

State capacity, Violence and Industrialization in Rwanda and England

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Introduction*

*This introduction is based in part on my work with James A. Robinson: "Colonialism and Development in Africa". Forthcoming in Carol Lancaster and Nicolas Van de Walle eds. *Handbook on the Politics of Development*, to be published by Oxford University Press.

Economic prosperity across African countries has greatly diverged over the last decades. On the one end, countries like Botswana, Ethiopia and Rwanda have grown rapidly. Others, like the Democratic Republic of the Congo, are poorer in the 21st century than they were at independence. Growing evidence shows that a considerable share of this variation is explained by the presence of centralized precolonial polities within these countries (Michalopoulos & Papaïannou, 2013). In this thesis, I investigate whether there is an effect of having a tradition of statehood matters for development outcomes today. I also investigate potential mechanisms behind the effect of a longer tradition of statehood and ask if there are interaction effects between historical states and intermediate outcomes. I furthermore attempt to understand the effects of large-scale state intervention in the rural economy of England on industrialization. This dissertation, then, is a study of the role of the state in comparative economic development.

1 African States on the Eve of the Scramble

Chapters 1-3 of this dissertation examine the precolonial state in Africa. Before the colonization of Africa, Africa was home to a wide variety of polities and political systems, ranging from bands of hunter-gatherers such as the !Kung San in Botswana to large centralized states such as Buganda in modern Uganda (see the essays in Fortes and Evans-Pritchard, 1950). More broadly, states such as the Tswana states in Botswana, the Asante state in Ghana, or the Rwanda state were becoming more centralized and consolidated before colonization, providing public goods and rationalizing their bureaucracies (Parsons and Robinson, 2006, Austen, 2005, Vansina, 2004). On the other hand, countries like Kenya, the Republic of the Congo or Sierra Leone had a patchwork of states. In Kenya, societies like the Masai or Kikuyu showed little trend towards centralization. In Sierra Leone, although the Mende states were consolidating in the period before the Scramble of Africa it plausibly follows from Abraham (2003) that there would not likely be one centralized Mende state. Finally, in countries like Somalia there was little trend toward centralization of any kind.

Just as there is variation in the degree of centralization of precolonial African states, there is also variation in public good provision: for example Asante, Buganda, Dahomey, and Ethiopia all built extensive road systems and many provided legal systems and methods of conflict resolution (the Kuba state even independently created trial by a jury of one's peers, see Vansina, 1978). Many states that exercised some form of territorial control did however not provide any public goods. Consider Abraham's (2003) depiction of the state system in Mendeland, southern Sierra Leone, in the second half of the 19th Century.

Mendeland was divided into a system of nine competing and warring states in the second half of the 19th Century. He makes a distinction between ‘territorial states’, which had well defined territories, such as the Sherbro, Lugbu, Gallinas, Bumpeh and Kpaa-Mende states, and which were not identified with a single person, and the ‘hegemonies’, such as the Tikongoh state of Makavoray and the Luawa state of Kai Londo, which were. Nevertheless, even the territorial states were not bureaucratized and did not collect systematic taxes from their inhabitants, though they did collect tribute and organize compulsory labor and armies. It is very difficult to imagine these states providing infrastructure or cooperating to build a railway, for example. Early observers and anthropologists further emphasize that the lack of political centralization resulted in permanent underprovision of public order and safety (see Speke, 1863, Douglas, 1962, or Colson, 1969, for examples).

Recent research has formalized these differences and shown that they matter for economic development. Using the Standard Cross-Cultural Sample (SCCS) a database of “pre-modern” or perhaps “traditional” societies coded by anthropologists over many decades (see Murdock and White, 1969), Osafo-Kwaako and Robinson (2012) show that a coding of the extent of political centralization very strongly positively correlated with the provision of public goods, such as roads, money, and the existence of written record keeping. It is also positively related to measures of economic development, for example the existence of loom weaving or metal smelting. Similarly, Gennaioli and Rainer (2007) and Michalopoulos and Papaianou (2013) show that the degree of political centralization of historical polities in Africa is positively correlated with public good provision and prosperity, as measured by light density at night, today.

2 Rwanda’s limping Leviathan

Many of these trends come together in Rwanda. The Rwandan precolonial state, the Nyiginya kingdom, was highly centralized in the sense that the king and his court controlled Rwanda through a bureaucratic hierarchy. In comparative perspective, the Nyiginya kingdom was as centralized as the Ashanti empire or the Zulu State (Murdock, 1967). Yet although the Nyiginya kingdom was strong and exercised an extraordinary degree of social control over its population (Vansina (2004) shows that the extent of forced labor and taxes levied on the population went up dramatically before colonization), it did not have a formal legal system, roads, or even money. The Nyiginya kingdom was therefore similar to the Mende states in terms of lack of public good provision. It did, however, provide peace and security and was the dominant

local polity, challenged periodically only by the Rundi state in Burundi.

At the time of the 1884-1885 conference of Berlin, Rwanda had not yet been visited by Europeans. It would not be until 1892 that Oscar Baumann first visited Rwanda, then thought to be the source of the river Nile (Baumann, 1894). Regardless, the European powers divided Rwanda between the Belgian Congo and German East Africa in 1885. When the Germans did arrive in Rwanda, they realized it would be infeasible to break up the cohesive Nyiginya kingdom and they slowly renegotiated Rwanda's borders to their current extent (Louis, 1963). German and Belgian colonization solidified Nyiginya rule, introducing a money economy, building roads and suppressing revolts in recently annexed territories. The Belgians also warped identities by designating Hutu and Tutsi social classes as different races. This intervention will be discussed in detail in this thesis.

Decolonization produced a majority-led single party state around the Hutu ethnic group, whereas the precolonial state and the chiefs under Belgian indirect rule had been selected from the Tutsi minority ethnic group. Although Rwanda was among the poorest countries in the world, the state still exercised oppressive social control, mostly through a wide network of informants and local bureaucrats, forced community labor and a rigorous schedule of mandatory celebrations of presidents Grégoire Kayibanda (1963-1972) and Juvénal Habyarimana (1972-1994) (Verwimp, 2013).

The Hutu majority mounted a coup in 1959, ousting the Tutsi king and proclaiming a republic. A large number of Tutsi fled at this time and their children joined the Ugandan army. In 1990 these Tutsi, led by among others Rwanda's current president Paul Kagame, mounted an invasion. Aided by French weapons and manpower, the Habyarimana government stopped the invasion, but under international pressure had to allow multi party government. Many members of the government and local bureaucrats sided with Hutu opposition parties or even with parties openly sympathetic to Tutsi interests. In response to this threat to its authority, a group of hardliners around Habyarimana started forming self-defence groups, training youth militias and importing large numbers of crude weapons, such as the later infamous machete. Rwanda's military expenditure, as a result, reached almost eight percent of GDP in 1992 (Mamdani, 2002). On April 6th, 1994, an airplane carrying Habyarimana was shot down on its approach to Kigali, crashing in the backyard of the presidential palace (where it remains today). Within an hour, members of the political opposition were assassinated in their homes and roadblocks were set up all across the country. In the hundred days that followed, between 500,000 and 1,000,000 Tutsi and politically

moderate Hutu were killed, often by machete blows from their next door neighbors, colleagues or even family (des Forges, 1999).

In post-genocide Rwanda, the victorious Paul Kagame is president. Rwanda is developing rapidly and Rwanda's government is a 'development darling' (Crisafulli and Redmond, 2012). It is again a single-party state, exercising tight social control through a parallel hierarchy of government and party with informal government representatives per as few as ten inhabitants (Purdeková, 2011). Elections are uniformly rigged, discussing ethnicity is taboo, and political opponents are routinely jailed or even murdered after being accused of being 'genocide deniers' (Reyntjens, 2013). The rapid re-formation of the bureaucracy after the cataclysmic genocide has often been attributed to Rwanda's deep tradition of centralized government. Reyntjens writes (2013, p. 25):

“An ancient state tradition played an undeniable role here: a mere two years after the extreme human and material destruction of 1994, the state was rebuilt. Rwanda was again administered from top to bottom.”

3 Understanding the long-run effect of Rwanda's state

Rwanda's precolonial state developed slowly and expanded over Rwanda's current territory over the course of two hundred years, between 1700 and 1898. This slow expansion introduces interesting variation in the depth of exposure to centralized rule at a local level in Rwanda. Chapters 1 and 2 of my dissertation exploit this variation to understand the effects of having had centralized government throughout the entire colonial period on modern outcomes, especially violence in the 1994 genocide. Chapter 2 uses one particular boundary of the expanding Nyiginya kingdom and implements a lab-in-the-field experiment to understand the individual level effects of a longer tradition of centralized rule.

In chapter 1 I relate antiquity of the local state to genocide violence. Using historical evidence from Vansina (2004) I reconstruct the history of the expansion of the Nyiginya kingdom into each of its 50 pre-colonial districts. Using detailed data at the level of the pre-genocide villages on the number of people prosecuted for genocide violence as well as the number of Hutu prosecuted for murder, I show as a first result that places with longer state presence experience significantly more violence and greater mobilization of the population on a per capita basis.

To establish the causality of this correlation I utilize the fact that the expansion of the Nyiginya kingdom was nonconcentric. Although newly annexed district always bordered the kingdom, expansion did not occur uniformly in all directions. Although many factors plausibly affect the decision to annex a district, I focus Rwanda's hilly geography. Specifically, I exploit the fact that districts differ significantly by their ease of access for an army on foot. I use several measures of the distance that Nyiginya armies needed to cover across Rwanda's hilly landscape from Rwanda's precolonial capital at Nyanza as a source of plausibly exogenous in the timing of annexation. As a first stage I estimate the correlation of this travel cost distance on the conditional on driving distance along the 1988 road network to Rwanda's precolonial and modern capitals, distance to Rwanda's modern border and modern province fixed effects. I find support for travel distance to Nyanza as an informative instrument. Importantly, travel cost distance is uncorrelated with a elevation, soil suitability, archaeological evidence for pre-Nyiginya population density, and several other geographical pre-characteristics.

I then show that the estimated relationship between state presence and genocide intensity is robust to using several different measures of genocide intensity, to different ways of measuring state presence, as well as to controlling for measures of population pressure on the land (André and Platteau, 1998) and ethnic fractionalization between Hutu and Tutsi (Prunier, 1995).

One plausible channel of transmission is the persistence of state capacity or presence at a local level. The German and Belgian colonizers, however, intended to rule Rwanda indirectly, and therefore aided the Nyiginya king in establishing its authority in recently annexed territories. After decolonization, public investment was targeted to the home constituency of presidents Kayibanda (whose home constituency was in the historical heart of Rwanda) and Habyarimana (whose home in recently annexed Ruhengeri in the North-East) (Verwimp, 2013).

Another interesting channel which I explore is the relationship between deeper state history and compliance with government demands. Genocide perpetrators repeatedly cite that killing was 'the law' and in a survey of 209 genocide perpetrators unenforced obedience is the third most commonly mentioned reason for killing, after coercion/enforced obedience and 'war related fear and combativeness' (Straus, 2006, p. 136). An interesting question is when Tutsis were placed outside the law. In December 1990, *Kangura*, a government sponsored magazine, published the Hutu Ten Commandments which basically forbade interaction with Tutsi and encouraged Hutu to 'stop having mercy' on the Tutsi. From the start of

the genocide on, it was clear that the central government had instigated and ordered the killings (see for instance (des Forges, 1999). This would suggest that a deeper tradition of centralized government may lead to greater participation in the government through increased compliance with government demand, as the Reyntjnes quote above suggests as well.

While many mechanisms are plausibly at work linking state presence to modern outcomes, in light of this evidence, I test two potential mechanisms: The persistence of local state capacity and the effect of longer state history on voluntary compliance. Scott Straus, in his summary of the historical literature on mobilization and obedience with authorities in Rwanda in concludes: “In Rwanda there was not total anarchy. State institutions stayed intact, as did norms of compliance, and both contributed to why so many men participated in the genocide.” (Straus, 2006, . p114). Using a wide variety of data sources, I find no systematic effects of state presence on public infrastructure, the presence of schools and hospitals, local taxation or local public expenditure. These results, although perhaps surprising, are in line with the history of state building briefly outlined above. Rwanda is a small country and the history of public investment and capacity building suggests that these were motivated by a desire to unify the country or divert resources to the presidential homeland. After showing evidence from the World Values Survey I turn to experimental evidence on the relationship between state presence and the propensity to follow rules.

I implemented a lab-in-the-field experiment close to, but on either side of, a stretch of the outer border of the Nyiginya kingdom in the eighteenth century that was subsequently crossed and is now well within Rwanda’s national borders. This border, which coincides with a stretch of the Akanyaru river in Southern Rwanda (see below for full background). I asked participants to comply with a demand to repeatedly pay taxes over an endowment in an anonymous environment. Individuals that are close to the boundary but just happen to be on the side that has longer state presence, are nine percentage points more likely to comply with a taxation demand.

In chapter 2, I take the compliance result from the lab-in-the-field experiment and understand what channels, in turn, drive the compliance result. Specifically, I ask whether political institutions or cultural norms drive the persistent effect of state presence in Rwanda. Although I did not find an effect of historical state presence on the local state in chapter 1, this paper zooms in on individual respondents and their proximity to, and interaction with, the Rwandan state.

This paper starts by showing how the Nyiginya kingdom interacted with individual Rwandans, shedding light on potential mechanisms at an individual level. Before the establishment of the state, Rwandans were organized into small kinship groups, roughly coinciding with individual hills. Within these communities, norms of sharing and redistribution providing social insurance operated. Based on first-occupier rights of land, there was also limited tribute to chiefs, organized through the same sharing norms. Upon annexation into the Kingdom, these kinship groups became part of the bureaucracy, and taxation was enforced through the same sharing norms, rather than through more formal institutions such as laws or a police force.

I designed a behavioral experiment which I implemented with 420 participants in rural Rwanda. This experiment measures the propensity of individuals to comply with a tax collection demand in the presence of financial incentives to steal, under anonymity and impunity, and is broadly based on the ‘resource allocation game’ developed by psychologists (Hruschka et al., 2014). Specifically, the experiment asks participants to repeatedly pay tax to the central government, based on a coin flip. I observe only money paid to the government, and infer compliance by comparing tax payments relative to the tax base implied by the fair coin.

I compare individual responses in a treatment-control setting by randomly sampling participants in districts on either side of a stretch of the Akanyaru river which cuts Rwanda longitudinally South of its capital, Kigali. This river, although now well within the borders of Rwanda, was for about one hundred years an outer border of the precolonial kingdom (from about 1700 to 1799). The kingdom then incorporated the district across the river, and since then both sides have been part of Rwanda.

I exploit this variation in the length of exposure to centralized government as a natural experiment, comparing experimental responses of randomly selected participants in randomly selected villages on either side of the Akanyaru river, as the core of the empirical strategy of this paper. The validity of this approach as an identification strategy hinges on the random selection of the participants and on the exogeneity of the timing of crossing of the Akanyaru as an outer border of the expanding kingdom. The history of the establishment of this border suggests that the timing of the expansion of the kingdom across the Akanyaru, which determines the differential exposure of villages on either side to state institutions, was not chosen by the state, but that the polity across the boundary collapsed as a result of a military conflict outside Rwanda’s borders, and the Nyiginya state simply filled the power vacuum by formally annexing the territory across the river.

As a first result I show that participants who today live on the side of the river that has been part of the kingdom longer voluntarily pay more taxes. I then show that the effect of historical exposure to state institutions is, however, robust to several measures of migratory status and that geography and pre-existing prosperity, measured by the density of archaeological findings that date from before the establishment of the kingdom balance. I subsequently test for the explanatory power of the various hypotheses described above as drivers of the persistence of the Nyiginya kingdom. Since I have individual level variation, I can test hypotheses that vary at an individual level, such as the presence of a cultural norm conducive to tax compliance or membership of social groups as potential sources of third-party-punishment of deviations from a social norm. Because the presence of the historical state varies at a geographical level, I can also test for persistence through the presence of government institutions and the quality of these government institutions. In chapter two, I use a rich dataset to test for the effects of local corruption and responsiveness of the state, local social networks, trust, religiosity and a variety of potential sources of persistence. On balance, the evidence in this chapter suggests that cultural norms rather than the quality or presence of government institutions are the primary source of persistence of the historical persistence of the Nyiginya kingdom. While it is never fully possible to preclude alternative channels, the results in this paper do suggest that there is an individual level persistent effect of historical state centralization, and that this results is not driven by the presence of the modern state nor by local social networks.

In chapter 3, I test two strategies, persuasion and enforcement, regularly employed by modern states in a stylized lab-in-the-field experiment in an effort to understand if it's possible to tests state building strategies in the lab. States, of course, do many things. States enforce laws, establish and maintain a monopoly of violence to attain the capacity to enforce laws. They also socialize their citizens through, for instance, education (Cantoni et al., 2014) and public awareness campaigns. More broadly, states build 'civic capital' (Guiso et al., 2010). As a first treatment I impose monetary penalty for non-socially optimal behavior in a standard repeated public goods game to capture the enforcement aspect of state building. I also read a message taken from a press release by the Rwandan government that reminds Rwandans that they have a nation building duty to capture the 'soft' aspect of state building. This chapter is a preliminary 'proof of concept' study aimed at informing future work.

I find that enforcement affects both the intensive and the extensive margin of contributions. Persuasion affects only the extensive margin. Individuals are persuaded to contribute to the public good if they

otherwise wouldn't have, but they are not persuaded to give more, on average, than participants in the baseline group do. This suggests that persuasion is effective for activating citizens, but not incentivizing them to make above average contributions. Enforcement decreases the probability of non-contribution and increases the amount contributed. I then consider heterogeneous effects by the proximity to Rwanda's capital, Kigali and by the antiquity of the local state. I find that enforcement is effective in places closer to the capital, and in places with shorter presence of centralized government. There are not heterogeneous treatment effects of persuasion by the distance to Kigali. There are interesting heterogeneous effects of persuasion by the presence of the historical state, however. In places with longer state presence, there is a negative treatment effect, whereas in places with a shorter state presence, there is a positive treatment effect. I review several explanations that are consistent with this results. Finally, participants played the public goods game anonymously and there was opportunity for participants to conceal money throughout the experiment. Although stealing happens throughout the experiment, there are no treatment effects on the amount stolen or the probability of theft occurring.

4 State building in Tudor England

By the early sixteenth century, the church's influence in English politics had diminished. Although the abbots of great monasteries still sat in the house of Lords, Henry VIII intended to break with the catholic church. One of his motivations was probably that the Pope refused to annul his marriage to Catherina of Aragon. Another was surely the prospect of seizing the massive assets held by the Monasteries in England. In chapter 4 of this dissertation, co-authored with James A. Robinson and Sebastian Vollmer, we investigate the long-run impact of the expropriation of monastic property on industrial development.

In the late medieval period the preponderance of land in England was held by the Crown, the Aristocracy and the Church. Though much was leased out, it was done so via various forms of archaic tenures such as copyhold. Not only was this land farmed inefficiently, but there was no effective land market. In the 1530s however, the expropriation of the Monastic lands by Henry VIII threw about 1/3 of agricultural land in England onto the market. This land was then rapidly sold off, 2/3 by 1547 and most of the rest by 1554 during the reign of Edward VI (Clay, 1984, p. 145). Clay (1984, p. 144) notes about the period from 1500 to 1640

"The pattern of landownership ... was to undergo a profound change ... The single most important factor in bringing this about was the partial dismantling of the enormous estates of

the Church ... from the 1530s onwards”

Historical evidence suggests that a much thicker market for land emerged (Habbakuk, 1958) and the shock allowed for enhanced possibilities to renegotiate archaic forms of tenure. The impact of the Dissolution varied spatially within England since the Monasteries held lands in some places but not others. We therefore argue that the Dissolution can be regarded as a natural experiment that created exogenous variation in economic institutions. We hypothesize that ultimately these improved economic institutions should be connected to industrial development in the first industrial revolution and that there should be a positive reduced form relationship at a sub-national (parish) level between the extent of land released by the Dissolution and industrialization. To the best of our knowledge, this link has not been proposed before.

We first investigate several channels that may potentially link the change in economic institutions induced by the Dissolution to the Industrial Revolution. The first and most obvious connection is to agriculture and the English Agricultural Revolution. The first-order effect of freeing up inefficiently used lands, creating a land market and changing tenancy relations ought to have been to move land into the hands of people who would use it more efficiently and to facilitate and encourage investment and innovation.

A second and complementary mechanism, first proposed by Tawney (1941a,b), is that the Dissolution led to a large change rural social structure that he characterized as the “rise of the gentry”, the rise of a new class of commercially minded rural entrepreneurs. Existing data strongly suggests that the gentry increased greatly in numbers and in the amount of land they controlled. Overton (1996, p. 169) concludes “it seems clear that the gentry class ... did grow considerably in numbers from the mid-sixteenth century.”

Though this channel is clearly related to the first, the gentry could have been connected to industrialization through other mechanisms as well. Firstly, through a cultural mechanism such as that proposed by Doepke and Zilibotti (2008) who stress how the emergence of capitalism endogenously led to a divergence between the preferences of the middle classes and the aristocracy. Secondly, the gentry were enfranchised and able to sit in Parliament to get legislation favorable to their economic interests. As Heal and Holmes put it (1994, p. 204)

“In the Tudor period the gentry ‘swarmed’ into Parliament. Not only the county seats,

but those of the old parliamentary boroughs, and those of towns newly enfranchised by the Crown, were taken by gentlemen. Some 80% of the 372 so-called ‘burgesses’ in the late Elizabethan House of Commons were country gentlemen.”

