consolidation of the underlying power structure. Although we are careful not to ascribe a causal interpretation to these results, the underlying statistical pattern is both robust and consistent. Both qualitative and quantitative evidence suggests a strong persistence of the political economy of shrines.

While past literature has investigated the influence of shrines mainly through a non-economics lens, this paper offers the first systematic application for development. Our findings support the intuition of both historical and contemporary observers (ranging from Darling to Aziz and Lieven) that perceived *pir-zamindars* as an obstructive force against educational progress. Apart from enriching the discourse on Punjab's political economy of development, our analysis also casts fresh light on the broader literature on religion and development. Rather than painting a uniformly bleak picture of shrines, we argue that the relationship between religion and development is mediated by the underlying power structure.

A comparison with *sufi* shrines in Northern India can be instructive in this regard. Although similarly patronized by past rulers through revenue-free land grants, *sufi* establishments in India witnessed a substantial decline in their material fortunes, firstly, under British rule, due to succession battles in civil courts, and, secondly, after the introduction of land reforms in 1950s. Jafri (2007) shows how the financial fortunes of a prominent shrine in southern Awadh suffered after the enactment of UP Zamindari Abolition and Land Reforms Act 1952. While the connection between religion, land and politics was decoupled after independence in India, it was structurally consolidated in Pakistan. Future research can consider such comparisons in more detail. While, within Pakistan, our analysis is centred on Punjab, extending it further south to Sind province is only likely to reinforce our argument, since the fusion between religion, land and politics is even stronger in Sind[65].

Our research has concrete implications for policy. Pakistan has witnessed a persistent education crisis, marked by low education spending and poor education indicators. In this milieu, educational expansion is not just about scaling up resource endowments, but also requires addressing structural inequalities. Malcolm Darling correctly observed in 1928 that "in agriculture the social factor is as im-

[65]Shrines in Sind also received significant colonial patronage. As Aziz (2001) notes, "according to official reports, at the time of the British arrival in Sindh the revenue appropriated to ecclesiastical establishments amounted to one third of the total revenue of the government". (Aziz, 2001, p. 17-18)

portant as the economic" (Lyall, 1928, p. 258). Few would disagree today that the same is true for education.

Table 6.1: Persistence of leading shrine families in politics

District/Tehsil	Shrine/Gaddi	Selected Family Representation in Politics
Okara/Shergarh	Daud Bandagi	Syed Mohammad Hussain (1921, 1924) Pir Mohammad Hussain Shah Kirmani (1927) Syed Ashiq Hussain Kirmani (1946) Syed Shahnawaz Kirmani (1962) Syed Sajjad Haider Kirmani (1985, 1988, 1990, 1997) Syed Sabtain Shah (2002) Syed Ashiq Hussain Shah Kirmani (2013)
D.G. Khan/ Taunsa	Taunsa Sharif	Khwaja Ghulam Murtaza (1945) Khawaja Ghulam Moeen-ud-Din (1985) Khwaja Kamal-ud-din Anwar (1988; 1993) Khwaja Sheraz Mahmood (2002; 2008) Khawaja Muhammad Nizam-ul-Mehmood (2013)
Pakpattan	Pakpattan Sharif	Diwan Ghulam Qutub-ud-din (1965) Mian Ghulam Ahmad Khan Maneka (1985; 1988) † Ahmad Raza Maneka (2002) † Dewan Azmat Said Muhammad Chishti (1997; 2013) Mian Atta Mohammad Maneka (2013) †
Jhang	Shah Jewana	Syed Hussain Shah (1924) Syed Abid Hussain (1946) Major Syed Mubarik Ali Shah (1946, 1951) † Zulfiqar Ali Bokhari (1962, 1977) Syed Abida Hussain (1972, 1985, 1997) Makhdoom Faisal Saleh Hayat (1970, 1988, 1993, 2002,2008) Syed Fakhr-e-Imam Shah (1985, 1990, 1997) † Syeda Sughra Imam (2002)
Multan	Shah Rukn-e-Alam	Pir Zahoor Hussain Qureshi (1951, 1956, 1962) Makhdum Muhammad Sajjad Hussain Qureshi (1962, 1965, 1977) Makhdum Shujaat Hussain Qureshi (1977, 1990, 1993) Makhdum Shah Mahmood Qureshi (1985, 1988, 1990, 1993, 2002, 2008)
Multan	Musa Pak Shahid	Syed Raza Shah Gilani (1921, 1924, 1936) Syed Alamdar Raza Gilani (1951) Syed Hamid Raza Gilani (1962, 1965, 1977, 1985) Syed Yousaf Raza Gilani (1985, 1988, 1990, 1993, 2008) Syed Asad Murtaza Gilani (2002)