To investigate whether or not such conjectures are plausible we use several sources of data. Most important we digitized the 1535 Valor Ecclesiasticus (henceforth Valor), the great survey of monastic and more broadly ecclesiastic (non-monastic Church) incomes implemented by Henry VIII prior to the Dissolution. To our knowledge this data has never been used systematically before. We hypothesize that in places where monastic assets generated more income, conditional on parish size, the Dissolution had a bigger impact, either in terms of redistributing more productive lands or greater amounts of land. For outcome variables measuring the Industrial Revolution we use the first is 1838 Mill Survey commissioned by the British Parliament.

Our first main set of results show that there is a very robust reduced form relationship between monastic income in 1535 and our measures of industrialization. Monastic income is positively and significantly correlated with a dummy variable for the presence of a textile mill in a parish, a count variable which measures the total number of mills in a parish, and total mill employment.

We then examine the channels via which the Dissolution might have impacted industrialization and which can shed some light of some of the mechanisms we discussed above. First, we look at whether or not the Dissolution was associated with an agricultural revolution. We measure the latter by data in three ways. First, we use data on wheat yields per acre in 1836 from Kain (1986). Second, we use data recently compiled by Dowey (2013) on the number of agricultural patents registered in a parish between 1700 and 1850. Finally, we use data on the structure of employment, in particular the proportion of the labor force in manufacturing, retail and agriculture from the 1831 British Census.

Second, we use a unique census from 1700 that records the number of gentry in each of 24,000 of the largest towns/cities and villages in England and Wales. To our knowledge, this data has never previously been analyzed systematically. Finally, we can examine directly one policy channel by using data compiled by Heldring, Robinson and Vollmer (2015) on the extent of parliamentary land enclosures at the parish level (Heal and Holmes, 1994, argue that the gentry were heavily involved in enclosing, see pp. 108-113). Using their data we show that monastic income is positively and significantly correlated with whether or

not land in a parish was enclosed between 1750 and 1840.

We find that monastic income is positively and significantly correlated with wheat yields and with patenting, though the former finding is not completely robust. These results are consistent with the idea that the Dissolution created a more efficient allocation of resources in rural England and this helped to stimulate the Agricultural Revolution. The connection to the Agricultural Revolution is further supported by our results with the 1831 Census data where we find that monastic income is negatively correlated with the share of the labor force in agriculture but positively correlated with the share in manufacturing and retail. The traditional account of the agricultural revolution stresses that one of the impacts was to shed labor and substitute it with capital, which is consistent with what we find. We also find that monastic income is positively correlated with the number of gentry in a parish, consistent with Tawney's hypothesis and the emphasis of Doepke and Zilibotti (2008) on social change. Finally, we also find evidence for the public policy channel and the possible role of the gentry in Parliament since we find that monastic income is positively correlated with whether or not land was enclosed in a parish.

Trying to interpret these findings as causal faces a number of challenges. Most obviously, the location of monastic land was not randomly assigned in 1535 and it could be that monasteries just happened to hold land in places which were attractive for industrialization for other reasons, thus creating potential omitted variable bias, at least to the extent we cannot control for these other factors. In chapter 4, we employ a variety of strategies to mitigate this issue.

Why did the Dissolution of the monasteries have such large effects? The most obvious explanation is that the land held by the Church was initially utilized inefficiently. Though North (1981, p.125) argued that "Monasteries were often the most effective farming centers in the Middle Ages" whether or not this is true empirically is controversial. As we discuss in chapter 4, the Church was the most sustained and strongest defender of feudal privileges in England in the wake of the Black Death. If the gentry could not expand by buying Church land could they not have purchased land from elsewhere? They did do so from the Crown, but the most important alternative was the aristocracy. Yet the Tudor aristocracy, like the Church, was still embedded in non-market social relations and maintained large armies of 'liveried retainers'. As late as the civil war of the 1640s aristocrats used such traditional loyalties to mobilize military forces (Holmes, 1974).

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Chapter 1:

State Capacity and Violence in Rwanda

1 Introduction

Economic development in Africa is affected by persistent historical factors as well as contemporary policy decisions.¹ While policies are often set at a national level, persistence is strongest at a historically relevant unit, such as an ethnic group, or a historical state (Michalopoulos and Papaioannou, 2014). Does this spatial mismatch create interaction effects between national policies and historical institutions? The answer to this question is relevant for our understanding of the nature of historical persistence and for understanding how, and whether, to tailor policy to local economic conditions. Furthermore, in post-independence Africa, periods of growth have been punctuated by period of economic and political instability.² These patterns are plausibly affected by both historical institutions and contemporary policy decisions (Bates, 2008).

In this paper, I study the effect of the precolonial state in Rwanda on contemporary conflict between 1990 and 2000. In this period, the Rwandan government fought rebels from Uganda (1990-1993), organized one of the largest genocides of the twentieth century (1994) and re-established territorial control (1995-2000). I focus on one aspect of the state, the duration of its presence. Because the Rwandan precolonial state expanded slowly, some parts of Rwanda had experienced two hundred years of centralized rule while others were just recently conquered when the Germany colonized Rwanda in 1897. Using detailed village level data, I find that places with a deeper state history experience more violence in the state-organized 1994 Rwandan genocide. Using data from the UCDP conflict data program, I also provide evidence showing that in the years before (1990-1993) and after (1995-2000) the genocide, these same places experience less rebel activity, as well as less government repression.³ Figure 2 uses binned scatterplots to visualize these results. When the Rwandan government sought to maintain its monopoly of violence, places with a deeper state history see less violence, but when the Rwandan government initiated a genocidal campaign against the Tutsi minority mobilizing the Hutu majority for violence, these same places experience more killing. These results are consistent with the consensus in the historical literature

¹Long-run factors affecting African development and conflict are for instance the slave trades (Nunn, 2008; Nunn and Wantchekon, 2011), the organization of precolonial states (Gennaioli and Rainer, 2007; Michalopoulos and Papaioannou, 2013, 2014), and colonialism (Acemoglu et al., 2001; Michalopoulos and Papaioannou, 2016). See for overviews Nunn (2009) and Acemoglu and Robinson (2010, 2012).

²For instance, after a period of growth after independence, Sierra Leone experienced dictatorship under Siaka Stevens and civil war between 1991 and 2002. Ghana also grew after independence, descending into a period of coups and instability that lasted until the early twenty first century. Rwanda experienced a coup in 1959, was poor but stable until 1990. From 1990 to 1994 it was first invaded from Uganda and then plunged into the 1994 genocide. After making a swift recovery, Rwanda is now one of the fastest growing countries in Africa.

³This result is consistent with previous work on the relationship between the state and violence, see Fearon and Laitin (2003) and Depetris-Chauvin (2013).

on Rwanda, which emphasizes the persistent effects of Rwanda's historical state. On the genocide, Gérard Prunier writes: "Rwandese political tradition, going back to the Banyiginya Kingdom ... made it easier for the architects of the genocide to encourage or force both men and women to become murderers" (Prunier, 1995, p. 141). On the post genocide period, Philip Reyntjens writes: "An ancient state tradition played an undeniable role here: a mere two years after the extreme human and material destruction of 1994, the state was rebuilt." (Reyntjens, 2013, p. 25). These results are also consistent with a view of persistence which emphasizes that effect of historical institutions on development outcomes varies with contemporary government policy.

Rwanda provides an attractive laboratory for studying persistence and violence. First, Rwanda was unaffected by the Scramble for Africa. Although in the congress of Berlin, Rwanda was split between Belgium and Germany (Rwanda had never been visited by Europeans at that point), its borders were renegotiated when the colonizers realized the impracticality of breaking up the Rwandan precolonial state (Louis, 1963). This continuity of administrative boundaries allows me to abstract from the persistent effects of split ethnic groups (Michalopoulos and Papaioannou, 2016). Second, Rwanda's recent history is characterized by periods of economic growth punctuated by outbursts of violence, of which the genocide is most well known. The incidence of this violence varies spatially, allowing me to relate local differences in state presence to local violence intensity. Finally, Rwanda's precolonial state, called the Nyiginya kingdom, has been studied extensively by historians which allows me to reconstruct its expansion at a spatially disaggregated level (Vansina, 2004).

It may be the case that the correlations between state presence and violence are driven by other factors, such as population pressure on the land (André and Platteau, 1998) or the pernicious effects of government propaganda (Yanagizawa-Drott, 2014). In order to establish a causal interpretation of my results, I follow several strategies. First, I directly control for confounding variables, as well as several measures of the most prominent competing explanations for local violence intensity in the genocide. Second, I use the fact that I have detailed information on the expansion of the kingdom to estimate several measures of the ease of expanding the Kingdom away from its capital at Nyanza. The kingdom expanded non-concentrically and although many factors affect the decision to expand into a new area, I hypothesize that geographical accessibility is an informative source of plausibly exogenous variation in the length of centralized rule. As a baseline measure, I use the geodesic, 'as the crow flies', distance from Nyanza as an instrument for state presence. I then compute the marching time across Rwanda's rugged terrain as

an alternative instrument. I finally follow Özak (2010, 2013) and use his calibrations of travel time as a final instrument. Using these measures as a source of plausibly exogenous variation, I quantify the relationship between state presence at a local level and the contemporary violence, conditional on driving distance to Rwanda's precolonial and modern capitals, distance to Rwanda's modern border and modern province fixed effects. I find support for these measures of accessibility as informative instruments. Importantly, travel cost distance is uncorrelated with elevation, soil suitability, archaeological evidence for pre-Nyiginya population density, and several other geographical pre-characteristics.

I then use this identification strategy to estimate the effect of state presence on violence before, during, and after the genocide. I first provide evidence on genocidal violence. Using data on violence as well as on mobilization of the population at a spatially disaggregated level,⁴ I find that an one century increase in state presence is associated with a 7% percentage point increase in genocide intensity and in mobilization rates (relative to a mean of 7%). This first result is robust to using several different measures of genocide intensity, to different ways of measuring state presence, as well as to controlling for measures of population pressure on the land (André and Platteau, 1998) and ethnic fractionalization between Hutu and Tutsi (Prunier, 1995). I then provide evidence on the relationship between state presence and violence, when the objective of the government changes from mass killing to maintaining its monopoly of violence. I use data from the Uppsala Conflict Data Program (UCDP) to estimate the relationship between state presence and violence when the objective of the government is to preserve its territorial control. I find that places with longer state presence see fewer violent incidents.

I then turn to explanations of these patterns. One intuitive channel of persistence is local state capacity. In places with longer state history, the government is better able to implement policy. In peacetime, this means that it is better able to maintain a monopoly of violence. During the genocide, it was better able to organize and direct the killings. The history of the Rwandan state does not support this channel, however. The presence of the state throughout Rwanda's territory was solidified in the colonial period. The Belgian colonial army supported the royal bureaucracy, supervised road building, and more generally brought the entire country firmly under royal control to facilitate colonial rule. After decolonization, public investment was instead targeted to the home constituency of presidents Kayibanda (whose home region was in the historical heart of Rwanda) and Habyarimana (whose home was in Ruhengeri in the North-East)

⁴These data are taken from the Gacaca court proceedings. The Gacaca courts are a transitional justice tool to resolve grievances and judge genocide perpetrators. Central to Gacaca is a system of over eight thousand local courts, trying alleged perpetrators. This data have previously been used in Yanagizawa-Drott (2014) and Rogall (2014) and are described in more detail in Verpoorten (2011).

(Verwimp, 2013). Using detailed data on local public good provision, fiscal capacity and public expenditure, I first provide IV estimates that shed light on the effect of state presence on local state capacity. I find no systematic effects of state presence on public infrastructure, the presence of schools and hospitals, local taxation or local public expenditure. I also report results for similar, although less rich, set of outcomes for the colonial period. The only significant association I find is between state presence and the presence of coffee pulping centres in 1960. This is, however, important since the Belgians used forced labor to grow coffee for export markets and this plausibly has long-run effects (Dorsey, 1989; Blouin, 2014).⁵

I then propose an alternative channel: Longer state presence builds compliance with government demands, and this compliance persists. The tendency of Rwandans to comply with (unenforced) orders has been noted by several commentators, but is debated in the academic literature (Mamdani, 2002; Prunier, 1995). Interestingly, at the time of the genocide, this tendency towards compliance was explicitly linked to the long history of statehood in Rwanda (see the discussion in Straus (2006), Mamdani (2002) and Prunier (1995)). Genocide perpetrators say that killing was ‘the law’ and in a survey of 209 genocide perpetrators unenforced obedience is the third most commonly mentioned reason for killing, after coercion/enforced obedience and ‘war related fear and combativeness’ (Straus, 2006, p. 136).⁶ While many mechanisms are plausibly at work linking longer state presence to modern outcomes, the historical evidence suggests the interaction of a strong repressive government a compliant population as central to mass mobilization and mass killing. Straus (2006) concludes: “In Rwanda there was not total anarchy. State institutions stayed intact, as did norms of compliance, and both contributed to why so many men participated in the genocide.” (Straus, 2006, p. 114).

I test this idea using survey and experimental evidence. I use data from the World Values Survey waves of 2007 and 2012 on beliefs about rule-following, the importance of tradition and obedience to authorities. Respondents living in district with longer state presence are less likely to find rule-breaking acceptable, value tradition more, and are more likely to think obedience to authorities is central to democracy. I then report results from a lab-in-the-field experiment close to, but on either side of, a stretch of the outer border of the Nyiginya kingdom in the eighteenth century that was subsequently crossed and

⁵In the online Appendix, I report results using the presence of the coffee sector as covariates and show that the effect of state presence remains stable and significant.

⁶An interesting question is when Tutsis were placed outside the law. In December 1990, *Kangura*, a government sponsored magazine, published the Hutu Ten Commandments which basically forbade interaction with Tutsi and encouraged Hutu to ‘stop having mercy’ on the Tutsi. From the start of the genocide on, it was clear that the central government had instigated and ordered the killings (see for instance Des Forges (1999)).

is now within Rwanda's national borders. This border, which coincides with a stretch of the Akanyaru river in Southern Rwanda, is mapped in Figure 6. I asked participants to comply with a demand to repeatedly pay taxes over an endowment in an anonymous environment, in a game that is a variation on rule following experiments from psychology (Hruschka et al., 2014). Section 6 provides background to the experiment and, importantly, shows that experimental villages balance on several geographical observables and that participants balance on demographic characteristics and migration status, as well as on measures of altruism, trust and social capital. I show that individuals that are close to the boundary but just happen to be on the side that has longer state presence, are nine percentage points more likely to comply with a taxation demand.

An important question is why compliance is so high in Rwanda more generally, and why it varies with the length of the presence of centralized government, especially considering the frequent changes in political leadership between colonizers, Tutsi and Hutu (see also the discussion of this puzzle in Acemoglu and Robinson (2016)). Although I cannot definitively answer this question within this paper, the results I find are consistent with a large body of research on the effects of 'culture'. In the uncertainty that prevailed once the Rwandan army started the genocide, individuals followed government orders as a 'rule of thumb' (see Nunn (2012) for an overview of rules of thumb as cultural products and Straus (2006) for the general environment of uncertainty perceived by Rwandans in the early days of the genocide). In areas with a longer tradition of government presence, the propensity to follow government orders in times of uncertainty is higher. Although this interpretation is commonly proposed for the high mobilization rates in the genocide more broadly, this is as far as I am aware the first paper that links within country differences in state history to compliance.⁷

This paper contributes to our understanding of the long-run effects of historical states. Most of the literature on this topic has found positive associations between measures of the presence or capacity of historical states and modern development outcomes (Acemoglu et al., 2014; Dincecco and Katz, 2014; Dell et al., 2015; Michalopoulos and Papaioannou, 2013; Gennaioli and Rainer, 2007). The results in this paper

⁷This interpretation leaves open the question how norms of compliance form in the first place. Although there is a large literature outside economics on the propensity to follow unenforced orders going back to at least Stanley Milgram's experiments (Milgram, 1963), the microfoundations of this behavior are not well-understood without appealing to initial differences in tastes for obedient behavior. One exception is Stigler and Becker (1977), who consider an agent with exogenous preferences who by repeatedly interacting with an environment, such as dealing with the establishment of a state or procuring heroin as in Stigler and Becker (1977), increases the marginal utility product of interacting with this environment (or develops a heroin addiction). Although this is not a dynamic theory of why a norm of compliance may develop, the evidence in this paper is consistent with the idea that interacting with a state develops rules of thumb governing interactions with the state.

suggest that, during the genocide, there is a positive association between the depth of centralized government and violence. This result suggests that the effect of historical states on current development is possibly non-linear, rapidly changing, and interacts with society in complex ways.⁸ The interaction of state and society is studied in a small but growing empirical literature in economics. For instance, Dell et al. (2015) show that when the state exercises its capacity through a strong civil society, it is less open to foreigners, and Acemoglu et al. (2014) show that chiefs in Sierra Leone use civil society institutions to cement their own authority.⁹ By showing that bottom-up participation rates are plausibly driven by norms of compliance with government demands resulting from a deeper history of centralized rule, I contribute to a literature that tries to understand the effects of historical events on modern norms, attitudes, and beliefs (Alesina and Fuchs-Schündeln, 2007; Di Tella et al., 2007; Giuliano and Spilimbergo, 2014), as well as to a growing literature on the historical determinants of ‘culture’ (Nunn, 2012; Nunn and Wantchekon, 2011). By providing evidence that state presence and compliance are important determinants of within-country violence, I contribute to the study of the determinants of violence and conflict (Blattman and Miguel, 2010; Besley and Persson, 2009; Dube and Vargas, 2013; Collier and Rohner, 2008; Esteban et al., 2012), as well as to the study of individual motivations to join conflict (Humphreys and Weinstein, 2008). The papers that are closest to this study are Yanagizawa-Drott (2014) who provides empirical evidence that the government hate radio was instrumental in organizing the killings and Lowes et al. (2014) who study the effects of the historical Kuba kingdom on rule-following today. I finally contribute to the study of Rwanda and its history (Verwimp, 2005; Verpoorten, 2005; Blouin, 2014).

The rest of this paper proceeds as follows. Section 2 gives an overview of the relevant episodes of Rwandan history. Section 3 presents the estimation framework used in this paper. Section 4 presents the main results of this paper, relating state presence to violence. Sections 5 and 6 discuss mechanisms, and section 7 concludes. An online Appendix provides extra results and background to the reconstruction of the expansion of the Nyiginya kingdom.

⁸In section 4, I provide evidence that the relationship between state presence and violence is negative before and after the genocide. Before and after the genocide, the Rwandan government used violence mostly to establish its monopoly of violence, which is less strong in areas with a shorter presence of centralized government. These results further speak to the external validity of this study because they suggest that outside this extraordinary event, the relationship between state presence is line with cross-country (Fearon and Laitin, 2003) and cross-ethnicity (Depetris-Chauvin, 2013) results.

⁹Additionally, Satyanath et al. (2013) show that higher social capital led to increased Nazi party membership in pre-WWII Germany. In political science, there is a large literature on the interaction between the state and (civil) society, see for instance Mann (2005), Valentino (2013) and Bates (2008).

2 Historical background

This section presents the relevant historical and institutional background to the estimations in the rest of this paper.

2.1 The expansion and organization of the Nyiginya kingdom

The Nyiginya kingdom was founded in the sixteenth century by Ndori, an immigrant from Uganda (Vansina, 2004, p. 32). Until about 1700, the extent of the kingdom was confined to a small area in central Rwanda. From 1700 to 1897, the small kingdom expanded to Rwanda's current borders. At the time of the Congress of Berlin, where European nation states partitioned Africa among themselves, the Nyiginya kingdom was partitioned between Belgium and Germany. When the first Europeans arrived in Rwandan in 1892, they realized the impracticality of splitting the Nyiginya state, and renegotiations of the boundaries were settled in 1910 at Rwanda's current extent (Louis, 1963).

The Nyiginya kingdom managed to annex adjacent polities because Ndori reformed the bureaucracy and the army. The army employed soldiers, support troops and large numbers of porters, and the court employed diviners, cattle herders, as well as large number of servants and (one estimate puts the population of the capital city at around 10.000 in 1920 (Des Forges, 2011, p. 184)). Importantly, Ndori reformed the army, introducing novel forms of hierarchy and hereditary lifelong conscription. Using this army, the Nyiginya kingdom expanded from its heartland in Nduga (see Map A1). Expansion generally involved a set of fixed steps (Des Forges, 2011). First, the army would move into a territory and establish a monopoly of violence. The soldiers requisitioned food and support through the chiefs of the local lineages. Second, over time, the court established a formal bureaucracy that consisted of three classes of officials. Former army generals became administrators charged with conscription and taxation on goods (these officials were called *batware*). Other officials (*banyabutaka*) were responsible for land allocation, land grants and land taxes. A final class of officials (*banyamukenke*) was responsible for pasture and cattle. At the village level, these chiefs exerted their authority through the existing lineages. Across lineages and along the bureaucratic hierarchy,¹⁰ the patron-client *ubuhake* contract developed (Vansina, 2004, p. 61). Under this arrangement, the patron gave one or more head of cattle in usufruct to the client, in exchange for labor services. This vassalage system enabled the king to establish an enforceable command structure.¹¹

¹⁰For the late nineteenth century, the Murdock ethnographic atlas for Rwanda records three levels of bureaucracy above the local, village, level. In his definition, this corresponds to a 'small state' (Murdock, 1967).

¹¹The *ubuhake* contracts subsequently diffused through Rwandan society. The system was only abolished in 1953 (Verwimp, 2013).

2.2 Violence between 1990 and 2000

Around independence, a large number of Tutsi fled to Uganda and many of their children joined the Ugandan army. In 1990 these Tutsi formed the Rwandan Patriotic Front (RPF) and invaded Rwanda. The Habyarimana government halted the invasion, but under international pressure had to agree to talks in Arusha, Tanzania. Although these talks resulted in a power sharing agreement, hostilities with the RPF, which controlled parts of Northern Rwanda and several killings which later turned out to be practice killings for the genocide occurred in between 1991 and 1993 (see Reyntjes (1994) and Des Forges (1999) for an overview of these events). The Habyarimana government's aim was to maintain its monopoly of violence over Rwanda in the face of the RPF threat and the new domestic political opposition (Des Forges, 1999). Several opposition parties had supporters in the government and other were openly sympathetic to Tutsi interests. In response to this threat to its authority, a group of hardliners around Habyarimana started forming self-defence groups, training youth-militias and importing large numbers of crude weapons, such as the machete. Rwanda's military expenditure, as a result, reached 7.8 percent of GDP in 1992 (Mamdani, 2002). On April 6th, 1994, an airplane carrying Habyarimana was shot down on its approach to Kigali. Within an hour, members of the political opposition were assassinated in their homes and roadblocks were set up all across the country. After this initial wave of killings, which targeted mostly senior government officials that were identified as potentially opposed to genocide, the policy of the new government, led by Théodore Sindikubwabo and Théoneste Bagosora, switched to genocide of the Tutsi minority. In the hundred days that followed, between 500,000 and 1,000,000 Tutsi and politically moderate Hutu were killed, often by machete blows from their next door neighbors, colleagues or even family (Des Forges, 1999).¹² The genocide ended when the RPF captured Rwanda's capital, Kigali.

In the years after the genocide, the RPF controlled the government. It intended to re-establish territorial control by arresting potential genocide perpetrators and pursuing perpetrators that had fled to the Democratic Republic of the Congo which resulted in frequent cross-border skirmishes and over crowded Rwandan prisons. By 2000 the backlog in trying all these perpetrators had run so high that the Gacaca court system was set up (see below).

¹²This number corresponds to about 75% of the targeted Tutsi minority (Straus, 2006). The genocide was perpetrated by government militias, the army and between 14 and 17% of adult Hutu males. This rate of mobilization is comparable to the highest rates in modern European wars (Onorato et al., 2014). Rwanda has historically been inhabited by three groups, Hutu and Tutsi and a small Twa minority (about one percent of the population). In precolonial times, these labels signified economic status and there was upward social mobility between classes. The king was always Tutsi. The Belgians recorded these categories as ethnic groups and gave a racial interpretation to differences in wealth.

3 Estimation framework

The research design of this paper exploits the fact that the Nyiginya kingdom expanded by annexing adjacent territories to its domain. Districts that were farther away, I hypothesize, were more likely to be incorporated later. Furthermore, this distance is plausibly uncorrelated with other factors that affect violence one hundred years after colonization. In this section, I set up a general framework for thinking about ease of access. I then explore the first stage relationship between proximity to Nyanza and the expansion of the Nyiginya kingdom. I also provide evidence that suggests that the exclusion restriction which validates the instrumental variables approach in this paper, is plausibly met.

The expansion of the Nyiginya kingdom. The historical literature suggests several factors that were important to the Nyiginya kings and plausibly factored into the decision to annex new territory (Vansina, 2004). First, external threats, such as from the nearby Rundi kingdom, would provoke pre-emptive expansions. Second, wealth accumulation, especially in cattle, required rustling and the acquisition of grazing lands. Third, annexation could result from a power vacuum across an outer border of the kingdom (d'Arianoff, 1952). I will exploit one such annexation in section 6 below. In each case, annexation proceeds from a district under control of the kingdom to an adjacent district that is not yet under royal control. The expansion of the kingdom is mapped in Figure 2. The process that leads from the oral histories that supply this data to Figure 2 is detailed in the appendix to this paper. This appendix also provides step-by-step maps of this expansion.

The Nyiginya kingdom had several capitals, and the king travelled between these capitals to assert royal authority. One of their early capitals was at Nyanza, in Southern Rwanda (see Figure 3). Nyanza is on the boundary between historical districts, Nduga and Busanza. Nduga is considered the historical heartland of the Nyiginya kingdom whereas Busanza was one of the earliest annexations from the Nyiginya kingdom, around 1720 (see table A18 in the online Appendix). Although the capital cities at *Nyamagana* and *Nyundo* are arguably established before Nyanza, Nyanza was prominent throughout the expansion of Nyiginya kingdom. By the early nineteenth century Nyanza had become the main capital (Newbury, 1991, p. 100), and Nyanza became Rwanda's sole capital before colonization (Lugan, 1997).¹³

¹³While Nyanza's exact location is known, only the approximate locations of Nyamagana and Nyundo are known. Nyamagabe is said to have been in Southern Nduga (Vansina, 2004, p. 49), and Nyundo is said to have been in Southern Nduga as well, close to a place called Bunyogombe (Vansina, 2004, p. 241). It is, however, possible, to identify pre-genocide village names that are close to the likely location of these capitals that have the same names as these capitals. Assuming these are the true historical locations, Nyamagana and Nyundo were 13 and 15 kilometres away from Nyanza.

3.1 Constructing proximity to Nyanza

Let i denote a precolonial district, and let M be a $n+1 \times n+1$ matrix with entries m_{ij} . m_{ij} denotes the cost of travelling from district i to district j or to Nyanza. In this section I consider several different measures of m_{ij} . In following sections, I use these measures of proximity to Nyanza as instruments for the presence of the Nyginyga kingdom.

Distance to Nyanza. The first instrument I use is the straight line distance in kilometres. Each m_{ij} is given by the distance between the centroids of districts i and j . I use the distance between Nyanza and i as an instrument for the year of annexation of district i . Distance is frequently used a source of exogenous variation, such as in Becker et al. (2009) who use distance to Wittenberg as an instrument for the spread of Protestantism, Dittmar (2011) who uses distance to Augsburg as an instrument for the spread of the printing press and Nunn (2008) and Nunn and Wantchekon (2011) who use distance to the coast as an instrument for the intensity of the slave trade.

Cost distance to Nyanza (days). The second instrument I use considers elevation variability as a cost to travel. Nyanza is in south central Rwanda on a plateau between Albertine rift mountain range that cross-cuts Rwanda longitudinally and the hilly savannah land bordering Tanzania. The Albertine mountain range is part of the mountain range that divides central Africa into the drainage basin of the Congo and the Nile. As a result, elevation varies substantially within Rwanda. The highest peaks in Rwanda reach four kilometre above sea level whereas the plateau is about one kilometre above sea level. Each m_{ij} is given the average travel time in days across Rwanda's hilly geography of marching back and forth once between i and j .¹⁴ I use a fine elevation grid from the Shuttle Radar Topography mission, which provides digital elevation models (DEM) at a 90 by 90 meter grid resolution.

I then compute travel time by finding the least costly route across this grid. Traversing one cell of this grid has a cost associated with it, and costs of routes across space are the accumulated costs of travelling the grid cells crossed by this route. The cost to travelling a grid cell is the maximum increase in elevation, or slope s , in north-south or east-west direction. Movements between two adjacent grid cell have cost $c_{n,m} = t(0.5(s_n + s_m))$, where $t(s)$ is a conversion function relating travel cost to travel time, or a 'vertical factor' in ArcGIS.¹⁵ For diagonal movements, s is multiplied by $\sqrt{2}$.

¹⁴ M in this case is not symmetric, since uphill marches are more costly than downhill marches.

¹⁵I use Tobler's function (Tobler, 1993) which is estimated on data collected by (Imhof, 1950). $t(s) =$

Let P be the set of all paths along the elevation grid between two nodes. A path $p \in P$, of length l is a set of l movements $q_{n,m}$ with associated costs $c_{n,m}$ across the grid. The least cost path between two points along the elevation grid raster is then:

$$\arg \min_{p \in P} \sum_{q_{n,m}} c_{n,m}, \quad q \in p \quad (1)$$

Intuitively, travel cost distance is the sum of costs of each move involved in the path. This process is visualized in Figure 3. Figure 3a maps elevation in Rwanda. Figure 3b plots contour lines of point that are six hours marching distance away. Figure 3c maps the optimal paths $p \in P$ across Rwanda's geography from Nyanza to each district. The methodology in this paragraph is an application of Dijkstra's algorithm (Dijkstra, 1959), which has recently been used in economics by Dell (2015).

Cost distance to Nyanza - Özak (days). Ömer Özak has recently computed a Human Mobility Index, which computes travel time taking into account not only elevation, but also weather patterns and soil conditions. As a third instrument I use the cost distance in days between Nyanza and each district computed according to his procedure (??).

Cost distance to nearest Nyiginya army location (days). I finally consider the expansion of the Nyiginya kingdom using the location of Nyiginya armies as the origin of expansion, rather than Nyanza.¹⁶ Although the Nyiginya bureaucracy was administered from the capital cities in the centre of the kingdom, the King did place armies throughout the kingdom to defend against invasions and launch new expansions. I use data from Kagame (1963) who reports the location of each army battalion recruitment as well as its year of establishment. I compute the travel cost distance to the nearest army that was established before the annexation of a district.

3.2 Estimating equations

OLS estimates. I first estimate the relationship between state presence in years and violence. My baseline estimating equation is:

$$Y_{sdp} = \beta_0 + \beta_1 StatePresence_d + \mathbf{X}'_d \beta_2 + \mathbf{Q}'_s \beta_3 + r_p + \varepsilon_{sd} \quad (2)$$

¹⁸ $\frac{18}{5} \exp(-3.5 |(\tan(s \frac{\pi}{180})) + 0.05|)$ where s is measured in degrees. $t(0) = 3.02205 \text{ km/h}$. For movement over paved terrain, multiply by $5/3$ (Tobler, 1993).

¹⁶The dimensions of M are therefore $n + a \times n + a$ for this instrument, where a is the number of precolonial armies.

where s indexes modern sectors ($n=1449$ in most specifications), d indexes precolonial districts ($n=50$) and p indexes modern provinces ($n=5$).¹⁷ Y_{sdp} is an outcome of interest, such violence in the 1994 genocide. $StatePresence_d$ is the number of years between the annexation of precolonial district d and colonization in 1897.

X'_d is a vector of travel distances along the 1988 road network. In addition to the distance to Nyanza, this vector includes distance to Kigali, Rwanda's modern capital.¹⁸ Q'_s is a vector of sector level covariates, including, for instance straight line distance to the national border. This vector also includes several other geographical and historical covariates, capturing the importance of geographical factors, such as soil productivity, as well as the potential impact of colonial rule. I discuss these covariates as they are introduced. This vector finally also includes household income as a measure of the attractiveness of sectors for looting, which was an important motivation killings (Straus, 2006), as well as the fraction of the population that was recorded as Tutsi in the 1991 census.¹⁹ ε_{sd} is an error term.

IV estimates. I test whether proximity to Nyanza is correlated with the expansion of the Nyiginya kingdom by estimating the following first stage relationship:

$$StatePresence_d = \gamma_0 + \gamma_1 Distance_d + X'_d \gamma_2 + Q'_s \gamma_3 + r_p + \nu_{sd} \quad (3)$$

where $Distance_d$ is either the straight line distance to Nyanza, or one of the cost distance measures introduced in the previous section. $StatePresence_d$ and $Distance_d$ both vary at the precolonial district level. I therefore report the first stage both at this level as well as the sector level.

I then use predicted state presence from the first stage in the following second stage. I estimate the system of (3) and (4) using Two Stage Least Squares:

$$Y_{sdp} = \beta_0 + \beta_1 StatePresence_d + X'_d \beta_2 + Q'_s \beta_3 + r_p + \varepsilon_{sd} \quad (4)$$

¹⁷Sectors were the smallest relevant unit at the time of the genocide. In 2002 there was an administrative reform which reduced the number of sectors to 416. I use modern, post-reform, provinces since these provinces divide the country into four districts - north, east, south and west - plus Kigali and these are natural unit for having fixed effects. Eastern Rwanda has historically interacted with the DRC, for instance (Newbury, 1988).

¹⁸Distance from Kigali is important because militias, who were important killers in the genocide, travelled from Kigali (Rogall, 2014). More generally, public service provision and 'state capacity' decline with distance from the capital city (Herbst, 2000; Michalopoulos and Papaioannou, 2014).

¹⁹The census data vary at the commune level which is one administrative level above the sector.

Y_{sdp} is an outcome of interest, such as violence or mobilization during the genocide. $\hat{\beta}_1$ is the coefficient of interest. Several variables in equations (1) - (3) do not vary at the sector level or may exhibit spatial correlation. I report single or double clustered standard error, as well as Conley (1999) standard errors, depending on the variables included in (1). For most results, the Conley standard errors are smaller than the clustered standard errors.

This instrumental variables strategy requires several assumptions to be a valid approach for causal inference. First, the instrument needs to be correlated with state presence in the first stage. Second, and in addition to this informativeness assumption, travel cost distance must be uncorrelated with any determinant of an outcome of interest other than state presence. This exclusion restriction is untestable since it pertains to unobservables and observables alike. To shed light, however, on the plausibility that it is met, table 1 reports regressions of several characteristics of Rwandan villages on travel cost distance to Nyanza.

The first characteristic I consider is pre-Nyiginya population density. I use data on locations of archaeological finds indicating population settlement before the foundation of the Nyiginya kingdom from Prioul and Sirven (1981). If prehistorical population density is correlated with proximity to Nyanza, the exclusion restriction may be violated because population density may persist and correlate with ε_{sd} . I furthermore consider use elevation and slope, as well as data on the suitability for growing banana, Rwanda's main staple crop, from the Food and Agricultural Organization. Finally, I use data on the geographical suitability of Savannah Tsetse, also from the Food and Agricultural Organization.²⁰ Presence of Tsetse increases cattle mortality and decreases the attractiveness for annexation since cattle was highly coveted in precolonial Rwanda (see also Alsan (2012)). Each panel reports results for a different instrument. All effect sizes are standardized (i.e. measured in standard deviations).

All instruments are uncorrelated with most pre-characteristics, which lends credence to the use of proximity to Nyanza as a source of plausibly exogenous variation. The only exception is Tsetse prevalence, which is positively and significantly correlated with all instruments but Cost distance to the nearest Nyiginya army (days). This effect is driven by the far West of Rwanda which is the only part of the country that is suitable for Savannah Tsetse. Motivated by this result, I include TseTse prevalence as a covariate in several specifications below.

Aside from the exclusion restriction being met, the first stage correlation between the instruments and

²⁰There are several subspecies of TseTse, and Savannah TseTse (subgenus *morsitans*) is the only subspecies endemic to Rwanda.

state presence needs to be sufficiently strong. If this correlation is too weak, the second stage results become difficult to interpret (Staiger and Stock, 1997). Table 2 reports regressions using state presence as the dependent variable and the four measures of proximity to Nyanza as independent variables. Even columns report univariate regressions using only the instruments as independent variables. Odd columns add travel distances along the pre-genocide road network to Nyanza and Kigali, as well as straight line distance to the national border and province fixed effects. The distance controls capture mechanical correlations between the instruments and state presence resulting from, for instance, accessibility for the Rwandan army, the police or militias who were active killers in the genocide. These controls constitute a ‘baseline’ set of controls and are included in all IV estimations in the remainder of this paper.

Columns (1) and (2) report results using the distance to Nyanza in kilometres as the variable of interest. In this line with the narrative in the introduction to this section, I find a negative correlation: District that are further away from Nyanza were annexed to the Nyiginya kingdom later. This effect remains strong and significant when introducing controls in column (2). I find a similarly strong results using the cost distance measures to Nyanza, in columns (3)-(4) and (5)-(6). Using cost distance to the nearest army as the variable of interest does not produce robust results when introducing controls.²¹

For the remainder of the analysis, I use the distance to Nyanza as kilometres as a baseline instrument in the specification reported in column (2) of table 2. This measure is precisely measured and parsimonious, since it does not rely on specific assumptions regarding movement speed of soldiers nor on assumptions regarding the impediments posed by traversing rugged terrain. The results in tables 1 and 2 show that the instrument is informative and provide evidence suggesting that the exclusion restriction is plausibly met. In the appendix I report all results estimated using two stage least squares with the other instruments as well.²²

3.3 Data

This section introduces the main data sources used. Summary statistics for all variables used in this paper are in the appendix.

²¹In the appendix I report two robustness exercises. In table A2 I report estimates of equation (2) at the precolonial district level, the level at which state presence varies. The estimated effects are very similar. Following a recent contribution by Ashraf and Galor (2013) I then verify that the results in table 3 are not driven by the distance to Addis Abbeba in table A3.

²²I do not report results using the cost distance to the nearest army since the correlation in column (8) of table 2 is insignificant.

3.3.1 Violence

Violence and mobilization in the genocide. Data on violence in the genocide is provided by the National Service of Gacaca Jurisdictions court proceedings. A Gacaca court meeting is a form of traditional local justice, revolving around a village meeting in which individuals accused of genocidal crimes confess or deny crimes and are sentenced or acquitted. Starting in 2001, over 8000 of these courts were instituted in Rwanda to reduce the enormous backlog in the regular court procedures (for a detailed description of the data as well as the Gacaca procedure, see Verpoorten (2011)). The data consist of three categories of crimes:

1. Planners, organizers and supervisors of the genocide. This includes organizers at the local bureaucratic level and within political parties as well as the youth militias
2. Murder, manslaughter, and non-lethal violence with the intention of killing
3. Violence against property, if not amicably settled

In my sample there are, 816.325 prosecuted individuals, 76.572 in category 1, 431.265 in category 2 and 308.488 in category 3. I will use two outcomes variables of interest. The first is the sum of categories 1 and 2 over the 1991 population. This measure captures overall violence in a village. Second, I use the number of prosecuted individuals in category 2, normalized by the Hutu population, to understand mobilization of the Hutu population. These data have been used before in economics, see e.g. Yanagizawa-Drott (2014). In the appendix I show that the main results in this paper are robust to using alternative data sources, such as a survey genocide victims conducted by a Swiss NGO in 2004. I also show robustness to normalizing by the number of Gacaca courts, rather than population.

Violence before and after the genocide. I take pre- and post-genocide violence from the UCDP database (Sundberg and Melander, 2013). This database records violent events that lead to 25 or more casualties and covers Rwanda from 1990. Its main sources are reports by international news agencies (such as Reuters and the BBC) as well as reports from NGOs (such as Human Rights Watch). In my sample there are 139 incidents in 1990-1993, 161 in 1994, and 147 in 1995-2000. The data for 1994 are an underestimate. The total death toll for 1994 in this data is 155,217 which is far below the death toll estimated after the genocide as well as below the data introduced above (see Straus (2006) for a discussion). I therefore use the Gacaca court data for 1994.²³ The UCDP data have been used extensively in economics,

²³Most results in the rest of this paper, however, hold when using the UCDP data, although I lose precision on some results. These results are available upon request.

see e.g. Michalopoulos and Papaioannou (2016).

The UCDP database records three types of violence. First, state-based armed conflict, which is defined as "contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in one calendar year". Before the genocide, these conflicts occur mostly between the Rwandan government and the invading RPF army. After the genocide, these conflicts occur between the Rwandan government and Hutu rebels. Before 1994, 82 out of a 139 recorded conflicts state-based. After 1994, 59 out of 147 recorded conflicts are state-based. Second, one-sided violence, which is defined as the "use of armed force by the government of a state or by a formally organized group against civilians which results in at least 25 deaths in a year". All remaining conflicts are of this type. The final category is conflicts "between two organized armed groups, neither of which is the government of a state, which results in at least 25 battle-related deaths in a year."

I use the number of violent incidents in a sector in a year, as well as the number of incidents involving the Rwandan government as one of the actors as dependent variables. On average, about ten percent of sectors experience a conflict pre- or post-genocide.

3.3.2 State Presence

I reconstruct the presence of the Nyiginya kingdom at the level of the precolonial district by subtracting the year in which a district was annexed from 1897, the year in which Rwanda was formally annexed to German East Africa. This procedure requires the reconstruction of the administrative divisions of the precolonial kingdom and the identification of the years of the annexation for each district. For the histories of the individual districts I rely on work by Jan Vansina, who has reconstructed the political history of the Nyiginya kingdom from oral histories cross-referenced with natural phenomena like solar eclipses (Vansina, 2004). I then reconstruct the precise history of expansion by combining precise historical data on each precolonial district with maps of these district from the Belgian colonial archives. Figure 1 maps the precolonial districts and the history of expansion. Full details of the procedure described in this section, as well as the raw data, are in the appendix.

In addition to the data sources discussed in this paragraph, I use several historical and administrative

dataset in this paper. I introduce these in the text when used in an empirical estimation. The appendix reports summary statistics, in table A1, as well as source information for all variables used in this paper.

4 Results

This section reports the main results in this paper, the effect of the historical state on violence. I first report the main results using OLS/Negative binomial regressions, and then introduce the IV estimates. I find a positive, significant and robust effect of state presence on violence in the genocide. Using the UCDP data for 1990-1993 and 1995-2000, I find a negative and significant effect of state presence during these periods. I also find that the first stage relationship between proximity to Nyanza and state presence is strong and robust. Finally, the IV results are in agreement with the OLS results, providing evidence for a causal interpretation of the effect state presence on violence.

4.1 OLS results for violence and mobilization in the genocide

Table 3 reports estimates of equation (1) using measures of violence and mobilization from the Gacaca records as dependents variables. The estimates in the first row show a consistent positive effect of state presence on violence and mobilization. This effect is consistent with historical evidence: The Rwandan state actively mobilized its citizens to take part in the violence. This effort was, these results suggest, more successful in places where the state has a longer presence. A natural concern when interpreting these effects is the role of Hutu and Tutsi in Rwandan society. In precolonial Rwanda, Hutu was a designation for poorer Rwandans and Tutsi as a designation for richer Rwandans (Vansina, 2004). The Rwandan king was always chosen from one of two Tutsi lineages and, over time, Nyiginya bureaucrats were increasingly referred to as Tutsi, regardless of individual wealth (Newbury, 1988). The Belgian colonizers instituted a policy of discrimination in favor of the Tutsi which culminated in the Tutsi king being ousted in a coup in 1959. When the exiled Tutsi invaded Rwanda in 1990, the Rwandan government started planning the extermination of all Tutsi in Rwanda (for a full background to this history, see Mamdani (2002)). This historical evidence suggest that the fraction of Tutsi may very well be an outcome of deeper state history because precolonial bureaucrats were designated Tutsi. I explore this idea below. For now, I include the fraction of the population that is classified as Tutsi in the 1991 census as a covariate in columns (2) and (4). Since the Tutsi were the targets of the genocide, greater presence of Tutsi increases genocide intensity, but the estimated effect of state presence remains stable and significant.