Notes: † Related to the shrine family. Year in the bracket represents the year elected to the National or Provincial Assembly. Information in the Table is purely illustrative; the list of individuals and their respective election years is not comprehensive.

Table 6.2: Shrines and literacy

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Literacy Rate, Year 10 and Above						
Shrines per capita	-2.6966**	-2.7342**	-2.5821**	-2.413**	-2.281*	-2.484**	-2.451**
	(1.2894)	(1.1542)	(1.1533)	(1.173)	(1.160)	(1.180)	(1.191)
Shrines pc x Distance from River	0.1135*	0.0905*	0.0723	0.042	0.025	0.042	0.043
	(0.0576)	(0.0518)	(0.0547)	(0.056)	(0.059)	(0.057)	(0.057)
Distance from River	-0.0004	-0.0000	0.0002	0.000	0.001	0.000	0.000
	(0.0006)	(0.0005)	(0.0006)	(0.001)	(0.001)	(0.001)	(0.001)
Latitude	0.2329	0.1978	0.1280	-0.161	-0.140	-0.162	-0.147
	(0.3014)	(0.2082)	(0.1987)	(0.177)	(0.203)	(0.174)	(0.183)
Longitude	2.1878***	1.6471***	1.5719**	0.868	0.782	0.897	1.187
	(0.5118)	(0.4586)	(0.7458)	(0.706)	(0.710)	(0.715)	(1.194)
Elevation	0.1224***	0.0765***	0.0573*	0.045	0.054*	0.044	0.044
	(0.0285)	(0.0231)	(0.0310)	(0.030)	(0.031)	(0.030)	(0.030)
Proportion Muzaara		-1.852***	-1.794***	-1.88***	-1.75***	-1.88***	-1.91***
		(0.3826)	(0.3669)	(0.353)	(0.360)	(0.359)	(0.348)
North			0.0387	0.010	0.000	0.011	0.008
			(0.0330)	(0.034)	(0.034)	(0.034)	(0.035)
Central			0.0139	0.006	0.001	0.003	0.007
			(0.0241)	(0.024)	(0.024)	(0.024)	(0.024)
South			-0.0128	-0.002	-0.010	-0.002	-0.003
			(0.0261)	(0.024)	(0.025)	(0.024)	(0.024)
Average Rainfall				0.06***	0.06***	0.06***	0.06***
				(0.019)	(0.019)	(0.019)	(0.021)
Distance from GT Road					-0.005		
					(0.003)		
Neighbouring Shrine per capita						-1.193	
						(2.471)	
Distance from Lahore							0.004
							(0.011)
Constant	-10.3706***	-7.5547***	-6.8827**	-3.074	-2.805	-3.188	-4.482
	(1.9791)	(1.9130)	(2.9722)	(2.818)	(2.815)	(2.863)	(5.140)
Adj R-Squared	0.5870	0.6739	0.6708	0.690	0.692	0.688	0.688

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Latitude, longitude and elevation are expressed in natural logs. The following variables are expressed in natural log: latitude, longitude, elevation, rainfall and distance from GT Road.

Table 6.3: Channels of transmission

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Literacy Rate, Year 10 and Above					
Shrines pc	1.131	3.114**	2.556*	1.177	1.043	0.183
	(1.404)	(1.334)	(1.361)	(1.344)	(1.530)	(1.302)
Latitude	0.176	0.166	0.128	-0.243	-0.227	-0.192
	(0.271)	(0.251)	(0.235)	(0.207)	(0.222)	(0.150)
Longitude	2.270***	2.256***	2.102***	1.335**	1.309	0.819
	(0.560)	(0.530)	(0.566)	(0.567)	(0.988)	(0.763)
Elevation	0.135***	0.132***	0.125***	0.097***	0.087***	0.066**
	(0.026)	(0.024)	(0.023)	(0.020)	(0.032)	(0.029)
River Dummy	0.043	0.021	0.012	-0.002	0.001	
	(0.027)	(0.028)	(0.029)	(0.028)	(0.029)	
Shrines pc x River Dummy	-4.322**	-1.601	-1.445	-0.622	-0.634	
	(2.010)	(2.246)	(2.367)	(2.306)	(2.431)	
Politics Dummy		0.047*	0.046	0.043	0.040	0.023
		(0.028)	(0.030)	(0.029)	(0.030)	(0.024)
Shrines pc x Politics Dummy		-5.489**	-5.792**	-4.901*	-4.900*	-3.308*
		(2.333)	(2.595)	(2.522)	(2.645)	(1.817)
Muzaara Dummy			-0.044	-0.055*	-0.055*	
			(0.029)	(0.029)	(0.029)	
Shrines pc x Muzaara Dummy			2.072	1.966	2.151	
			(1.978)	(1.904)	(2.036)	
Average rainfall				0.067***	0.061**	0.057***
				(0.022)	(0.025)	(0.020)
North					0.033	0.017
					(0.042)	(0.035)
Central					0.015	0.015
					(0.030)	(0.027)
South					0.010	0.011
					(0.029)	(0.025)
Proportion Muzaara						-1.74***
						(0.376)
Constant	-10.634***	-10.528***	-9.684***	-5.235**	-5.103	-2.893
	(2.169)	(2.059)	(2.320)	(2.539)	(4.096)	(3.090)
Adjusted R-squared	0.585	0.594	0.596	0.623	0.614	0.686

Notes: See notes for Table 5.2.

Table 6.4: Shrines and literacy (excluding *tehsils* with shrine-politics linkage)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Literacy Rate, Year 10 and Above						
Shrines per capita	0.307	-0.496	-0.181	-0.684	-0.428	-0.450	-0.593
	(2.946)	(2.422)	(2.415)	(2.437)	(2.465)	(2.474)	(2.452)
Shrines pc x Distance from River	0.056	0.037	0.004	0.008	-0.007	0.002	0.007
	(0.107)	(0.088)	(0.088)	(0.088)	(0.090)	(0.089)	(0.088)
Distance from River	-0.000	0.000	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Latitude	0.217	0.204	0.061	-0.094	-0.095	-0.103	-0.097
	(0.221)	(0.182)	(0.192)	(0.226)	(0.226)	(0.227)	(0.227)
Longitude	2.955***	2.437***	2.296**	1.638	1.446	1.559	1.963*
	(0.667)	(0.555)	(0.888)	(0.986)	(1.018)	(0.998)	(1.111)
Elevation	0.122***	0.057	0.026	0.017	0.026	0.016	0.015
	(0.028)	(0.025)	(0.034)	(0.035)	(0.036)	(0.035)	(0.035)
Proportion Muzaara		-2.334***	-2.166***	-2.239***	-2.164***	-2.270***	-2.292***
		(0.398)	(0.402)	(0.406)	(0.417)	(0.410)	(0.416)
North			0.068*	0.054	0.044	0.0555	0.0491
			(0.039)	(0.042)	(0.044)	(0.042)	(0.042)
Central			0.023	0.022	0.020	0.027	0.022
			(0.032)	(0.033)	(0.033)	(0.034)	(0.033)
South			-0.029	-0.019	-0.021	-0.018	-0.022
			(0.034)	(0.035)	(0.035)	(0.035)	(0.035)
Averarge Rainfall				0.035	0.032	0.032	0.036
				(0.029)	(0.029)	(0.029)	(0.029)
Distance from GT Road					-0.004		
					(0.005)		
Neighbouring Shrine per capita						1.944	
						(2.992)	
Distance from Lahore							0.009
							(0.014)
Constant	-13.618***	-10.823***	-9.554**	-6.306	-5.507	-5.938	-7.719
	(2.955)	(2.472)	(3.773)	(4.334)	(4.461)	(4.391)	(4.871)
Adj R-Squared	0.552	0.6739	0.698	0.707	0.705	0.704	0.704