Economic impact. The estimated coefficients in table 3 are not only significant, they are economically meaningful as well. To take the estimate in column (1), 0.0307 (clustered s.e. 0.00953), one century longer state presence (or about its mean) is associated with an increase in violence of about 3 percent. This increase is equal to about 40 percent of the mean of violence. A different way of benchmarking the effect size is to consider effect sizes moving through the interquartile range of state presence. The interquartile range of state presence is 132 years. Taking the point estimate from column (1) again, this range is associated with an 4 percent increase in violence, which is about 40 percent of its interquartile range. The effect sizes for mobilization are very similar.

Robustness. I undertake a series of robustness exercises, which I'll only briefly discuss here. The appendix reports and discusses results. First, I re-estimate equation (1) at the precolonial district level, the level at which state presence varies. It may be the case that in places with longer state presence the Gacaca courts operated better. I show that normalizing by the number of Gacaca courts or using an alternative data sources for genocide violence results in qualitatively similar, and statistically significant estimates. I also verify that differences in income are not driving the results in table 2.

Pre-existing differences and the colonial period. It may be the case that the places that were annexed earlier were richer which may explain the observed effects in table 3. Although controlling for income before the genocide is one strategy to alleviate this concern, ideally, I would prefer to have a measure of income differences before the inception of the Nyiginya state. No such data exist but I can use data from Prioul and Sirven (1981) that record archaeological sites in Rwanda where remains have been found that predate the Nyiginya kingdom. In addition to pre-existing differences, the German and Belgian colonization may have had differential impacts across Rwanda. In order to understand the impact of the colonial period, I use data from the Government of Belgium (1960) and the Parliament of Belgium (1935) on the number of missionary stations in 1935 to account for missionary presence and the number of cattle in 1960. In absence of income data, cattle is the best measures of prosperity in the colonial period. I report results using these variables as covariates in the appendix table A7. To further assess the effect of pre-Nyiginya differences, I also control for terrain elevation, terrain slope, the geographical suitability for growing banana and the prevalence of the TseTse fly. Including these variables reduces the magnitude of the estimated effects from about 0.03 to about 0.02, but it does not significantly move the corresponding p-values. The reduction in estimated effects can be further assessed using a 'selection on observables'

exercise following Altonji et al. (2005) and Bellows and Miguel (2009). Let $\hat{\delta}$ be the reduction in the estimated effect resulting from including observable covariates, and $\hat{\beta}$ be the estimated effect in the baseline regressions in table 3. Then $\frac{\hat{\beta}}{\hat{\delta}}$ can be interpreted as a measure of how much unobservables would have to reduce the estimated baseline effects to explain them away, expressed in terms of the reduction in the same effect resulting from including observables. This ratio, reported in every column in table A7, is around 2, suggesting that, in order to explain away the effect, selection on unobservables would have to be twice as strong as selection on observables. Figure 4 graphically presents the estimated effects in the baseline table, the estimated effects including the covariates introduced in this subsection and the estimated effects including income as a covariate.

Alternative explanations for violence in the genocide. The results in table 3 suggest that state presence affects genocide intensity. Previous contributions have advanced other hypotheses to explain local differences in genocide intensity. André and Platteau (1998) argue that Rwanda’s rapid growing population created Malthusian pressures since plots were increasingly subdivided to the point that farming a plot did not meet subsistence needs. The genocide can then be interpreted as a Malthusian ‘positive check’. I use data on population growth between the 1978 and 1991 census as well as a measure of the extent to which Rwandan communes could provide the calories to feed the local population in 1980 from the Rwandan government.²⁴ Another theory of genocide intensity views the genocide as an outburst of ethnic hatred between Hutu and Tutsi (see Prunier (1995) for a statement of this view). Hatred towards other groups is hard to measure, and I will only show results for the fraction of Tutsi at a local level and the local fractionalization of Hutu and Tutsi.²⁵ In places where Tutsi are more numerous, the Hutu population may, for instance, feel more competition over resources or propaganda initiatives by the government may be more effective (Yanagizawa-Drott, 2014). I assess the relationship between state presence and these hypotheses in appendix table A8. Column (1) uses the percent increase in population between the 1978 and 1991 censuses as the dependent variables. Column (2) uses as dependent variable an indicator variable equal to one if a sector was unable to meet the caloric needs of the local population in 1980. I find a negative and insignificant effect of state presence on population growth and a negative and significant effect of state presence on the inability to provide sufficient calories. I find a positive and significant effect of state presence on the presence of Tutsi and on the fractionalization of Hutu-Tutsi, consistent with the idea

²⁴The commune is the geographical unit above the sector, my unit of observation.

²⁵For Hutu, H and Tutsi, T , let π_g be the fraction of the local population belonging to group g , $g \in H, T$. I disregard the marginal Twa ethnic group. Fractionalization is then defined as $\pi_H(1 - \pi_H) + \pi_T(1 - \pi_T)$. This measure is maximized at $\pi_H = \pi_T = 0.5$ and can be interpreted as the probability that two randomly selected individuals will belong to different groups.

that the precolonial bureaucracy was Tutsi-run. Table A9 in the online appendix assesses the robustness of the correlation between state presence and violence and mobilization to including these variables as covariates. Although the estimated effects are smaller than in table 2, the effect of state presence remains positive and significant.

4.2 The impact of state presence on genocide intensity

This section presents an instrumental variable approach to test whether the presence of a centralized state affected the intensity of the violence in the Rwandan genocide as well as the mobilization of the Hutu majority. In line with the results in the previous section, I find a positive and statistically significant effect of a history of centralized government on the intensity of the genocide. These results provide evidence for a causal effect of state presence and violence in the genocide.

Table 4 reports estimates of equations (2) and (3), using distance to Nyanza as the excluded instrument. Panel I reports 2SLS estimates and panel II reports the corresponding first stages. All regressions include travel distance to Nyanza and Kigali along the 1988 road network as well as geodesic distance to the country border and province fixed effects. The first stage results show that places further away from Nyanza are incorporated later. The first stage F-statistics indicate that the first stage is informative.

Columns (1) and (2) of Table 4 use the fraction of the population prosecuted for either organizing the genocide or for murder as the dependent variable. Columns (3) and (4) use the fraction of Hutu individuals prosecuted for murder as dependent variable. As before, columns (2) and (4) add the fraction of the population classified as Tutsi in the 1991 census as a covariate. Columns (1) and (3) report the main result, a positive and significant relationship between state presence and genocide intensity and mobilization. Using the point estimate in the first row and column (1), a hundred year increase in state presence, which is equal to the mean of state presence, increases genocide intensity by about 85 percent of its mean. Column (3) shows similar effects for the fraction Hutu prosecuted for murder. These estimates are twice as large as the corresponding OLS estimates in table 3. There are a number of reasons for why OLS estimates are typically smaller than IV estimates. State presence could be measured with error, for instance. The IV estimates may pick up the Local Average Treatment Effect only for those sectors affected by the instrument, the OLS estimate may be biased downwards due omitted variables or the exclusion restriction could be severely violated. Given the results in table 1 it is unlikely that the exclusion restriction is violated. It is more likely that the expansion is measured with some error. It seems even more likely that

the OLS estimates are biased downwards due to the presence of omitted variables. The previous section has discussed several candidates for such variables and quantified their potential effects.

Economic impact. The estimated effects in table 4 are almost twice as large as the corresponding OLS estimates in table 3. This means that increasing state presence by its mean increases violence by about 80 percent of its mean. Similarly, increasing state presence by its interquartile range increases violence by about 80 percent of its interquartile range. The estimated effects of mobilization are similar.

Alternative instruments. Appendix tables A10 and A11 repeat table 4 using instruments based on the cost distance calculations presented in section 3. The details of these estimations are discussed in the appendix. The main results presented here are robust to using these instruments. Figure 4 presents a graphical comparison of the estimated effects using these different instruments.

Interpretation. The results in this section suggest a causal effect of state presence on violence in the genocide. Although this result is consistent with a large case study on the involvement of the Rwandan government in the planning and execution of the genocidal violence, interpreting this effect requires knowledge of the precise channel of transmission. In addition, and as argued in the introduction, the genocide was a highly unusual event. Although Rwanda had known previous outbursts of violence against Tutsi before, such as in the 1959 coup, a massacre at this scale, planned by the government and executed by the military, the police, militias and countless ordinary Rwandans had never happened before. Since the Rwandan government planned the genocide, it also constitutes a break in policy. At the start of the genocide, the government used its control over the radio to incite fear and encourage killings (Yanagizawa-Drott, 2014). Instead of maintaining order, it orchestrated chaos as a backdrop to organized violence (see Straus (2006) for a detailed analysis of the environment of uncertainty that was deliberately created by the organizers of the genocide). Instead of providing public goods, it provided weapons and instead of appealing to the duty of every Rwandan to farm and be self-sufficient, as president Habyarimana often did (Verwimp, 2013), it appealed to the duty of every Hutu to kill. It is therefore plausible that the causal effect found in this section only holds true when the government executes a policy of large scale mobilization and massacre. Indeed, the literature on the state and violence suggests that greater state capacity or longer state presence should be associated with less violence (Fearon and Laitin, 2003; Depetris-Chauvin, 2013). In the next section, I therefore consider violence before and after the genocide as outcome variables.

4.3 Negative binomial results for violence before and after the genocide

The Rwandan government organized and executed the genocide. Before and after the genocide, it was concerned with maintaining its monopoly of violence, which was threatened by invading and domestic rebel forces. In these periods of relative peace, the relationship between state presence and violence may be different. Whether this is the case will ultimately depend on the channel of transmission of the persistent effect of state presence. Before presenting results on channels, this section presents results using data on violence before and after the genocide. I find a negative relationship between state presence and violence in these periods.

In the period before the genocide, 1990-1993, the Rwandan government faced an invasion from Uganda. The RPF mounted attacks from Ugandan soil in northern Rwanda, and forced the Habyarimana government into power-sharing talks in Arusha, Tanzania in 1992. In the period after the genocide, 1995-2000, the new government, now led by the commanders of the RPF rebuilt the state, and re-established territorial control. The main threat to its monopoly of violence were recurrent attacks from genocide perpetrators from within Rwanda, supported by invasions from perpetrators who fled to the DRC.

I use the count of the number of violent incidents as dependent variables. Since these variables are overdispersed, I first report negative binomial regressions using the number of conflicts, as well as the number of conflicts involving the Rwandan government as dependent variables.

Table 5 reports results, using distance to Kigali and the country border, as well as province fixed effects as covariates that capture the location of a sector relative to the seat of the government and the power bases of the invading rebels. The estimates in the first row show a consistently positive effect of state presence on violence and mobilization. These estimates suggest that in places where the state has a longer presence, there was less rebel activity, and the government used less repression.

Economic impact. The estimated effect in column (1) implies that a one year increase in state presence is associated with a 1.5% drop in the number of violent events ($\exp(-0.0155) - 1 = -0.015$).

IV estimates Table 6 and appendix tables A12-A13 estimate equation (2) using violence before and after the genocide as dependent variables. Table 6 reports results using distance to Nyanza as the instru-

ment. The appendix tables use the alternative cost distance instruments introduced above. The results in these table corroborate the results in table 5.

5 Mechanisms: Survey evidence

The previous section quantified the causal effect of longer state presence on genocide intensity and mobilization of the Hutu population. In this section, I explore the mechanisms through which a longer history of centralized government affects conflict in the genocide. Although there are many potential mechanisms, the literature on the Rwandan has emphasized the top-down organization of the Rwandan state in organizing and directing the killings, as well as the high rates of bottom-up participation (Prunier, 1995; Hintjens, 1999; Des Forges, 1999; Straus, 2006). Before presenting empirical evidence on the effect of deeper state history on government institutions and participation rates before the genocide, I will present a stylized account of the local organization of the genocide to fix ideas.

5.1 Mechanisms: a stylized case study

This section describes the local execution of the genocide in order to understand how local government may be connected to greater genocide intensity and participation rates.²⁶

During the genocide, local men throughout Rwanda were called to a central location by a local government official, usually between 6AM and 9AM, who sent village level bureaucrats to go house by house to summon Hutu to this meeting. Due to high rates of radio ownership, many Hutu had since before the genocide been told that the Tutsi were invading to kill everybody and that the only way for Hutu to survive was to seek a ‘solution’ for the Tutsi problem Yanagizawa-Drott (2014). An interesting empirical question, which will be tested below, is whether the radio was more effective in places with a deeper state history. At these morning meetings, targets for that day would be announced, usually important Tutsi. Before the genocide, the government had drawn of lists of people who could be used as leaders in the genocide. These ‘intimidators’, as the civilian perpetrators called them, were in charge of morale and order. Usually, intimidators would be shopkeepers, teachers and other local notables. When the intimidators could not motivate the civilians or when they encountered resistance, the authorities would call on the national police or the youth militias, to break the resistance or lead the killings.²⁷ After a day of

²⁶This section is based on the detailed reconstructions of the genocide in several districts of Rwanda by Alison Des Forges (Des Forges, 1999), and on interviews with genocide perpetrators (Straus, 2006; Hatzfeld, 2005).

²⁷Before the genocide, however, training programs were set up in each district to train the youth to fight with machetes. One

‘work’, as the killings became known, the authorities would usually blow a whistle to announce the end of the day’s work. At the end of a day like this, perpetrators could keep anything they looted, but land of killed Tutsis was divided by the authorities. Shirkers were reminded of their duty, and charged a fine for missing a day of work. This process was repeated every day, but stayed local. Local execution ensured that intimidators and administrators knew the perpetrators, the perpetrators knew who was Tutsi and where the loot was, and that everybody could be home for dinner. Only the national police and the youth militias travelled.

This stylized case study suggests that the local government was heavily involved in the day to day organization of the killings. It furthermore suggests that the process of ensuring participation was decentralized, often coming down to ‘intimidators’. In the next sections I test several implications of these observations. First, I test whether longer state history is associated with greater public good provision, greater local government presence, greater fiscal capacity or greater local government spending. I find no support for this hypotheses. I do, however, find interesting heterogeneous effects by the political affiliation of the local mayor. Mayors aligned with the opposition were less likely to recruit civilians for the genocide offers since they recognized that the genocide was planned by the MRND, the ruling party. I then test the idea that longer state presence may be associated with greater obedience to authority which, in turn, explains the effect of state presence on mobilization numbers and genocide intensity. Using a variety of data sources, I find support for this hypothesis.

5.2 The local state

Before the genocide, the Rwandan government operated primarily through the governments of each of 154 communes whose mayors, called ‘burgomasters’, were the main local bureaucrats. This section tests whether longer state presence is associated with greater presence of local government institutions, public good provision, tax collection and public expenditure at the commune level. Ex ante, the relationship is ambiguous. It may be, for instance, that a deeper state history is correlated with greater public good provision, as is the case in the cross country literature (Bockstette et al., 2002). State capacity building and public investment during the colonial period, however, was directed at unifying state control to facilitate indirect rule. Postcolonial public investment was directed towards the homeland of the sitting president. During the rule of Grégoire Kayibanda from independence in 1962 until 1973, public investment was

person in ten would be trained while living at home, under the pretence of self defence. Coordination of these activities was left to local bureaucrats and the local police. See Rogall (2014) for empirical evidence on the role of militias.

diverted to central Rwanda. After Juvénal Habyarimana took over in 1973, all government posts and public investment went to his home region in the north-west of Rwanda (Verwimp, 2013).

Table 7 uses data from the Rwandan government a large number of public investments and other aspects of local government to test for a relationship between state presence and local government presence or capacity. To avoid issues with multiple testing, I report principal components as dependent variables (I report full results in table A9 in the online Appendix). In column (1) I use the first principal component of number of energy centres, energy transformers, water installations and water pumps in 1980. In column (2) I use the first principal component of the number of primary, secondary and secondary technical schools in 1980. In column (3) I use the first principal component of the number of hospitals, maternity clinics, health clinics and other clinics in 1980. In column (4) I use the first principal component of the number of social centres, reading centres, nutritional centres, and orphanages in 1980. In column (5) I use the first principal component of the number of post offices, grain silos, gas stations and banks in 1980. In column (6) I use the first principal component of the number of agricultural cooperatives, markets, trade centres and commercial centers in 1980. In column (7) I use the first principal component of total tax received, trade tax received and other tax received, all in per capita terms, in 1980. In column (8) I use the first principal component of total public expenditure, administrative expenditure, social expenditure and economic expenditure, in per capita terms, in 1980. Panel I reports 2SLS estimates and Panel II reports the corresponding OLS estimates. The results suggest that there is no consistent relationship between state presence and the presence or capacity of the local government. Column (6) suggests that places with longer state presence are more likely to have more markets. Table A8 shows that this effect is driven by the number of commercial centers and is not robust across different measures of market presence including the most direct measure, the number of markets. Overall, this evidence suggests that there is no consistent relationship between state presence and the presence or capacity of the Rwandan government before the genocide.

5.3 Obedience to authority as a mechanism

The previous subsection suggested that there is no systematic correlation between state presence and local government, either during the colonial period or at the time of the genocide. This section provides motivating evidence for another channel I propose in this paper: the propensity to comply with unenforced orders, from either the government or local ‘intimidators’. Many case studies have pointed to the

apparent ease with which ordinary Rwandans were mobilized by the Rwandan government (for discussions, see Hintjens (1999) and Newbury and Newbury (2000)). Gerard Prunier explicitly links this alleged obedience to the history of centralized rule in Rwanda: "Rwandese political tradition, going back to the Banyiginya Kingdom through the German and Belgian colonial period, is one of systematic, centralised and unconditional obedience to authority ... made it easier for the architects of the genocide to encourage or force both men and women to become murderers" (Prunier, 1995, p. 141). This observation is echoed in many eyewitness accounts of the seeming ease with which Rwandans obeyed instructions to kill neighbors, friends and even close family (for a collection of such accounts, see Gourevitch (1998)). In a survey of 210 incarcerated genocide perpetrators, Scott Straus finds that 45% of perpetrators was motivated by 'Intra-Hutu coercion and/or obedience'. He describes (p. 137):

"Here respondents said that they joined attacks because doing so was 'the law' (*igeteko*). Others said that they went with murderous groups or killed because they were 'obeying' what they had been told to do. Still other said that they participated because they had been 'authorized' to kill Tutsis. In these accounts, respondents stressed that 'the state' or 'the authorities' had mandated participation for all able-bodied Hutu men. Killing was 'the law'."

It is of course hard to disentangle the effect of norms of obedience from threats for non-compliance, social pressure and the prospect of material gain (this is the conclusion Straus reaches, see p. 140). Furthermore, arguments about norms of behavior are always made comparing Rwanda to other countries. There is no empirical evidence that provides guidance on whether these effects should hold within Rwanda. To further isolate compliance that is driven by factors internal to the individual, I report results from a fieldwork exercise which, as part of an experiment, holds environmental effects constant. I find a greater propensity to follow rules in villages with a deeper state history. Before presenting these results, I present evidence from the World Values Survey.

5.4 Evidence on attitudes

Before turning to the experimental evidence, I use responses on attitudes towards rule following, tradition and obedience from the World Values Survey waves for 2007 and 2012 to provide further evidence for a norm of rule following and obedience in Rwanda. In 2007 and 2012 participants were asked a series of questions regarding rule following. Specifically, questions v198-v202 asked participants to indicate on a scale from 1 to 10 how justifiable it is to: claim government benefits to which you're not entitled, avoid a fare on public transport, steal property, cheat on taxes if you have a chance and how justifiable it is for

someone to accept a bribe in the course of their duties. A score of 1 is interpreted as never justifiable and 10 as always justifiable. I use the first principal component of these questions, and report results for each question separately in table A10 in the online Appendix. I also use question v89 in the 2007 wave and question V79 in the 2012 wave which asks the respondent about the extent to which he/she identifies with the statement: "Tradition is important to this person; to follow the customs handed down by one's religion or family". The possible categories are 'very much like me', 'like me', 'somewhat like me', 'a little like me', 'not like me', 'not at all like me'. I recoded this question such that a higher score indicates closer identification with tradition. Finally, I consider question v138 from the 2012 wave which asks about essential aspects of democracy. It asks: "Many things may be desirable, but not all of them are essential characteristics of democracy. Please tell me for each of the following things how essential you think it is as a characteristic of democracy. Use this scale where 1 means "not at all an essential characteristic of democracy" and 10 means it definitely is "an essential characteristic of democracy". I consider the statement: "People obey their rulers". When estimating the effect of state presence on attitudes, I match the respondents based on their place of residence to precolonial districts, and control for demographic characteristics as well as a literacy indicator and survey year fixed effects.

Table 8 reports results. In places with longer state presence, respondents are less likely to consider rule breaking acceptable, are more likely to think that tradition is important and or more likely to think that obedience to authorities is a central aspect of democracy. The estimated effects in column (2) and (3) are standardized such that, to consider column (3), a one standard deviation increase in state presence (or about 67 years) is associated with a 0.1 standard deviation increase in the importance respondents attach to obedience in a democracy (the mean of the dependent variable is 7.2, s.d. = 2.6). The observed effects in this table are not large, but they support the hypothesis that individuals in parts of Rwanda with longer state presence are more likely to think that rule breaking is unacceptable and that tradition and obedience are important.

6 Mechanisms: experimental evidence

The evidence in the previous section suggests that the effect of state presence on genocide intensity is not driven by the persistence of the presence or the effectiveness of local government. Instead I hypothesized that in the environment of uncertainty that existed when the genocide started, individuals in places with a longer state history were more likely to comply with government demands to join the killings. To iso-

late the voluntary component of this compliance from the coercive part by local intimidators, police or militias, I present results from a lab-in-the-field experiment which I implemented in fall 2014 in Southern Rwanda.

This experiment asks participants living on either side of a river that was an external boundary of the Nyiginya kingdom before it was crossed in 1799 to comply voluntarily with a government demand to pay taxes. This experiment is carried under full anonymity and under impunity and therefore allows me to detect differences in compliance that are driven by factors internal to the individuals, provided that several assumptions regarding sample selection are met. I discuss these assumptions, the sampling and historical background to the fieldwork below. I then show that individuals that live in villages with a deeper state history are more likely to voluntarily comply with a demand to pay taxes. In Heldring (2016), I provide evidence that this effect is robust to accounting for the presence or accountability of the modern Rwandan state, to the effect of altruism, trust, social capital and a variety of other potential confounders.

6.1 Historical background and sample selection

Figure 6 highlights one boundary of the Nyiginya kingdom, between two precolonial districts, Mayaga and Bugusera (see Figure 1 and A1). Mayaga became part of the Nyiginya kingdom around 1700 and Bugusera around 1799. The boundary was crossed by farmers in 1799 after the polity occupying Bugusera, called Gisaka, was attacked by Burundi in the South, and subsequently annexed by the Nyiginya king. Jan Vansina notes about this annexation: "The .. conquest .. illustrates the role of serendipity and private initiative in the process" (Vansina, 2004, p. 155). This history, which is more fully detailed in Heldring (2016), suggests that villages on either side of the boundary are similarly attractive for incorporation. I formally test balance across the boundary on elevation and agricultural productivity below.

The study boundary coincides with a river, the Akanyaru. Up to the administrative reorganization of 2002, the study boundary coincided with the border between three communes in Bugusera and four communes in Mayaga. After the 2002 redrawing of boundaries, Bugusera became one district and Mayaga is subdivided into three districts.²⁸ These districts are mapped in Figure 6. Within these districts, I randomly sampled villages to participate in a fieldwork exercise and within these villages, I randomly sampled participants. Each village was visited twice, once to identify participants, and once for to carry out

²⁸This means that the effect that I observe may be driven by post-2002 district level confounders. This is however unlikely since district are very similar across Rwandan in terms of duties, and employ the same number of employees everywhere. An advantage of focusing on a river is that I measure the historical boundary without error.

the fieldwork. In total, I have 21 villages and 420 participants. An important identifying assumption for the empirical part of this section is that these participants are randomly selected. I provide balance tests below to shed light on the extent to which this assumption is met.

6.2 An experimental approach to measuring rule following

I measure rule following across the study boundary by experimentally eliciting compliance with a government demand to pay taxes. Taxation of labor and output was introduced upon annexation into the Nyiginya kingdom, and Rwandans pay income taxes, VAT and a variety of other taxes today. For full background to precolonial and modern taxation in Rwanda as well as to the design of the experiment, see Heldring (2016).

I have modified the ‘resource allocation game’ pioneered by psychologists (Hruschka et al., 2014) to measure compliance with a government demand to pay taxes. In each experimental village, I identified an experimental ‘lab’ for the day, usually a small room in the local hotel or bar, which are common in Rwandan villages. This location had to meet two criteria: 1) it can not be owned by the government and 2) it should guarantee anonymity of choices the participant makes as part of the experiment.

The experiment proceeds as follows: I provide an endowment equal to 6000 Rwandan Francs (about equal to wage compensation for one week of work), and I ask the participants to pay taxes to the central government over this endowment based on a coin flip. The participants are led into the experimental lab, which is prepared with thirty stacks of two coins of 100 Rwandan Francs (RWF). Upon flipping an enumerator-provided coin, a participant pays taxes over the first pile. The rule that participants need to follow is: If the coin comes up heads, the participant pays one coin, or 100RWF, into an unmarked envelope. The other coin is deposited in another unmarked envelope. If the coin comes up tails, no tax needs to be paid. This process is then repeated for every pile. Importantly, the participant is unsupervised throughout this process. At the end of the experiment, the participant walks away with the envelope that the participant associated with him/herself and hands back the envelope associated with the government. This experiment emphasizes compliance with a demand under impunity and anonymity, with a financial incentive to deviate from the prescribed behavior. To understand how longer state presence affects compliance in this fieldwork, I compare participants close to the study boundary with a deeper state history to those just on the other side of the boundary.

6.3 Balance

Balance on observables indicates that the randomization was successful. Balance also suggests that the side on the Akanyaru annexed a century later is a valid counterfactual for what would have happened had the side of the boundary annexed earlier been incorporated later.

Table 9 provides balance tests for several individual-level characteristics in panel I and several village-level characteristics in panel II. Different columns have different observables corresponding to observables determined before the start of the fieldwork. Columns (1) and (2) report the effect of longer state presence, now measured as an indicator variable equal to one for those individuals in Mayaga, on education and income. Columns (3) and (4) assess migrant status, accounting for differential sorting across the study boundary. Columns (5) and (6) report results for two measures from a dictator game, measuring altruism towards employees of the local and central government. Columns (7) and (8) assess effects on trust and social capital. In panel II, there are two dependent variables measuring underlying differences in geography between places across the study boundary, elevation and banana suitability. Pairs of columns restrict the sample to villages closer to the study boundary and columns (7) and (8) report effects within the experimental sample.

In panel I, education does not balance. All other individual observables balance. I show in Heldring (2016) that inclusion of education as a covariate does not change the estimated effect of state presence nor its estimation precision. In panel II, elevation and banana suitability start balancing as I restrict to villages closer to the study boundary. These results suggest that villages and participants look similar in terms of observables before the start of the fieldwork.

6.4 Experimental results on rule following

This section uses OLS to estimate the relationship between state presence and rule following in the sample of participants described in the previous section. The balance tests reported in table 9 suggest that selection into treatment is not a concern with interpreting the effects of state presence. I nevertheless control for several demographic covariates and the location of experimental villages relative to the study boundary when estimating causal effects. I estimate the following relationship:

$$y_{iv} = \alpha + \beta_D \cdot D_{iv} + \mathbf{x}'_{iv} \cdot \boldsymbol{\beta}_X + f(location) + \varepsilon_{iv} \quad (5)$$

y_{iv} is compliance with the demand to pay taxes for individual i in village v . D_v is an indicator variable equal to one if village v is in Mayaga, rather than in Bugusera such that $\hat{\beta}_D$ is the coefficient of interest, the measured effect of being on the side of the river with a deeper history on compliance. $f(location)$ is a linear function of latitude and longitude. X_{iv} includes all covariates at the individual or village level such as age, gender or the distance to Kigali. Finally, ε_{iv} is an error term. I estimate equation (5) using Ordinary Least Squares. I report heteroskedasticity robust standard errors. Following Young (2016) I also report p-values from a permutation test.

Table 10 reports results. Column (1) reports the effect of state presence using no covariates. This estimate is similar to a simple difference in means, with the difference that the estimated standard errors are heteroskedasticity robust. Longer state presence increases compliance by about 4.5% relative to a mean of 71%. Columns (2) include covariates that potentially absorb residual variation as well as account for unobserved heterogeneity at the village level. Column (2) includes latitude and longitude as a flexible measure of the sample village relative to the study boundary. Column (3) adds age, age squared and a gender dummy as covariates. Column (4), instead, includes distance to Kigali to account for the potentially differential effect of the central government across sample villages. Column (5) includes both demographic covariates as well as distance to Kigali and latitude and longitude. Across all specifications, I find a positive and significant effect of state presence on rule following. To take the estimated effect in column (5), a hundred years longer state presence (which is about the mean of state presence), captured by the state presence dummy, leads to an increase in compliance with a tax demand in the experimental fieldwork of 9.832% (s.e. 4.457, permutation p-value 0.023). This effect is equal to about 14% of the mean of compliance.²⁹

The previous sections have presented heterogeneous effects, results on attitudes as well as experimental as evidence that supports the hypothesis that longer state presence in Rwanda exerts an effect on rule following. This increased propensity to follow rules plausibly interacted with the state demands to produce a central driver behind higher participation rates in the genocide and, ultimately, higher death tolls.

²⁹Because participants observe the coin flip privately and follow the rule based on this coin flip, it may be the case that individuals are equally compliant with a rule but individuals in places with a longer state presence are less honest. In cross-country honesty experiments, however, individuals living in places with ‘better’ institutions are found to be more honest (Gächter and Schulz, 2016).

7 Conclusion

The paper quantifies a causal effect of a deeper tradition of centralized government on participation rates and violence in the 1994 Rwandan genocide. The Belgian colonial authorities and the post-independence Rwandan government invested in local state capacity to either subjugate the Rwandan population, in the case of the Belgians, or to favor the presidential tribe. I therefore find no evidence of a causal effect of historical state presence on the density of government institutions, public investments or tax collection today. Instead I emphasize the role state history played in molding compliance with state demands. In places with a deeper state history, individuals display a greater propensity to comply with unenforced government demands. This propensity was used in the genocide to mobilize ordinary Rwandans to take part in the genocide.

The invasion from Uganda and the start of the genocide created an environment of uncertainty in which the government demanded compliance with directives to participate in the killings. This policy interacted with the historically determined propensity to follow such demands to produce higher rates of participation and violence in places with a deeper state history *during* the genocide. Before and after the genocide, however, the state did not intend to mobilize individuals for violence. Instead it sought to maintain its monopoly of violence in the face of an invasion (pre-genocide) and during the rebuilding after the genocide. To understand the results in this paper in their broader context, I therefore re-estimate the relationship between state presence and violence before and after the genocide, finding a negative effect.

Based on historical evidence, I hypothesize two channels of transmission. First, top-down persistence of state infrastructure and state power. Using an extensive dataset on the presence and capacity of the local state in pre-genocide Rwanda as well as during the colonial period, I find no evidence for this channel. Second, bottom-up mobilization of the population for genocide participation. The precolonial state established its authority over time and part of this process was the socialization of the Rwandan population into complying with government demands. Although the capacity of the state was uniformized by the Belgian authorities and was directed towards the home region of each postcolonial president, differential exposure to the precolonial state had an effect on the propensity to follow rules. When the genocide was planned there was, therefore, less resistance and more compliance in those areas with a deeper tradition of centralized government. Compliance interacted with the policy to enact the genocide to produce higher

participation rates and, ultimately, greater death tolls.

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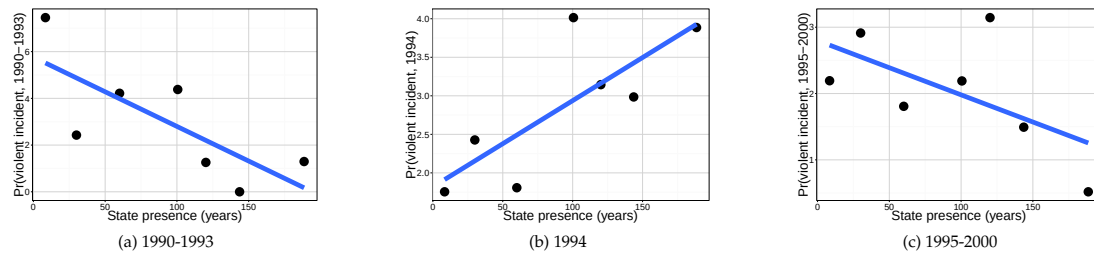
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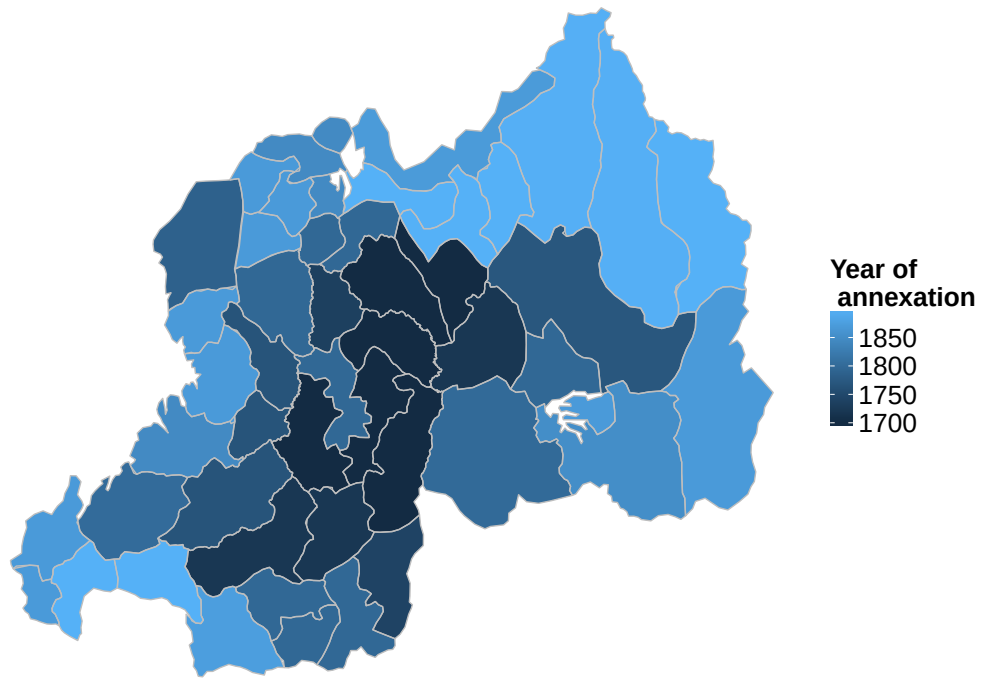
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Figure 1: THE RELATIONSHIP BETWEEN VIOLENCE AND STATE PRESENCE BEFORE, DURING, AND AFTER THE 1994 RWANDAN GENOCIDE



Subfigures (a)-(c) are binned scatterplots of the relationship between the probability of experiencing a violent conflict involving the Rwandan government and the length of the presence of the centralized state across sectors in Rwanda ($n=1449$). Subfigure (a) contains a scatter of the probability of experiencing a violent incident involving the Rwandan military or police as recorded in the UCDP violence data (Sundberg and Melander, 2013). I restrict the sample to incidents that occurred before the Rwandan genocide, between January 1990 and December 1993. Subfigure (b) contains a scatter of the probability of experiencing a violent incident involving the Rwandan military or police as recorded in the UCDP violence data (Sundberg and Melander, 2013). I restrict the sample to incidents that occurred during the Rwandan genocide, in 1994. Subfigure (c) contains a scatter of the probability of experiencing a violent incident involving the Rwandan military or police as recorded in the UCDP violence data (Sundberg and Melander, 2013). I restrict the sample to incidents that occurred after the Rwandan genocide, between January 1995 and December 2000.

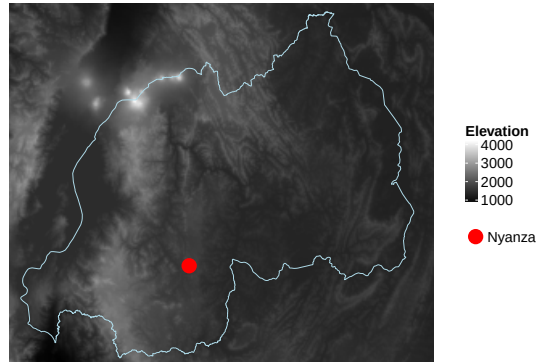
Figure 2: MAP OF THE EXPANSION OF THE NYIGINYA KINGDOM



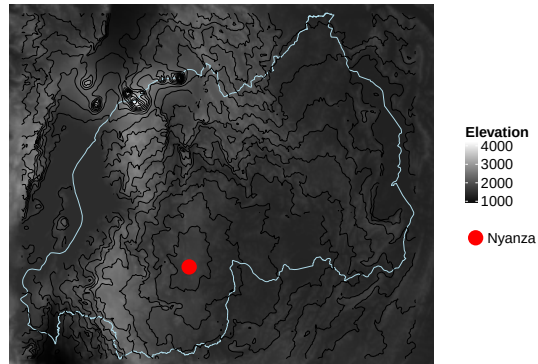
Map of precolonial district in Rwanda, shaded by the length of their state presence. The legend indicates the year of annexation. The raw data are reported in the Appendix.

Figure 3: THE CONSTRUCTION OF COST DISTANCE INSTRUMENTS

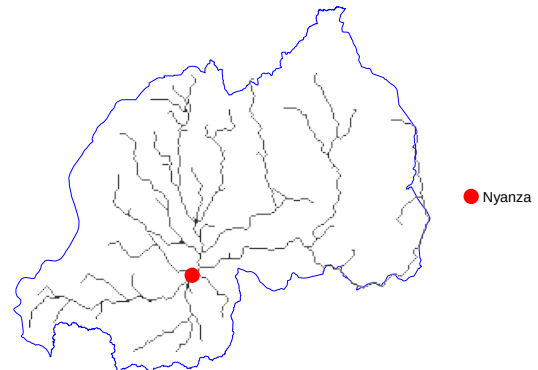
(a) Step 1: Terrain slope is the relevant impediment to movement of soldiers



(b) Step 2: Terrain slope and distance jointly determine travel time. Contours indicate six hour marches from Nyanza

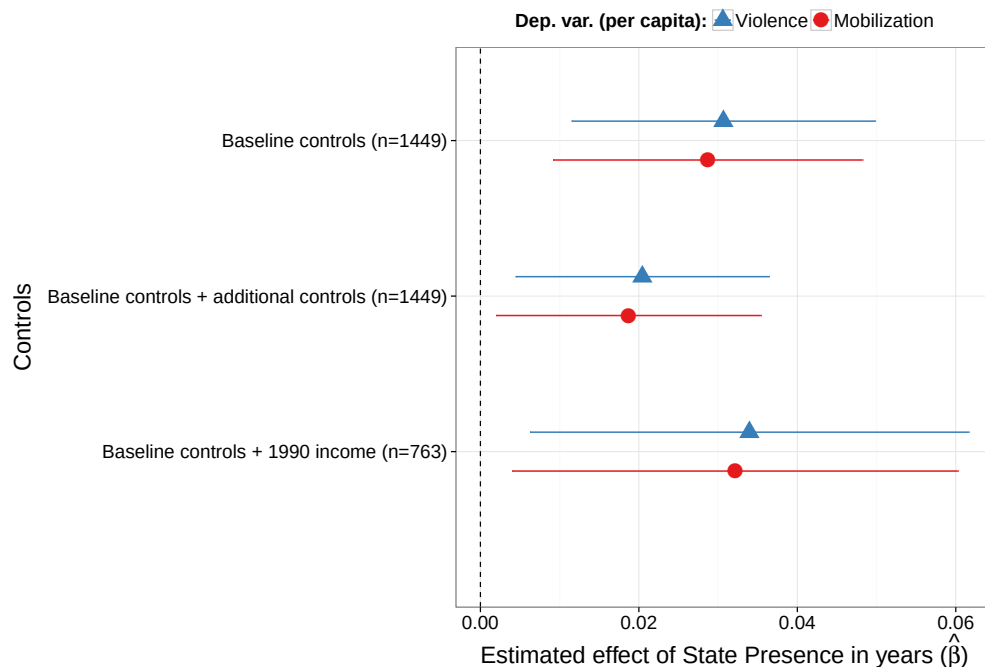


(c) Step 3: Travel time grid defines optimal paths and minimum travel time to precolonial districts



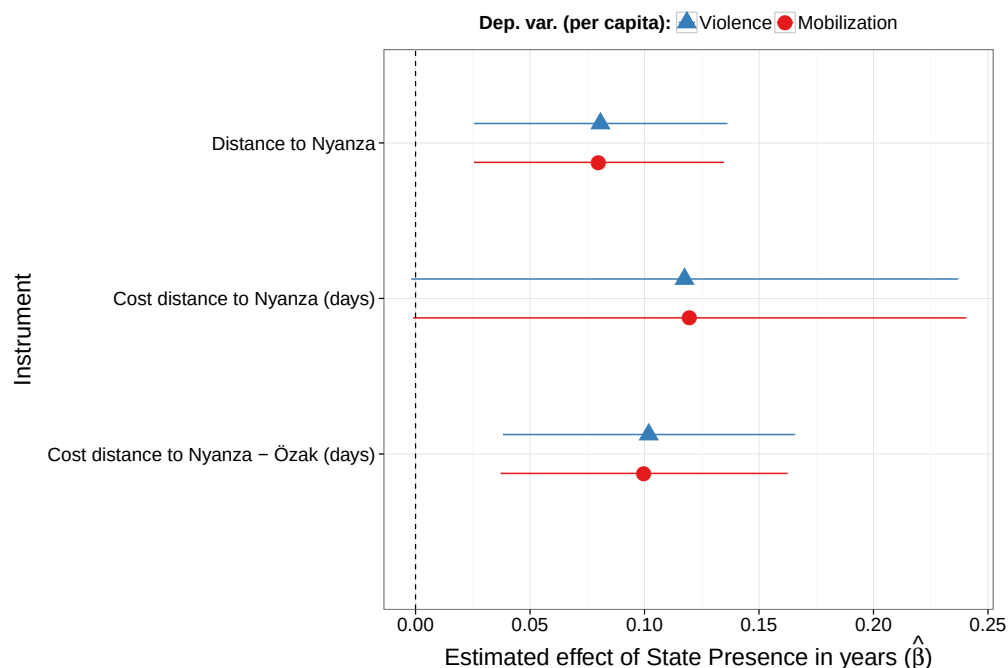
Subfigures (a)-(c) describe different parts of the construction of the cost distance instruments. The full procedure is described in the main text. This process starts with a grid that defines the cost of traversing a grid cell, such as elevation in (a). After transforming the elevation grid into a slope grid, I assign costs using Tobler's hiking function (Tobler, 1993) or using the approach developed in Özak (2010, 2013). These costs define, for each grid cell, the time to travel to that cell from Nyanza. Subfigure (b) visualizes this cost by plotting contour lines onto the elevation surface in subfigure (a). Using Dijkstra's algorithm, I can then find the least time-consuming path to travel from Nyanza to each precolonial district's centroid. These paths are visualized in subfigure (c). The Human Mobility Index proposed by Özak (2010, 2013) proceeds similarly using a coarser grid. For details, see Özak (2010, 2013).