Robust standard errors in parentheses:
*** p<0.01, ** p<0.05, * p<0.1

The sample excludes all thesils in which a shrine has a link with politics. The following variables are expressed in natural logs: latitude, longitude, elevation, rainfall and distance from GT road.

Table 6.5: Shrines and literacy, historical sample

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Literacy Rate, Year 10 and above					
Shrines pc	1.326**	1.211**	1.238**	1.279**	1.205**	1.052*
	(0.538)	(0.565)	(0.537)	(0.566)	(0.535)	(0.527)
Politics Dummy	0.041	0.050	0.053	0.054	0.048	0.045
	(0.035)	(0.035)	(0.035)	(0.036)	(0.035)	(0.034)
Shrines pc x Political Dummy	-1.914**	-1.687**	-1.689**	-1.790**	-1.648**	-1.450**
	(0.746)	(0.771)	(0.747)	(0.796)	(0.751)	(0.738)
Average rainfall, 1923	0.009***	0.007***	0.007***	0.007***	0.006**	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Latitude	0.237	0.143	0.113	0.146	0.147	0.033
	(0.211)	(0.221)	(0.219)	(0.216)	(0.216)	(0.218)
Longitude	0.235	0.931	1.068	0.962	0.818	0.786
	(1.133)	(1.192)	(1.203)	(1.188)	(1.208)	(1.153)
Elevation	-0.053	-0.021	-0.016	-0.018	-0.020	-0.002
	(0.050)	(0.053)	(0.053)	(0.053)	(0.052)	(0.052)
North	0.138**	0.127**	0.131**	0.126**	0.127**	0.053
	(0.052)	(0.054)	(0.052)	(0.052)	(0.051)	(0.065)
Central	0.090*	0.082*	0.078*	0.084*	0.091*	0.086*
	(0.046)	(0.047)	(0.046)	(0.047)	(0.050)	(0.045)
South	0.051	0.032	0.030	0.035	0.042	0.030
	(0.042)	(0.049)	(0.043)	(0.044)	(0.049)	(0.042)
Zamindari Villages (% of total)		-0.149*	-0.148*	-0.155*	-0.139	-0.136
		(0.084)	(0.084)	(0.085)	(0.087)	(0.082)
Historical Literacy Rate, 1931		-0.001				
		(0.021)				
Migrant Literacy Rate, 1951			-0.120			
			(0.193)			
Education expenditures, 1911				-0.001		
				(0.002)		
Proportion *Nahri*					-0.021	
					(0.046)	
Military Recruitment, %						0.004*
						(0.002)
Constant	-1.141	-3.958	-4.443	-4.104	-3.483	-3.073
	(4.802)	(5.057)	(5.052)	(5.014)	(5.091)	(4.875)
Observations	61	61	61	61	61	61
Adjusted R-squared	0.720	0.726	0.728	0.727	0.727	0.742

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The following variables are expressed in natural log: latitude, longitude, elevation, and historical literacy rate.