Figure 4: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE



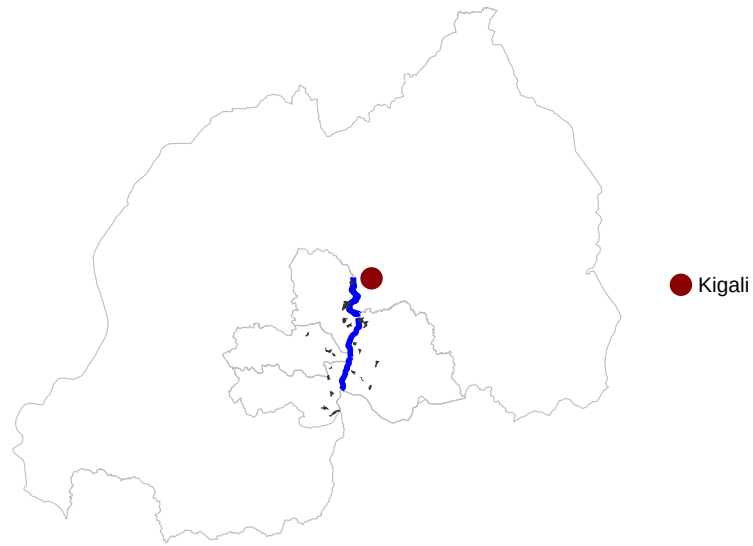
Effect sizes and 95% confidence intervals for the estimated effect of State Presence on violence and mobilization in the Rwandan genocide, for different sets of controls. Violence is defined as the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Mobilization is defined as the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. The point estimates are taken from tables 1, and tables A2 and A3 in the online appendix. These tables present OLS estimates, conditional on different sets of covariates. Baseline controls include province fixed effects, travel distance to Kigali along the 1988 road network and the geodesic distance to country border. Additional controls are the number of archaeological sites indicating population presence before the establishment of the Nyiginya kingdom, the number of cattle in 1960, the number of missionary stations (any denomination) in 1935, as well as terrain elevation, terrain slope, the geographical suitability for growing banana and the local prevalence of the savannah tsetse fly. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. 1990 income is the log of equivalent household income in 1990. Parentheses give the number of observations used to compute the estimated effects and confidence intervals. The confidence intervals are computed using standard errors that are clustered at the level of the precolonial district.

Figure 5: IV ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE

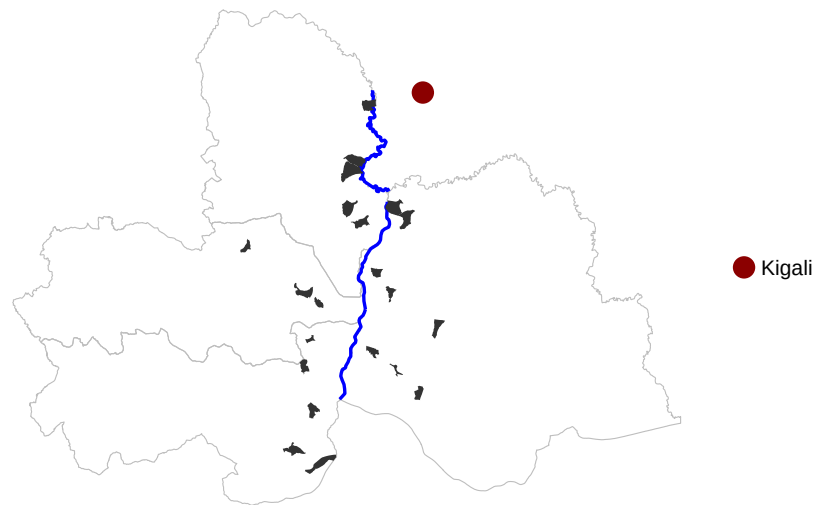


Effect sizes and 95% confidence intervals for the estimated effect of State Presence on violence and mobilization in the Rwandan genocide, for different instruments. Violence is defined as the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Mobilization is defined as the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Distance to Nyanza is the geodesic distance between the centroid of a precolonial district and Nyanza. Cost distance to Nyanza (hours) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed by Özak (2010, 2013). The reported point estimates and confidence intervals are taken from the even columns of tables 5, and tables A8 and A9 in the online appendix. These tables present 2SLS estimates, conditional on the following covariates: Travel distance to Kigali along the 1988 road network, travel distance to Nyanza along the 1988 road network and the geodesic distance to country border. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. 1990 income is the log of equivalent household income in 1990. The confidence intervals in this figure are computed using standard errors that are clustered at the level of the precolonial district.

Figure 6: THE LOCATION OF PARTICIPANTS IN THE COMPLIANCE EXPERIMENT



(a)



(b)

Subfigures (a) and (b) depict the villages where participants in the compliance game live. In subfigure (a), grey lines outline Rwanda's national boundaries and the districts within which participating villages are randomly selected. These villages are depicted in black. The boundary separating the villages by their exposure to the Nyiginya kingdom is indicated in blue. Kigali, Rwanda's capital is also indicated. Subfigure (b) depicts districts in grey, villages in black, the boundary separating the villages by their exposure to the Nyiginya kingdom is indicated in blue, as well as Kigali.

Table 1: CORRELATION OF PREDETERMINED CHARACTERISTICS AND DISTANCE TO NYANZA

		Pre-Nyiginya settlement	Elevation	Slope	Banana Suitability	TseTse prevalence
		(1)	(2)	(3)	(4)	(5)
Panel I						
Distance to Nyanza		0.425	0.0754	0.118	-0.112	0.718***
	<i>White s.e.</i>	(0.405)	(0.163)	(0.145)	(0.230)	(0.251)
	<i>Conley s.e.</i>	[0.225]	[0.124]	[0.101]	[0.117]	[0.180]
R^2		0.171	0.547	0.364	0.455	0.574
Panel II						
Cost distance to Nyanza		0.125	0.191	0.0522	-0.0835	0.439**
	<i>White s.e.</i>	(0.200)	(0.197)	(0.190)	(0.171)	(0.170)
	<i>Conley s.e.</i>	[0.104]	[0.151]	[0.118]	[0.100]	[0.123]
R^2		0.122	0.560	0.361	0.454	0.498
Panel III						
Cost distance to Nyanza - Özak		0.315	0.222	-0.0513	-0.113	0.767***
	<i>White s.e.</i>	(0.338)	(0.177)	(0.219)	(0.218)	(0.249)
	<i>Conley s.e.</i>	[0.192]	[0.104]	[0.148]	[0.095]	[0.199]
R^2		0.144	0.559	0.361	0.455	0.584
Panel IV						
Cost distance to nearest Nyiginya army location		0.122	-0.108	0.287*	-0.0845	0.0324
	<i>White s.e.</i>	(0.0962)	(0.137)	(0.165)	(0.144)	(0.0527)
	<i>Conley s.e.</i>	[0.042]	[0.079]	[0.053]	[0.084]	[0.023]
R^2		0.126	0.553	0.416	0.456	0.419
Observations		50	50	50	50	50

Notes: All regressions are estimated using OLS. The unit of observation is a precolonial district. All point estimates are standardized. All regressions include fixed effects at the modern province level. Parentheses report heteroskedasticity robust (White) standard errors. Square brackets report Conley (1999) standard errors, correcting for two-dimensional spatial correlation (assuming a 4 decimal degree cutoff). * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level, computed using White standard errors.

Table 2: OLS ESTIMATES OF THE DETERMINANTS OF PRESENCE OF THE NYIGINYA STATE

<i>Dependent variable: State Presence (years)</i>		Distance to Nyanza		Cost distance to Nyanza (days)		Cost distance to Nyanza - Özak (days)		Cost distance to nearest Nyiginya army location (days)	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
estimated coefficient		-1.356*** (0.194)	-1.675*** (0.435)	-26.41*** (4.234)	-14.80** (7.157)	-108.3*** (15.52)	-134.7*** (34.50)	-12.06*** (3.798)	-5.718 (4.302)
	<i>Clustered s.e.</i>								
	<i>Conley s.e.</i>	[0.062]	[0.220]	[1.731]	[3.038]	[7.085]	[14.781]	[2.739]	[3.113]
Travel distance to Nyanza along 1988 road network	N	Y	N	Y	N	Y	N	N	N
Travel distance to Kigali along 1988 road network	N	Y	N	Y	N	Y	N	N	Y
Geodesic distance to country border	N	Y	N	Y	N	Y	N	N	Y
Province fixed effects	N	Y	N	Y	N	Y	N	N	Y
Number of clusters		50	50	50	50	50	50	50	50
Observations		1553	1553	1553	1553	1553	1553	1553	1553
R ²		0.404	0.622	0.443	0.594	0.356	0.629	0.116	0.564

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Distance to Nyanza is the geodesic distance between the centroid of a precolonial district and Nyanza. Cost distance to Nyanza (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed Özak (2010, 2013). Cost distance to nearest Nyiginya army location is the travel distance (in days) between the centroid of a precolonial district and the nearest Nyiginya army battalion, measured in hours. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Regressions include fixed effects as indicated in the table. Parentheses report clustered standard errors at the level of the precolonial district. Square brackets report Conley (1999) standard errors, correcting for two-dimensional spatial correlation (assuming a 4 decimal degree cutoff). * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level, computed using standard errors clustered at the precolonial district level.

Table 3: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0307***	0.0287***	0.0287***	0.0259***
<i>Clustered s.e.</i>	(0.00953)	(0.00796)	(0.00972)	(0.00688)
<i>Conley s.e.</i>	[0.00508]	[0.00433]	[0.00487]	[0.00364]
Fraction Tutsi of population 1991		0.250*** (0.0653)		0.363*** (0.0507)
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Mean dependent variable	7.95	7.95	7.75	7.75
Number of clusters	50	50/142	50	50/142
Observations	1449	1449	1449	1449
R^2	0.191	0.234	0.184	0.273

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. Square brackets report Conley (1999) standard errors, correcting for two-dimensional spatial correlation (assuming a 4 decimal degree cutoff). * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level, computed using standard errors clustered at the precolonial district level.

Table 4: IV ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates</i>				
State Presence (Years)	0.0807*** (0.0270)	0.0664*** (0.0208)	0.0799*** (0.0267)	0.0578*** (0.0184)
Mean dependent variable	7.95	7.95	7.75	7.75
<i>Panel II: First stage estimates</i>				
Distance to Nyanza	-1.675*** (0.435)	-1.720*** (0.433)	-1.675*** (0.435)	-1.720*** (0.433)
F-stat of excluded instrument	14.59	15.98	14.59	15.98
R^2	0.622	0.623	0.622	0.623
Fraction Tutsi of population 1991	N	Y	N	Y
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50/142	50	50/142
Observations	1449	1449	1449	1449

Notes: All regressions in Panel I are estimated using two stage least squares using distance to Nyanza as the instrument, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Distance to Nyanza is the geodesic distance between the centroid of a precolonial district and Nyanza. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 5: DETERMINANTS OF VIOLENCE BEFORE AND AFTER THE RWANDAN GENOCIDE

<i>Dependent variable:</i>	Violence 1990-1993 (count)	Violence involving the Rwandan government 1990-1993 (count)	Violence 1995-2000 (count)	Violence involving the Rwandan government 1995-2000 (count)
	(1)	(2)	(3)	(4)
State Presence (Years)	-0.0155** (0.00633)	-0.0143** (0.00614)	-0.00924** (0.00471)	-0.0127*** (0.00485)
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Mean dependent variable	0.09	0.08	0.09	0.05
Log-likelihood	-273.06	-268.57	-343.73	-230.43
Number of clusters	50	42	50	42
Observations	1553	1553	1553	1553

Notes: Negative binomial regressions, estimated using maximum likelihood. The unit of observation is an administrative sector in 1994. Violence 1990-1993 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence involving the Rwandan government 1990-1993 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence 1995-2000 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. Violence involving the Rwandan government 1995-2000 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. Square brackets report Conley (1999) standard errors, correcting for two-dimensional spatial correlation (assuming a 4 decimal degree cutoff). * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level, computed using standard errors clustered at the precolonial district level.

Table 6: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE BEFORE AND AFTER THE RWANDAN GENOCIDE

<i>Dependent variable:</i>	Violence 1990-1993 (count)	Violence involving the Rwandan government 1990-1993 (count)	Violence 1995-2000 (count)	Violence involving the Rwandan government 1995-2000 (count)
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates</i>				
State Presence (Years)	-0.00518** (0.00232)	-0.00472** (0.00210)	-0.00236** (0.00119)	-0.00142* (0.000785)
Mean dependent variable	0.09	0.08	0.09	0.05
<i>Panel II: First stage estimates</i>				
Distance to Nyanza	-1.675*** (0.435)	-1.675*** (0.435)	-1.675*** (0.435)	-1.675*** (0.435)
F-stat of excluded instrument	14.83	14.83	14.83	14.83
R ²	0.622	0.622	0.622	0.622
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1553	1553	1553	1553

Notes: All regressions in Panel I are estimated using two stage least squares using distance to Nyanza as the instrument, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Violence 1990-1993 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence involving the Rwandan government 1990-1993 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence 1995-2000 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. Violence involving the Rwandan government 1995-2000 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 7: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON LOCAL GOVERNMENT

<i>Dependent variable:</i>	Principal component energy and water 1980	Principal component schools 1980	Principal component health services 1980	Principal component social provisions 1980	Principal component commercial institutions 1980	Principal component markets 1980	Principal component fiscal capacity 1980	Principal component public expenditure 1980
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel I: 2SLS estimates</i>								
State Presence (Years)	0.00517 (0.00681)	0.000398 (0.00751)	0.00507 (0.00697)	0.0106 (0.0103)	0.00435 (0.00704)	0.0109 (0.0120)	0.00353 (0.00678)	0.00316 (0.0120)
<i>Panel II: OLS estimates</i>								
State Presence (Years)	0.00122 (0.00180)	-0.00345** (0.00154)	0.00160* (0.000949)	-0.00133 (0.00187)	0.000263 (0.00148)	-0.00100 (0.00194)	0.00131 (0.00120)	0.000595 (0.00150)
<i>R</i> ²	0.109	0.229	0.044	0.073	0.087	0.060	0.272	0.277
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y	Y	Y	Y	Y
Number of clusters	50	50	50	50	50	50	50	50
Observations	1553	1553	1553	1553	1553	1553	1297	1468

Notes: All regressions in Panel I are estimated using two stage least squares and distance to Nyanza as the instrument, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. All point estimates are standardized. Principal component energy and water 1980 is the first principal component of the number of energy centres, energy transformers, water installations and water pumps in 1980. Principal component schools 1980 is the first principal component of the number of primary, secondary and secondary technical schools in 1980. Principal component health services 1980 is the first principal component of the number of hospitals, maternity clinics, health clinics and other clinics in 1980. Principal component social provisions 1980 is the first principal component of the number of social centres, readings centres, nutritional centres, and orphanages in 1980. Principal component commercial institutions 1980 is the first principal component of the number of post offices, grain silos, gas stations and banks in 1980. Principal component markets 1980 is the first principal component of the number of agricultural co-operatives, markets, trade centres and commercial centres in 1980. Principal components fiscal capacity 1980 is the first principal component of total tax received, trade tax received and other tax received, in per capita terms, in 1980. Principal component public expenditure 1980 is the first principal component of public expenditure, administrative expenditure, social expenditure and economic expenditure, in per capita terms, in 1980. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 8: DETERMINANTS OF ATTITUDES TOWARDS RULE BREAKING

<i>Dependent variable:</i>	Principal component rule breaking is acceptable	Tradition is important; following customs handed down by ancestors	Obedience to authorities considered central to democracy
	(1)	(2)	(3)
State Presence (Years)	-0.113** (0.0498)	0.0493* (0.0275)	0.103*** (0.0398)
Demographic controls	Y	Y	Y
Survey year fixed effect	Y	Y	N
Observations	2535	2576	1203
<i>R</i> ²	0.021	0.065	0.015

Notes: All regressions are estimated using OLS. The unit of observation is the individual. Principal component rule breaking is acceptable is the first principal components of several questions in the World Values survey waves of 2007 and 2012 that ask whether it's justifiable to do the following: claiming government benefits to which you're not entitled, avoiding a fare on public transport, stealing property, cheating on taxes if you have a chance, someone accepting a bribe in the course of their duties. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Demographic controls include age, age squared, a gender dummy and a literacy dummy. Survey year fixed effects are indicator variables for whether an individual respondent was interviewed as part of the 2007 or the 2012 World Values survey wave. Heteroskedasticity robust standard errors are in parentheses. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 9: CORRELATION OF PREDETERMINED CHARACTERISTICS AND EARLY STATE INDICATOR

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Dependent variable:</i>	Education in years	Eq. daily income (RWF)	Immigrant	Immigrant from outside sample area	Amount shared with sector employee	Amount shared with national gov't employee	Trust	Social capital
<i>Panel I: individual covariates</i>								
Early State	0.387*** (0.0912)	-0.0348 (0.120)	-0.126 (0.0982)	0.119 (0.101)	0.0478 (0.101)	-0.162 (0.106)	-0.0214 (0.0989)	0.0477 (0.0974)
Observations	420	420	420	420	420	420	420	420
R ²	0.139	0.007	0.046	0.056	0.006	0.015	0.050	0.043
<i>Dependent variable:</i>	Elevation <10KM from Akanyaru	Banana Suitability <10KM from Akanyaru	Elevation <5KM from Akanyaru	Banana Suitability <5KM from Akanyaru	Elevation <3KM from Akanyaru	Banana Suitability <3KM from Akanyaru	Elevation experimental sample	Banana Suitability experimental sample
<i>Panel II: Geography</i>								
Early State	30.55*** (10.99)	-5.415*** (0.909)	15.77** (6.792)	0.114 (1.113)	4.775 (8.720)	0.379 (1.307)	32.88 (20.37)	-3.565 (3.519)
Observations	300	300	164	164	82	82	21	21
R ²	0.149	0.260	0.033	0.000	0.004	0.001	0.119	0.051

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent in panel I and a village in panel II. Education in years is the total number of years a respondent has received fulltime education. Eq. daily income (RWF) is the equivalent daily income earned by a respondent. Immigrant is an indicator variable equal to one if the respondent immigrated into the sample village. Immigrant from outside area is an indicator variable equal to one if the respondent immigrated into the sample village from outside the sample districts Bugesera, Kamonyi, Ruhango and Nyanza. Amount shared with sector employee is the amount shared (out of RWF 1500) with an anonymous employee of the local administrative sector in which the sample village was located in a dictator game. Amount shared with national government employee is the amount shared (out of RWF 1500) with an anonymous employee of the national government in a dictator game. Trust is an indicator variable equal to one if the respondent answered that most people can be trusted in the post-fieldwork survey. Social capital is the number of civil society organizations a respondent is a member of. Terrain elevation is the elevation in meters under the centroid of the village the respondent lives in. Banana suitability is the geographical suitability for growing bananas in the respondent's village. Early State is an indicator equal to one if a village is situated to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 10: THE EFFECT OF STATE PRESENCE ON RULE FOLLOWING

<i>Dependent variable:</i>	Compliance with tax demand (% of base)				
	(1)	(2)	(3)	(4)	(5)
Early State	4.416*	8.838**	9.424**	9.110**	9.832**
<i>Robust s.e.</i>	(2.609)	(4.492)	(4.424)	(4.513)	(4.457)
<i>Permutation test p-value</i>	0.095	0.053	0.029	0.028	0.023
Mean dependent variable	71.34	71.34	71.34	71.34	71.34
Sd dependent variable	27.30	27.30	27.30	27.30	27.30
Demographic controls	N	N	Y	N	Y
Distance to Kigali	N	N	N	Y	Y
<i>f(location)</i>	None	Latitude & longitude	Latitude & longitude	Latitude & longitude	Latitude & longitude
Observations	416	416	414	416	414
R^2	0.006	0.013	0.036	0.014	0.038

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Compliance with tax demand (% of base) is the tax paid by an individual in the random taxation game, divided by the theoretical tax base, 1500 Rwandan Francs. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Appendix to:
State Capacity and Violence in Rwanda

1 Further results

Table A1 reports summary statistics for all variables used in the paper and in this appendix.

OLS estimates - first stage. Table A2 repeats the regressions in table 2, using the precolonial district level as the unit of observation, rather than an administrative sector at the time of the genocide. State Presence varies at the level of the precolonial district ($n=50$) whereas the different measures of distance to Nyanza vary at the sector level ($n=1449$). The estimated effects in this table are virtually identical to those in table 1.

Table A3 repeats the regressions in table 2, adding the geodesic, ‘as the crow flies’, distance to Addis Abbeba as a covariate, controlling for the effect distance to Addis Abbeba has on comparative development (Ashraf and Galor, 2013). The estimated effects are slightly larger, as are standard errors, showing that the relationship between the measures of distance to Nyanza considered in this table and state presence is not driven by the distance to Addis Abbeba.

OLS estimates. Tables A4-A8 report a series of empirical exercises assessing the robustness of the results reported in tables 3 in the paper, in which the determinants of violence and mobilization in the Rwandan genocide were explored using OLS.

First, table A4 repeats the regressions in table 1, using the precolonial district level as the unit of observation, rather than an administrative sector at the time of the genocide. The measures of violence and mobilization used in table 1 vary at this finer ($n=1449$) whereas State Presence varies at the level of the precolonial district ($n=50$). The positive association between State Presence and violence/mobilization in the genocide remains positive and significant when estimated at this level, and estimated effect sizes are similar.

Second, table A5 reports results using four different measures of violence in the genocide. To understand the effect of state presence on the ability of the Rwandan government to identify and convict genocide perpetrators in the Gacaca courts, columns (1) and (2) reports the number of individuals prosecuted for murder and violence, respectively, normalized by the number of Gacaca courts. Columns (3) and (4) use data, collected at the commune level ($n=135$ and $n=107$, respectively) taken from surveys of

the number of genocide victims in Rwandan commissioned in 2004 and 1996 (see data appendix below for sources). For each of these alternative violence measures, the estimated relationship between State Presence and violence is positive and significant.

Third, table A6 repeats table 3 in the paper, including the log of equivalent household income as a covariate (see Clay et al. (1997) and ? for background on the income data). Estimated effects of State Presence are virtually unchanged.

Fourth, table A7 repeats table 3 in the paper, with additional controls. The rational behind adding these controls is described in the paper. Each regression Pre-Nyiginya population density, the number of cattle in 1960, as well as terrain elevation, terrain slope, the geographical suitability for growing banana and the local prevalence of the savannah tsetse fly. Point estimates fall somewhat, indicating that there may be selection on one or more of these controls. In the main text I report a sensitivity test based on these estimates.

Third, table A8 explores several alternative hypotheses for local differences in genocidal violence that have been identified in the literature. Columns (1) and (2) explore the hypothesis advanced in André and Platteau (1998) that Rwanda was caught in a Malthusian trap. The genocide, in this view, was a Malthusian ‘positive check’. Column (1) uses the population increase (in percent) between the 1978 and 1991 censuses as a measure of increased demands placed on the food supply (Ministère du Plan, 1982, 1992). In places where population grew faster, competition over resources may have more severe, leading to more violence in the genocide. Column (2) uses a measure of the degree to which a local community could supply the necessary calories to its members in 1980, collected by the Rwandan government (Lamoureaux, 1980). State Presence is negatively correlated with both measures. Columns (3) and (4) explore the idea that the genocide was the culmination of deep-rooted ethnic hatred between Hutu and Tutsi (Prunier, 1995). I use the fraction of Tutsi, the group targeted in the genocide, in 1991 as the dependent variable in column (3). In column (4) I compute the fractionalization between Hutu and Tutsi.¹ In places where Tutsi are more numerous, the Hutu population may, for instance, feel more competition over resources or propaganda initiatives by the government may be more effective (Yanagizawa-Drott, 2014). Although State Presence is positively correlated with both measures of ethnic composition, the effects are insignificant

¹For Hutu, H and Tutsi, T , let π_g be the fraction of the local population belonging to group g , $g \in H, T$. I disregard the marginal Twa ethnic group. Fractionalization is then defined as $\pi_H(1 - \pi_H) + \pi_T(1 - \pi_T)$. This measure is maximized at $\pi_H = \pi_T = 0.5$ and can be interpreted as the probability that two randomly selected individuals will belong to different groups.

(column (3)) or marginally significant (column (4)).

Fourth, table A9 tests for the robustness of the correlations presented in table 3 by adding the variables used as dependent variables in table A8 as covariates. Before adding these covariates in columns (2) and (4), however, columns (1) and (3) add a number of geographical covariates. To the extent that, for instance, elevation affects agricultural productivity, elevation may correlate with the presence of the Nyiginya state. The geographical covariates included in this table are terrain elevation, terrain slope, the geographical suitability for growing banana and the local prevalence of the savannah tsetse fly. Columns (2) and (4) then add these covariates together with the measures of alternative hypotheses from table A4. Throughout, the estimated effect of State Presence remains positive and significant.²

IV estimates. Table A10 repeats the regressions in table 4, using cost distance to Nyanza (days) as the instrument. Because the first stage partial F-statistics indicate that this instrument may be weak, I report Anderson-Rubin confidence intervals with the second stage results. The estimated second stage effects, and the fact that the Anderson-Rubin confidence interval does not include zero, suggest a positive causal effect of state presence on violence and mobilization using this instrument. Note that the estimated effect sizes are larger than in table 4, although the difference is not statistically significant (results available upon request).

Table A11 repeats the regressions in table 4 as well, using cost distance to Nyanza - Özak (days) as the instrument. The estimated second stage effects suggest a positive causal effect of state presence on violence and mobilization using this instrument. Note that the estimated effect sizes are larger than in table 5, although the difference is not statistically significant (results available upon request).

Table A12 repeats the regressions in table 6, using cost distance to Nyanza (days) as the instrument. Because the first stage partial F-statistics indicate that this instrument may be weak, I report Anderson-Rubin confidence intervals with the second stage results. The estimated second stage effects, and the fact that the Anderson-Rubin confidence interval does not include zero, suggest a negative causal effect of state presence on violence before and after the genocide. Note that effects are less precisely estimated than in tables 6 and A13. This results from the weaker first stage.

²The estimated effect size decreases somewhat, which is to be expected given that there was a correlation between state presence and, for instance, fractionalization in table A4. Table 2 in the paper performs a sensitivity analysis to understand the extent to which a decreasing estimated effect size affects the interpretation of the results.

Table A13 repeats the regressions in table 6 as well, using cost distance to Nyanza - Özak (days) as the instrument. Panel I reports the second stage coefficients and clustered standard errors whereas Panel II reports Probit and Negative Binomial estimates of the same relationship. The estimated second stage effects suggest a negative causal effect of state presence on violence before and after the genocide using this instrument.

Further additional results. Table A14 reports heterogeneous effects by the party affiliation of the relevant local politicians before the genocide and by radio ownership. The interpretation of these results is discussed in the paper.

Table A15 reports IV estimates for different measures of local public good provision and state capacity before the genocide, using distance to Nyanza and the instrument. First principal components are presented in column (1). These principal components are also presented in table 7. The interpretation of these results is discussed in the paper.

Table A16 reports OLS and IV results using the number of hospitals, schools, and coffee pulping centers in 1960 as dependent variables, as well as the number of missionary stations in 1935. The interpretation of these results is discussed in the paper.

Table A17 reports OLS results using several questions from the 2007 and 2012 World Values Survey as dependent variables. A The first principal component of the answers to the questions in columns (2)-(6) is used as dependent variable in column (1). This principal components are also presented in table 8. The interpretation of these results is discussed in the paper.

TABLE A1: SUMMARY STATISTICS

	N	mean	sd	10th percentile	90th percentile
Unit of observation: Sector. Sample: Main sample					
Fraction of population prosecuted for genocide participation	1460	7.916858	7.809828	.3157611	17.24832
Fraction of Hutu population prosecuted for murder	1460	7.736806	7.886511	.2740837	17.44656
Violence 1990-1993 (count)	1576	.088198	.7931214	0	0
Violence involving the Rwandan government 1990-1993 (count)	1576	.0805838	.6986453	0	0
Violence 1995-2000 (count)	1576	.0932741	.577509	0	0
Violence involving the Rwandan government 1995-2000 (count)	1576	.0501269	.3446093	0	0
State Presence (Years)	1553	100.9472	65.71094	2	197
Distance to Nyanza	1576	65.27946	30.62782	23.12311	101.3946
Cost distance to Nyanza (days)	1553	2.90364	1.656719	.86905	5.50025
Cost distance to Nyanza - Ōzak (days)	1553	.7586982	.3620835	.3017139	1.228012
Cost distance to nearest Nyiginya army location (days)	1553	2.780276	1.859381	.3982925	6.0696
Travel distance to Nyanza along 1988 road	1553	105528.5	49801.4	43244.2	169805.6
Travel distance to Kigali along 1988 road	1553	99027.58	53825.47	34194.9	168643.6
Travel cost distance to Kigali	1553	-.1792182	1.076034	-1.77203	1.447757
Geodesic distance to country border	1576	22463.18	13972.85	4477.82	42812.34
Terrain elevation	1576	1765.349	281.4835	1445	2148
Terrain slope	1576	392.1288	298.7535	67	821
Distance to nearest river	1576	6.222947	4.908907	1.319759	13.07343
TseTse prevalence	1573	.0790543	.2132588	9.85e-06	.1894174
Banana suitability	1576	6.998553	13.51527	0	31.27
Population 2002 (sector)	1565	13601.21	1904.695	11055	16197
Population 1991 (commune)	1576	51730.88	18156.11	33315	73115
Population 1978 (commune)	1567	35282.79	11216.6	24491	46458
Total number of Hutu 1991	1576	4699.1	1706.841	2844	6775
Total number of Tutsi 1991	1576	415.6263	421.2897	9	939
Fraction Tutsi of population 1991	1576	8.108401	7.934117	.2380953	18.86503
Population growth 1978-1991	1567	.4773635	.29467	.238652	.7177965
Fractionalization Hutu Tutsi	1576	.1483521	.1209627	.0066854	.3247043
log equivalent household income 1990	829	9.367825	.4428594	8.788908	10.06533
Unable to meet caloric need of population 1980	1576	.2956853	.456495	0	1
Local leader opposition 1993	1483	.163857	.3702707	0	1
Radio ownership 1991	1576	.3277789	.0864121	.2386889	.4300992
Principal component energy and water 1980	1576	1.19e-09	1.072162	-.8778389	1.75577
Energy centers 1980	1576	.1884518	.4400792	0	1
Energy transformers 1980	1576	.2392132	.6708519	0	1
Water installations 1980	1576	.4149746	.6573668	0	1
Water pumps 1980	1576	.1465736	.3847419	0	1
Principal component schools 1980	1576	-1.18e-09	1.14416	-1.352822	1.464512
Primary schools 1980	1576	11.32614	4.013814	7	17
Secondary schools 1980	1576	.8794416	.8215718	0	2
Secondary technical schools 1980	1576	.0513959	.2208741	0	0
Principal component health services 1980	1576	-8.57e-10	1.274519	-.9346766	1.50034
Hospitals 1980	1576	21.27919	61.51257	0	80
Maternity clinics 1980	1576	10.02157	14.55981	0	32
Health clinics 1980	1576	16.02602	17.86237	0	40
Other clinics 1980	1576	2.637056	21.24841	0	0
Principal component social provisions 1980	1576	1.86e-09	1.173693	-1.100518	1.612993
Social centers 1980	1576	3.501269	1.436043	2	5
Reading centers 1980	1576	1.97335	2.059878	0	5
Nutritional centers 1980	1576	.6732234	.694061	0	1
Orphanages 1980	1576	.2392132	.6207096	0	1
Principal component commercial institutions 1980	1576	-6.13e-09	1.109594	-.832226	.5988494
Banks 1980	1576	.3927665	.4885206	0	1
Post offices 1980	1576	.4543147	.511897	0	1
Grain silos 1980	1576	.090736	.2873245	0	0
Gas stations 1980	1576	.0513959	.2208741	0	0
Principal component markets 1980	1576	-4.38e-09	1.320582	-1.401663	1.855265
Agricultural cooperatives 1980	1576	.1345178	.3413161	0	1
Markets 1980	1576	1.331218	1.006993	0	3
Trade centers 1980	1576	1.107868	.9083956	0	2
Commercial centers 1980	1576	.1091371	.3119101	0	1
Principal component fiscal capacity 1980	1318	2.19e-09	1.554533	-1.041444	1.257922
Tax received per capita 1980	1318	4014.304	1670.217	2634.2	5873.9
Trade tax received per capita 1980	1318	999.2687	1170.166	339	1821.3
Other taxes received per capita 1980	1318	1115.142	1323.262	130.1	2158.6
Principal component public expenditure 1980	1489	1.40e-09	1.667038	-1.522031	2.537059
public expenditure per capita 1980	1489	3923.835	1577.298	2711.8	5471.4
Administrative expenditure per capita 1980	1489	1951.896	460.0686	1499.4	2483.4
Social expenditure per capita 1980	1489	574.2789	281.4922	324	892.4
Economic expenditure per capita 1980	1489	875.6055	505.1217	377.3	1536.5

For data sources, see below in this appendix.

TABLE A1: SUMMARY STATISTICS CONTINUED

	N	mean	sd	10th percentile	90th percentile
Unit of observation: Sector. Sample: Main sample					
Number of hospitals 1960	1576	.0590102	.2357185	0	0
Number of schools 1960	1576	1.046954	1.119673	0	2
Number of coffeepulping centers 1960	1576	.1656091	.3852651	0	1
Number of missionary stations 1935	1576	.0253807	.1573284	0	0
Number of individuals prosecuted for genocide participation per Gacaca court	1369	1628.053	1968.748	62.5	3641.379
Number of individuals prosecuted for murder per Gacaca court	1369	1379.381	1690.874	47.82609	3116.667
Genocide victims per capita 2004 estimate	139	.1298848	.1293098	.0074702	.3536004
Genocide victims per capita 1996 estimate	110	.2209414	.304267	.0024985	.6473615
Unit of observation: Individual. Sample: World Values Survey					
Principal component rule breaking is acceptable	2535	3.40e-09	1.692392	-1.434546	1.491858
Tradition is important to this person; to follow the customs handed do	2576	4.244177	1.430244	2	6
Democracy: People obey their rulers	1203	7.283458	2.657101	3	10
Age	2597	34.39353	12.92395	21	52
Sex	2597	1.506353	.5000559	1	2
Justifiable: Claiming government benefits to which you are not entitled	2555	2.245401	1.728558	1	4
Justifiable: Avoiding a fare on public transport	2593	1.909371	1.422605	1	3
Justifiable: Stealing property	2589	1.877945	1.595907	1	3
Justifiable: Cheating on taxes if you have a chance	2593	2.148477	1.565671	1	4
Justifiable: Someone accepting a bribe in the course of their duties	2582	1.801317	1.354184	1	3
Unit of observation: Individual. Sample: Experiment participants					
Compliance with tax demand (% of base)	416	71.34615	27.29979	40	100
State presence (dummy)	422	.6184834	.4863354	0	1
Age	420	39.9119	13.53734	24	58
Male dummy	422	.450237	.498108	0	1
Education in years	420	5.454762	3.462772	0	11
Daily income	420	1261.986	5116.758	0	2555.556
Unit of observation: Village. Sample: Modern villages					
Terrain elevation, village within 10KM from study boundary	300	1450	44.24619	1382	1495
Banana suitability, village within 10KM from study boundary	300	42.58467	3.996373	38.12	48.59
Terrain elevation, village within 5KM from study boundary	160	1445.875	50.18065	1360	1510
Banana suitability, village within 5KM from study boundary	160	41.0825	4.438938	38.12	48.59
Terrain elevation, village within 3KM from study boundary	80	1405.75	37.73576	1360	1462
Banana suitability, village within 3KM from study boundary	80	40.7375	4.562247	38.12	48.59
Terrain elevation, villages in experiment	21	1446.476	47.42217	1388	1495
Banana suitability, villages in experiment	21	39.76571	7.847312	25.46	48.59

For data sources, see below in this appendix.

TABLE A2: OLS ESTIMATES OF THE DETERMINANTS OF PRESENCE OF THE NYIGINYA STATE, USING PRECOLONIAL DISTRICTS AS UNIT OF OBSERVATION

Dependent variable: State Presence (years)	Distance to Nyanza		Cost distance to Nyanza (days)		Cost distance to Nyanza - Özak (days)		Cost distance to nearest Nyiginya army location (days)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
estimated coefficient	-1.470*** (0.144)	-1.504*** (0.371)	-26.33*** (3.513)	-15.33** (7.516)	-114.8*** (14.22)	-121.5*** (33.18)	-9.117** (4.401)	-2.596 (4.970)
Travel distance to Nyanza along 1988 road network	N	Y	N	Y	N	Y	N	N
Travel distance to Kigali along 1988 road network	N	Y	N	Y	N	Y	N	Y
Geodesic distance to country border	N	Y	N	Y	N	Y	N	Y
Province fixed effects	N	Y	N	Y	N	Y	N	Y
Observations	50	50	50	50	50	50	50	50
R ²	0.466	0.683	0.432	0.657	0.389	0.682	0.063	0.623

Notes: All regressions are estimated using OLS. The unit of observation is a precolonial district. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Distance to Nyanza is the geodesic distance between the centroid of a precolonial district and Nyanza. Cost distance to Nyanza (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed Özak (2010, 2013). Cost distance to nearest Nyiginya army location is the travel distance (in days) between the centroid of a precolonial district and the nearest Nyiginya army battalion, measured in hours. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Regressions include fixed effects as indicated in the table. Parentheses report heteroskedasticity robust (White) standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A3: OLS ESTIMATES OF THE DETERMINANTS OF PRESENCE OF THE NYIGINYA STATE, WITH DISTANCE TO ADDIS ABBEBA AS A COVARIATE

Dependent variable: State Presence (years)	Distance to Nyanza		Cost distance to Nyanza (days)		Cost distance to Nyanza - Özak (days)		Cost distance to nearest Nyiginya army location (days)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
estimated coefficient	-2.057*** (0.230)	-1.963*** (0.544)	-26.71*** (4.340)	-13.30* (6.787)	-193.3*** (23.41)	-169.0*** (45.33)	-17.40*** (4.577)	-6.704 (4.298)
Geodesic distance to Addis Abbeba	Y	Y	Y	Y	Y	Y	Y	Y
Travel distance to Nyanza along 1988 road network	N	Y	N	Y	N	Y	N	N
Travel distance to Kigali along 1988 road network	N	Y	N	Y	N	Y	N	Y
Geodesic distance to country border	N	Y	N	Y	N	Y	N	Y
Province fixed effects	N	Y	N	Y	N	Y	N	Y
Observations	50	50	50	50	50	50	50	50
R ²	0.466	0.683	0.432	0.657	0.389	0.682	0.063	0.623

Notes: All regressions are estimated using OLS. The unit of observation is a precolonial district. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Distance to Nyanza is the geodesic distance between the centroid of a precolonial district and Nyanza. Cost distance to Nyanza (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed Özak (2010, 2013). Cost distance to nearest Nyiginya army location is the travel distance (in days) between the centroid of a precolonial district and the nearest Nyiginya army battalion, measured in hours. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Regressions include fixed effects as indicated in the table. Parentheses report heteroskedasticity robust (White) standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A4: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE USING PRECOLONIAL DISTRICTS AS UNIT OF OBSERVATION

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0372*** (0.0109)	0.0306*** (0.00925)	0.0369*** (0.0113)	0.0284*** (0.00821)
Fraction Tutsi of population 1991		0.369*** (0.136)		0.476*** (0.114)
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Mean dependent variable	7.36	7.36	7.19	7.19
Observations	50	50	50	50
R^2	0.604	0.736	0.584	0.796

Notes: All regressions are estimated using OLS. The unit of observation is a precolonial district. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report heteroskedasticity robust (White) standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A5: DETERMINANTS OF VIOLENCE IN THE RWANDAN GENOCIDE USING ALTERNATIVE VIOLENCE MEASURES

<i>Dependent variable:</i>	Number of individuals prosecuted for genocide participation per Gacaca court	Number of individuals prosecuted for murder per Gacaca court	Genocide victims per capita 2004 estimate	Genocide victims per capita 1996 estimate
	(1)	(2)	(3)	(4)
State Presence (Years)	5.125** (2.127)	4.531** (1.790)	0.00101*** (0.000208)	0.00181*** (0.000639)
2002 Population	Y	Y	N	N
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Province fixed effects	Y	Y	N	N
Mean dependent variable	1633.416	1384.178	13.08	22.17
Number of clusters	50	50	NA	NA
Observations	1359	1359	135	107
R^2	0.202	0.188	0.188	0.086

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994 in columns (1) and (2) and the administrative *commune* in columns (3) and (4). Number of individuals prosecuted for genocide participation per Gacaca court is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total number of Gacaca courts. Number of individuals prosecuted for murder per Gacaca court is the number of individuals convicted for murder in the Gacaca courts divided by total number of Gacaca courts. Genocide victims per capita, 2004 estimate is an estimate of genocide victims as identified by the Rwandan government in 2004 (see text for exact source) divided by total population in the 1991 census. Genocide victims per capita, 1996 estimate is an estimate of genocide victims as identified by the Rwandan government in 2004 (see text for exact source) divided by total population in the 1991 census. 2002 Population is the total population in the 2002 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Regressions include fixed effects as indicated in the table. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A6: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE,
WITH INCOME AS A CONTROL

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0340** (0.0141)	0.0328*** (0.0115)	0.0321** (0.0143)	0.0305*** (0.0103)
Fraction of population Tutsi 1991	N	Y	N	Y
Log equivalent adult income 1990	Y	Y	Y	Y
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	763	763	763	763
R^2	0.177	0.228	0.173	0.267

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Log equivalent adult income is the natural logarithm of the equivalent adult income in Rwandan Francs in 1990. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A7: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE,
WITH ADDITIONAL CONTROLS

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0204** (0.00795)	0.0205*** (0.00642)	0.0187** (0.00831)	0.0189*** (0.00569)
Fraction Tutsi of population 1991		0.191*** (0.0520)		0.314*** (0.0425)
Pre-Nyiginya population density	Y	Y	Y	Y
Nr. of cattle 1960	Y	Y	Y	Y
Nr. of missionary stations 1935	Y	Y	Y	Y
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Geographical controls	Y	Y	Y	Y
Altonji et al. (2005) selection statistic using corresponding table 1 point estimate	1.99	2.51	1.87	2.70
Mean dependent variable	7.95	7.95	7.75	7.75
Number of clusters	50	50/142	50	50/142
Observations	1449	1449	1449	1449
R^2	0.254	0.276	0.247	0.306