Table 6.6: Determinants of political selection (probit models)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dummy Variable for Political Shrines					
Whether shrine mentioned in PDG	0.305***	0.248**	0.232**	0.226**	0.370**	0.417***
	(0.087)	(0.096)	(0.101)	(0.100)	(0.156)	(0.156)
Latitude		-1.143	-0.739	0.060	0.449	1.509
		(1.008)	(0.932)	(1.072)	(1.408)	(1.356)
Longitude		1.780	-6.241	-4.790	-15.216	-10.307
		(3.149)	(4.705)	(4.747)	(11.626)	(10.607)
Elevation		-0.419**	-0.329**	-0.316*	-1.618***	-1.711***
		(0.169)	(0.164)	(0.162)	(0.553)	(0.596)
Distance from River		-0.001	-0.003	-0.003	0.007	0.008
		(0.003)	(0.003)	(0.003)	(0.007)	(0.007)
North			0.321	0.421*	0.707***	0.735***
			(0.253)	(0.255)	(0.104)	(0.101)
Central			0.441**	0.459***	0.845***	0.875***
			(0.171)	(0.166)	(0.155)	(0.124)
South			0.408**	0.365**	0.630***	0.777***
			(0.183)	(0.186)	(0.125)	(0.089)
Average rainfall				-0.164	0.016	0.022
				(0.146)	(0.015)	(0.016)
Historical literacy rate						-0.571***
						(0.213)
Sample	Full	Full	Full	Full	Historical	Historical
Pseudo R-squared	0.075	0.194	0.233	0.24	0.482	0.545
Chi-Square test		0.608	0.615	0.487	0.755	0.922

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The sample consists of 115 tehsils. In columns 5-6, the historical sample consists of 69 tehsils.

6.A Appendix

Table 6.A.1: Key shrine statistics across various regions of Punjab

Regions	Shrines (per 10,000 people)	Shrines Mentioned in District Gazetteers (*Number*)	Shrines with families active in politics (*Number*)
North	0.011	9	2
Centre	0.008	36	25
South-West	0.009	101	37

Source: Authors' own calculations using the shrines database. See Cheema et al. (2008) for a precise description of regional classifications.

Table 6.A.2: Estates of leading shrine families under Court of Wards

District	Year	Name of Estate	Family	Total Area	Cultivated Area
				Land Held in Proprietary Rights (in acres)	
Shahpur	1930	Jahanian Shah	Ghulam mohammad Shah; Riaz hussain shah	6423	3652
Attock	1893	Makhad	Sardar Sher Muhammad Khan (probably the pirs of makhad)	25185	3273
Jhang	1916	Shah Jiwana	Khizer Hayat Shah; Mubarak Ali; Abid Hussain	9564	4895
	1893	Jaiwan Estate	Son of late Kutub Shah	2862	
Multan	1901	Sher Shah	Syed Amir Haider Shah; Syed Ghulam Akbar Shah	11917	4064
	1903	*Sher Shah*	Makhdum Pir Shah	11917	4080
	1903	Salarwahan	Syed Muhammad Nawaz Shah; S.M. Baqir Shah; Jafir Shah (Gardezi Syeds of Salarwahan)	7165	4928
	1903	Jalalpur Pirwala	Syed Ghulam Abbas; Syed Muhammad Ghaus	34144	9495
	1893	Kabirpur	Faiz Bakhsh; Zainul Abdin Shah	1178	393
	1893	Estate of Syed Hamid Shah and Fateh Shah	Gillani Syeds of Multan	11467	3789
	1905	Makhdoom Hassan Bakhsh	Makhdoom Hassan Bakhsh	4911	2152
	1909	Daultana	Allah Yar Khan of Luddhan	21680	11042
Dera Ghazi Khan	1922	Mian Sahib Serai	Mian Shah Nawaz Khan of Hajipur	726	130
Muzaffargarh	1931	Daira Din Panah	Malik Allah Bakhsh; Qadir Bakhsh; Ahmad Yar; Nur Muham	2641	1224
	1893	Sitpur	Makhdum Sheikh Muhammad Hussain (Makhdooms of Sitpur)	23500	4463

*Source***:** Statement I: General Statement of Estates Under Charge of the Court of Wards During the Year Ending 30th September

Table 6.A.3: List of *tehsils* in the full sample

District	Tehsil	District	Tehsil
Attock	Attock	Lodhran	Kehror Pacca
Attock	Fateh Jang	Lodhran	Lodhran
Attock	Hasanabdal	Mandi Bahauddin	Malakwal
Attock	Jand	Mandi Bahauddin	Mandi Bahauddin
Attock	Pindigheb	Mandi Bahauddin	Phalia
Bahawalnagar	Bahawalnagar	Mianwali	Mianwali
Bahawalnagar	Chishtian	Mianwali	Piplan
Bahawalnagar	Fort Abbas	Multan	Jalalpur Pirwala Town
Bahawalnagar	Haroonabad	Multan	Multan
Bahawalnagar	Minchinabad	Multan	Shujabad Town
Bahawalpur	Ahmedpur East	Muzaffargarh	Ali pur
Bahawalpur	Bahawalpur	Muzaffargarh	Jatoi
Bahawalpur	Hasilpur	Muzaffargarh	Kot Addu
Bahawalpur	Khairpur Tamewali	Muzaffargarh	Muzaffargarh
Bahawalpur	Yazman	Nankana Sahib	Nankana Sahib
Bhakkar	Bhakkar	Nankana Sahib	Sangla Hill
Bhakkar	Darya Khan	Nankana Sahib	Shah Kot
Bhakkar	Kallur Kot	Narowal	Narowal
Bhakkar	Mankera	Narowal	Shakargarh
Chakwal	Chakwal	Okara	Depalpur
Chakwal	Choa Saidan Shah	Okara	Okara
Chakwal	Talagang	Okara	Renala Khurd
D.G. Khan	DG Khan	Pakpattan	Arifwala
D.G. Khan	Taunsa	Pakpattan	Pakpattan
Faisalabad	Chak Jhumra Town	R.Y. Khan	Khanpur
Faisalabad	Faisalabad	R.Y. Khan	Liaqatpur
Faisalabad	Jaranwala Town	R.Y. Khan	RY Khan
Faisalabad	Sumundri Town	R.Y. Khan	Sadiqabad
Faisalabad	Tandlianwala Town	Rajanpur	Jampur
Gujranwala	Gujranwala	Rajanpur	Rajanpur
Gujranwala	Kamoke Town	Rawalpindi	Gujjar Khan Town
Gujranwala	Nowshera Virkan Town	Rawalpindi	Kahuta Town
Gujranwala	Wazirabad Town	Rawalpindi	Murree Town
Gujrat	Gujrat	Rawalpindi	Rawalpindi
Gujrat	Kharian	Rawalpindi	Taxila Town
Gujrat	Sara-e-Alamgir	Sahiwal	Chichawatni
Hafizabad	Hafizabad	Sahiwal	Sahiwal
Hafizabad	Pindi Bhattian	Sargodha	Bhalwal
Jhang	Ahmadpur Sial	Sargodha	Kot Momin
Jhang	Chinniot	Sargodha	Sahiwal2
Jhang	Jhang	Sargodha	Sargodha
Jhang	Shorkot	Sargodha	Shahpur
Jhelum	Jhelum	Sargodha	Sillanwali
Jhelum	Pind Dadan Khan	Sheikhupura	Ferozewala
Kasur	Chunian	Sheikhupura	Muridke
Kasur	Kasur	Sheikhupura	Safdarabad
Kasur	Pattoki	Sheikhupura	Sharaqpur Sharif
Khanewal	Jahanian	Sheikhupura	Sheikhupura
Khanewal	Kabirwala	Sialkot	Daska
Khanewal	Khanewal	Sialkot	Pasrur
Khanewal	Mian Channu	Sialkot	Sambrial
Khushab	Khushab	Sialkot	Sialkot
Khushab	Noorpur Thal	TT Singh	Gojra
Lahore	Lahore	TT Singh	Kamalia
Layyah	Choubara	TT Singh	TT Singh
Layyah	Karor Lal Esan	Vehari	Burewala
Layyah	Layyah	Vehari	Mailsi
Lodhran	Dunya Pur	Vehari	Vehari

Table 6.A.4: Summary statistics for key variables

Variable	Mean	Median	Minimum	Maximum	Standard Deviation
Shrines Per capita	0.007	0.005	0.000	0.029	0.006
Literacy (over 10)	0.571	0.572	0.311	0.850	0.120
Literacy (over 15)	0.530	0.529	0.282	0.829	0.121
Boys school (Gov) 2kmto5km	5.094	3.475	0.000	21.640	4.956
Girls (Gov) school < 2km	91.314	95.880	54.730	100.000	9.714
Girls (Gov) school 2kmto5km	5.610	3.425	0.000	27.250	5.952
Girls (Gov) school > 5km	3.075	0.700	0.000	30.490	5.091
Boys school (Pvt) 2kmto5km	7.934	4.015	0.000	39.420	9.007
Girls (Pvt) school 2kmto5km	7.904	3.865	0.000	38.940	8.971
Shrine families in politics	0.542	0.000	0.000	3.000	0.834
Distance from River	21.155	15.000	1.000	80.000	18.246
Log of Population	13.074	13.078	11.571	15.659	0.669
Proportion *Muzaara*	0.048	0.049	0.003	0.124	0.024
No. of observations	115	115	115	115	115

TABLE 6.A.5: Distance regressions

	Government Schools			Private Schools	
Dependent Variable	Boy: 2-5 km	Girl: 2-5 km	Girl<2 km	Boy: 2-5 km	Girl: 2-5 km
Shrines per capita	37.495**	48.460***	-4.174*	56.946***	59.208***
	(15.355)	(16.415)	(2.395)	(17.093)	(16.877)
Shrines x River	-0.760	-1.475**	0.131	-2.459***	-2.418***
	(0.604)	(0.666)	(0.086)	(0.779)	(0.766)
Distance from River	0.010	0.010	-0.001	0.017**	0.016*
	(0.006)	(0.007)	(0.001)	(0.008)	(0.008)
Adjusted R-squared	0.372	0.341	0.339	0.304	0.294

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. All regressions include latitude, longitude, elevation, and total population as the basic set of controls.

Chapter 7

Conclusion

This thesis has contributed to the broader research theme on the Economic History of South Asia in several ways. First, by showing in Chapter 1 that the expulsion of religious minorities led to a reduction in school provision in post-Independence Pakistan it highlights the role played by religious diversity in public goods provision.

Then, Chapter 2 provides evidence for the Partition of colonial India being associated with long-run agricultural development in post-Independence India. In doing so the chapter contributes towards understanding the long-run consequences of Partitions followed by large population exchanges.

Next, Chapter 3 shows that a positive agricultural productivity shock (i.e. the adoption of high yieldings varieties of crops) reduces infant mortality in India. In doing so it highlights the importance of agricultural technology in improving child health outcomes.

Furthermore, Chapter 4 examines the relationship between irrigation and agricultural development. It shows that baseline differences in irrigation prior to the adoption of high yielding varieties of crops is associated with differences in yield growth after adoption. Specifically, it finds that areas with a better pre-exiting irrigation infrastructure are associated with higher yields in the period after adoption.

Finally, Chapter 5, empirically investigates the impact of shrines on development in the Punjab province of Pakistan. It statistically documents the relationship between literacy rates and the presence of holy Muslim shrines. In particular, it finds that the regional variation in literacy rates across areas of Pakistani Punjab can be attributed to to differences in the concentration of shrines in those districts. The chapter represents a systematic analysis of the confluence of three factors – religion, land and politics – in perpetuating under-development in Pakistan.

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