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Pre-Nyiginya population density is the number of archeological sites indicating population presence before the establishment of the Nyiginya kingdom. Nr. of cattle 1960 is the number of cattle in 1960. Nr. of missionary stations 1935 is the number of missionary stations (any denomination) in 1935. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Geographical controls include terrain elevation, terrain slope, the geographical suitability for growing banana and the local prevalence of the savannah tsetse fly. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A8: ALTERNATIVE EXPLANATIONS FOR VIOLENCE IN THE RWANDAN GENOCIDE

<i>Dependent variable:</i>	Population growth 1978-1991	Unable to meet caloric need of population 1980	Fraction of population Tutsi 1991	Fractionalization Hutu Tutsi 1991
	(1)	(2)	(3)	(4)
State Presence (Years)	-0.0706 (0.0844)	-0.0880** (0.0417)	0.0858 (0.101)	0.0552* (0.0303)
R^2	0.410	0.185	0.330	0.964
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1544	1553	1553	1553

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. All point estimates are standardized. Population growth 1978-1991 is the percentage increase in population between the 1978 census and the 1991 census. Unable to meet caloric need of population is an indicator variable equal to one if a village was unable to supply enough food to provide its inhabitants with a minimum number of calories in 1980. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. fractionalization Hutu Tutsi 1991 is the index of local Hutu Tutsi fractionalization described in the text. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A9: DETERMINANTS OF VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE,
WITH FURTHER ADDITIONAL CONTROLS

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0209** (0.00795)	0.0189*** (0.00642)	0.0191** (0.00831)	0.0173*** (0.00580)
Population growth 1978-1991	N	Y	N	Y
Unable to meet caloric need of population 1980	N	Y	N	Y
Fraction of population Tutsi 1991	N	Y	N	Y
Fractionalization Hutu Tutsi 1991	N	Y	N	Y
Travel distance to Kigali along 1988 road network	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Geographical controls	Y	Y	Y	Y
Mean dependent variable	7.95	7.95	7.75	7.75
Number of clusters	50	50/142	50	50/142
Observations	1449	1441	1449	1441
R^2	0.240	0.272	0.234	0.301

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Population growth 1978-1991 is the percentage increase in population between the 1978 census and the 1991 census. Unable to meet caloric need of population is an indicator variable equal to one if a village was unable to supply enough food to provide its inhabitants with a minimum number of calories in 1980. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Fractionalization Hutu Tutsi 1991 is the index of local Hutu Tutsi fractionalization described in the text. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. Geographical controls include terrain elevation, terrain slope, the geographical suitability for growing banana and the local prevalence of the savannah tsetse fly. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A10: IV ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE USING COST DISTANCE TO NYANZA (DAYS) AS INSTRUMENT

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates.</i>				
State Presence (Years)	0.117**	0.0871**	0.120**	0.0730**
<i>Clustered s.e.</i>	(0.0586)	(0.0419)	(0.0592)	(0.0365)
<i>Anderson-Rubin c.i.</i>	[0.050, 0.347]	[0.032, 0.251]	[0.051, 0.351]	[0.022, 0.216]
Mean dependent variable	7.95	7.95	7.75	7.75
<i>Panel II: First stage estimates. Dependent variable is State Presence</i>				
Cost distance to Nyanza (days)	-14.80**	-15.60**	-14.80**	-15.60**
	(7.157)	(7.189)	(7.157)	(7.189)
F-stat of excluded instrument	4.43	5.19	4.43	5.19
R^2	0.594	0.595	0.594	0.595
Fraction Tutsi of population 1991	N	Y	N	Y
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50/142	50	50/142
Observations	1449	1449	1449	1449

Notes: All regressions in Panel I are estimated using two stage least squares, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Cost distance to Nyanza (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A11: IV ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE AND MOBILIZATION IN THE RWANDAN GENOCIDE USING COST DISTANCE TO NYANZA - ÖZAK (DAYS) AS INSTRUMENT

<i>Dependent variable:</i>	Fraction of population prosecuted for genocide participation		Fraction of Hutu population prosecuted for murder	
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates.</i>				
State Presence (Years)	0.102** (0.0312)	0.0824** (0.0226)	0.0997*** (0.0307)	0.0698*** (0.0195)
Mean dependent variable	7.95	7.95	7.75	7.75
<i>Panel II: First stage estimates. Dependent variable is State Presence</i>				
Cost distance to Nyanza - Özak (days)	-134.7*** (34.50)	-142.2*** (32.22)	-134.7*** (34.50)	-142.2*** (32.22)
F-stat of excluded instrument	15.01	20.70	15.01	20.70
R^2	0.629	0.632	0.629	0.632
Fraction Tutsi of population 1991	N	Y	N	Y
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50/142	50	50/142
Observations	1449	1449	1449	1449

Notes: All regressions in Panel I are estimated using two stage least squares, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Fraction of population prosecuted for genocide participation is the number of individuals convicted for being an organizer of genocide violence or for murder in the Gacaca courts divided by total population in the 1991 census. Fraction of Hutu population prosecuted for murder is the number of individuals convicted for murder in the Gacaca courts divided by total Hutu population in the 1991 census. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed Özak (2010, 2013). Fraction Tutsi of population 1991 is the total number of Tutsi divided by total population in the 1991 census. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report (double) clustered standard errors at the level of the precolonial district, or at the level of commune and the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A12: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE BEFORE AND AFTER THE RWANDAN GENOCIDE USING COST DISTANCE TO NYANZA (DAYS) AS INSTRUMENT

<i>Dependent variable:</i>	Violence 1990-1993 (count)	Violence involving the Rwandan government 1990-1993 (count)	Violence 1995-2000 (count)	Violence involving the Rwandan government 1995-2000 (count)
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates</i>				
State Presence (Years)	-0.0122*	-0.0109*	-0.00390	-0.00240*
<i>Clustered s.e.</i>	(0.00695)	(0.00620)	(0.00241)	(0.00132)
<i>Anderson-Rubin c.i.</i>	[-0.039, -0.003]	[-0.035-, 0.003]	[-0.013, -0.000]	[-0.007, -0.000]
Mean dependent variable	0.09	0.08	0.09	0.05
<i>Panel II: First stage estimates</i>				
Cost distance to Nyanza (days)	-14.80** (7.157)	-14.80** (7.157)	-14.80** (7.157)	-14.80** (7.157)
F-stat of excluded instrument	4.28	4.28	4.28	4.28
R^2	0.594	0.594	0.594	0.594
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1553	1553	1553	1553

Notes: All regressions in Panel I are estimated using two stage least squares, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Violence 1990-1993 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence involving the Rwandan government 1990-1993 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence 1995-2000 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. Violence involving the Rwandan government 1995-2000 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Cost distance to Nyanza (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured in hours. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A13: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON VIOLENCE BEFORE AND AFTER THE RWANDAN GENOCIDE USING COST DISTANCE TO NYANZA - ÖZAK (DAYS) AS INSTRUMENT

<i>Dependent variable:</i>	Violence 1990-1993 (count)	Violence involving the Rwandan government 1990-1993 (count)	Violence 1995-2000 (count)	Violence involving the Rwandan government 1995-2000 (count)
	(1)	(2)	(3)	(4)
<i>Panel I: Second stage estimates</i>				
State Presence (Years)	-0.00597** (0.00232)	-0.00545** (0.00210)	-0.00282** (0.00119)	-0.00147** (0.000785)
Mean dependent variable	0.09	0.08	0.09	0.05
<i>Panel II: First stage estimates</i>				
Cost distance to Nyanza - Özak (days)	-134.7*** (34.50)	-134.7*** (34.50)	-134.7*** (34.50)	-134.7*** (34.50)
F-stat of excluded instrument	15.25	15.25	15.25	15.25
R ²	0.629	0.629	0.629	0.629
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1553	1553	1553	1553

Notes: All regressions in Panel I are estimated using two stage least squares, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. Violence 1990-1993 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence involving the Rwandan government 1990-1993 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1990 and December 1993. Violence 1995-2000 (count) is a count variable measuring the number of violent incidents that resulted in more than twenty five casualties in the UCDP dataset occurring between January 1995 and December 2000. Violence involving the Rwandan government 1995-2000 (count) is a count variable measuring the number of violent incidents involving the Rwandan government that resulted in more than twenty five casualties in the UCDP dataset occurring between January 19995 and December 2000. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Cost distance to Nyanza - Özak (days) is the travel distance between the centroid of a precolonial district and Nyanza for by a person on foot, measured by the Human Mobility Index proposed Özak (2010, 2013). Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A14: ESTIMATES OF THE HETEROGENEOUS TREATMENT EFFECTS OF STATE PRESENCE ON MOBILIZATION

<i>Dependent variable:</i>	Fraction of Hutu population prosecuted for murder			
	Local leader MRND 1993	Local leader opposition 1993	Below median radio ownership 1991	Above median radio ownership 1991
	(1)	(2)	(3)	(4)
State Presence (Years)	0.0281** (0.0118)	0.0192 (0.0164)	0.0154 (0.0120)	0.0476*** (0.00615)
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1146	221	899	550
R^2	0.176	0.029	0.205	0.204

Notes: All regressions are estimated using OLS. The unit of observation is an administrative sector in 1994. All point estimates are standardized. Local leader MRND 1993 is an indicator variable equal to one if the local burgomaster is a member of the ruling MRND party in 1993. Local leader opposition 1993 is an indicator variable equal to one if the local burgomaster is a member of the a Hutu opposition party in 1993. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A15: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON LOCAL GOVERNMENT

	(1)	(2)	(3)	(4)	(5)
<i>Panel I: Dependent variable:</i>	Principal component energy and water 1980	Energy centers 1980	Energy transformers 1980	Water installations 1980	Water pumps 1980
State Presence (Years)	0.00517 (0.00681)	-0.00228 (0.00280)	0.00329 (0.00371)	-0.00601 (0.00655)	0.00441* (0.00241)
Observations	1553	1553	1553	1553	1553
<i>Panel II: Dependent variable:</i>	Principal component schools 1980	Primary schools 1980	Secondary schools 1980	Secondary technical schools 1980	
State Presence (Years)	0.000398 (0.00751)	-0.0199 (0.0252)	0.000345 (0.00510)	0.00226 (0.00161)	
Observations	1553	1553	1553	1553	
<i>Panel III: Dependent variable:</i>	Principal component health services 1980	Hospitals 1980	Maternity clinics 1980	Health clinics 1980	Other clinics 1980
State Presence (Years)	0.00507 (0.00697)	0.0559 (0.294)	0.0400 (0.0847)	0.133 (0.115)	-0.111 (0.102)
Observations	1553	1553	1553	1553	1553
<i>Panel IV: Dependent variable:</i>	Principal component social provisions 1980	Social centers 1980	Reading centers 1980	Nutritional centers 1980	Orphanages 1980
State Presence (Years)	0.0106 (0.0103)	-0.00711 (0.0108)	0.00710 (0.0125)	0.0117* (0.00649)	0.00362 (0.00435)
Observations	1553	1553	1553	1553	1553
<i>Panel V: Dependent variable:</i>	Principal component commercial institutions 1980	Banks 1980	Post offices 1980	Grain silos 1980	Gas station 1980
State Presence (Years)	0.00435 (0.00704)	-0.00536 (0.00396)	-0.00320 (0.00375)	0.00313 (0.00217)	-0.00140 (0.00156)
Observations	1553	1553	1553	1553	1553
<i>Panel VI: Dependent variable:</i>	Principal component markets 1980	Agricultural cooperatives 1980	Markets 1980	Trade centers 1980	Commercial centers 1980
State Presence (Years)	0.0109 (0.0120)	-0.00342 (0.00260)	0.00122 (0.00794)	-0.00522 (0.00821)	-0.000296 (0.00252)
Observations	1553	1553	1553	1553	1553
<i>Panel VII: Dependent variable:</i>	Principal component fiscal capacity 1980	Tax received per capita 1980	Trade tax received per capita 1980	Other taxes received per capita 1980	
State Presence (Years)	0.00353 (0.00678)	-0.0000777 (0.000226)	0.0000415 (0.000130)	-0.0000857 (0.000193)	
Observations	1288	1288	1288	1288	
<i>Panel VIII: Dependent variable:</i>	Principal component public expenditure 1980	public expenditure per capita 1980	Administrative expenditure per capita 1980	Social expenditure per capita 1980	Economic expenditure per capita 1980
State Presence (Years)	0.00316 (0.0120)	-0.0000643 (0.000243)	-0.0000823 (0.0000948)	0.0000556 (0.0000460)	-0.0000891 (0.0000943)
Observations	1468	1459	1459	1459	1459
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y	Y
Number of clusters	50	50	50	50	50

Notes: All regressions are estimated using two stage least squares. The unit of observation is an administrative sector in 1994. Principal components in column (1) are the first principal component of columns (2)-(5). State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A16: ESTIMATES OF THE EFFECT OF STATE PRESENCE ON LOCAL GOVERNMENT IN THE COLONIAL PERIOD

<i>Dependent variable:</i>	Hospitals 1960	Schools 1960	Coffeepulping Centers 1960	Number of Missionary Stations 1935
	(1)	(2)	(3)	(4)
<i>Panel I: 2SLS estimates</i>				
State Presence (Years)	0.000181 (0.000482)	0.00934* (0.00487)	0.00321** (0.00144)	0.000452 (0.000377)
<i>Panel II: OLS estimates</i>				
State Presence (Years)	0.0000183 (0.000119)	-0.000990 (0.000866)	0.000754** (0.000331)	-0.0000722 (0.0000636)
R^2	0.000	0.109	0.029	0.006
Travel distance to Nyanza along 1988 road	Y	Y	Y	Y
Travel distance to Kigali along 1988 road	Y	Y	Y	Y
Geodesic distance to country border	Y	Y	Y	Y
Number of clusters	50	50	50	50
Observations	1553	1553	1553	1553

Notes: All regressions in Panel I are estimated using two stage least squares and distance to Nyanza as the instrument, all regressions in panel II are estimated using OLS. The unit of observation is an administrative sector in 1994. All point estimates are standardized. State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Travel distance is defined as the distance (in kilometres) between the centroid of a precolonial district and an endpoint along the Rwandan road network in 1988. All regressions include fixed effects at the modern province level. Parentheses report clustered standard errors at the level of the precolonial district. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

TABLE A17: DETERMINANTS OF ATTITUDES TOWARDS RULE BREAKING

<i>Dependent variable:</i>	Principal component rule breaking is acceptable	Justifiable: Claiming government benefits to which you are not entitled	Justifiable: Avoiding a fare on public transport	Justifiable: Stealing property	Justifiable: Cheating on taxes if you have a chance	Justifiable: Someone accepting a bribe in the course of their duties
	(1)	(2)	(3)	(4)	(5)	(6)
State Presence (Years)	-0.113** (0.0498)	-0.0259 (0.0456)	-0.0776** (0.0386)	-0.0853* (0.0442)	-0.0942** (0.0441)	-0.0652* (0.0364)
Demographic controls	Y	Y	Y	Y	Y	Y
Survey year fixed effect	Y	Y	Y	Y	Y	Y
Observations	2535	2555	2593	2589	2593	2582
R^2	0.021	0.069	0.017	0.058	0.011	0.059

Notes: All regressions are estimated using OLS. The unit of observation is the individual. Principal component rule breaking is acceptable is the first principal components of the questions in the World Values survey waves of 2007 and 2012 in columns (2)-(6). State presence (years) is the number of years a sector was under centralized rule before colonization in 1898. Demographic controls include age, age squared, a gender dummy and a literacy dummy. Survey year fixed effects are indicator variables for whether an individual respondent was interviewed as part of the 2007 or the 2012 World Values survey wave. Heteroskedasticity robust standard errors are in parentheses. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

2 Reconstructing the expansion of the Nyiginya kingdom

This section contains further background to the reconstruction of the history of the expansion of the Nyiginya kingdom. I compute the variable of interest in this paper, state presence in years, for each precolonial district by subtracting its year of annexation into the Nyiginya kingdom from 1897, the year Rwanda was colonized and became part of German East Africa. This paragraph describes the procedure to reconstruct the expansion.

Step 1: Mapping precolonial districts. Precolonial districts are reported by Vansina (2004). He reports names for districts as well as approximate locations for the Nyiginya at the time of colonization as well as maps of the expanding kingdom in 1700, 1796, 1867 and 1897. He does not report boundaries for the historical districts. To assign boundaries to each district, I use the fact that Belgian colonial chiefdoms ('chefferies' in French), were based on precolonial administrative units (Paternostre de La Mairieu, 1972). 37 of 50 district directly match with the chiefdoms and I use the chiefdom boundaries as the precolonial district boundaries. For all other precolonial districts I geographically merge the approximate locations to colonial chiefdoms using standard georeferencing procedures available in ArcGIS. Figure A1 reports the resulting map.

Step 2: Identifying the year of annexation for each precolonial district. In terms of the availability of data on the year of annexation, there are three categories of districts. First, districts whose year of annexation into the Nyiginya kingdom is explicitly mentioned by Vansina (2004). Second, districts for which the incorporation is linked to a specific year of the reign of a Rwandan king. Third, those districts not explicitly mentioned in Vansina. For the first group I directly use the year of annexation Vansina reports. For the second group, I use the list of royal succession in table A12 to assign a year to the annexation of these districts. If a district was incorporated 'early' in the reign of a King, I code this as five years after his accession to the throne. For the third group, I use Vansina's cross sectional maps of the expansion of the kingdom up to 1700, 1796, 1867 and 1897. I consider a district incorporated in the year of the earliest cross sectional map it appears on which it appears.

Table A11 reports results of this coding scheme. It reports colonial chiefdom names (for which I know geographical boundaries) in column (1). Column (2) gives the corresponding district from Vansina. Column (3) gives the latest year at which the district was incorporated from the cross sectional maps. Column

(4) contains a reference to the page number in Vansina (2004) that I used to identify the year of annexation in column (6). Column (5) has the name of the reigning king at the time of the incorporation of the district. Column (6) gives the final year of annexation used to compute the length of state presence. This year is obtained using the procedure in the previous paragraph, and is either taken from the page number in column (4) or from column (3). Column (7), finally, reports the map in Vansina from which I take the precolonial district name. The numbers refer to the maps printed before the introduction that display the kingdom as a central, a western and an eastern part. Map 1 refers to the map of central Rwanda, map 2 refers to the map of eastern Rwanda and map 3 refers to the map of western Rwanda.

Table A18: Precolonial Districts

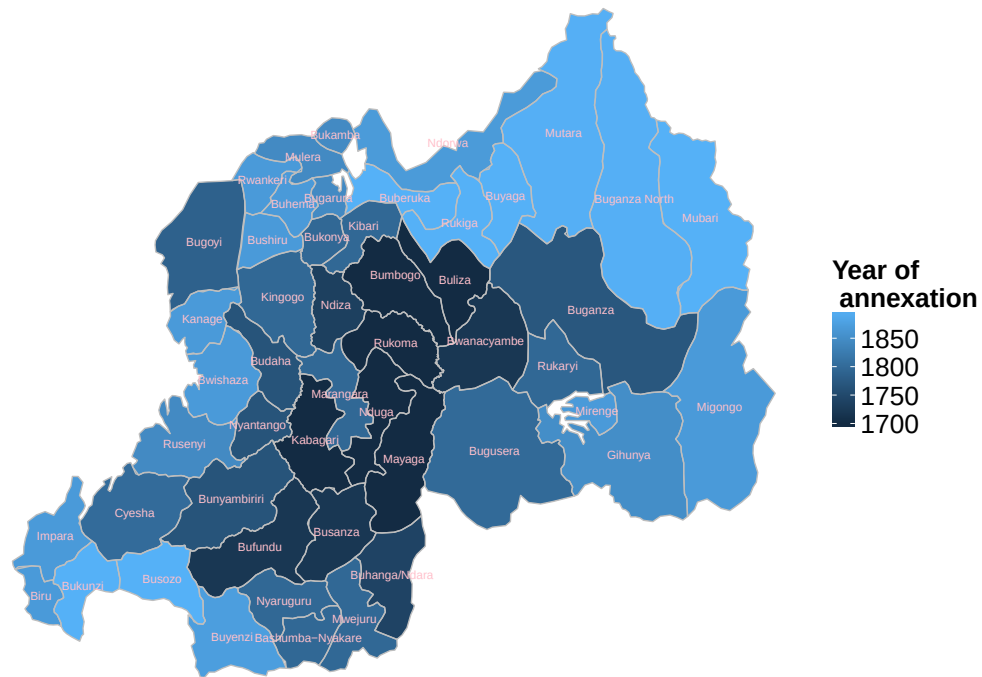
Colonial District (1)	Precolonial District (2)	Cross section (3)	Page (4)	King (5)	Year of annexation (6)	Map (7)
Biru	Biru	1867	153		1867	3
Buberuka	Buberuka	1897	178		1897	2
Rukiga	Buberuka	1897	178		1897	2
Budaha	Budaha	1796	114	Mazimpaka	1766	1
Bufundu	Bufundu	1796	116	Rujugira	1775	1
Buganza	Buganza	1796	118	Rujugira	1771	2
Bugoyi	Bugoyi	1867	159	Rujugira	1786	3
Bugusera	Bugusera	1867	124	Sentabyo	1799	1
Buhanga/Ndara	Buhanga and Ndara	1720	50	Gisanura	1720	1
Buhema	Buhoma	1867	153		1867	3
Bukonya	Bukonya	1796	125	Sentabyo	1796	1
Cyesha	Bukunza	1897				
Bumbogo	Bumbogo	1700	46	Ndori	1700	1
Nyaruguru	Bungwe	1796	124		1796	1
Bunyambiriri	Bunyambiriri	1796	116	Rujugira	1766	1
Ndiza	Burembo	1796	114	Gisanura	1735	1
Bumbogo	Buriza	1796	46	Ndori	1700	2
Busanza	Busanza	1720	50	Gisanura	1720	1
Bushiru	Bushiru	1867	153		1867	3
Buliza	Busigi	1700	46	Ndori	1700	1
Bukunzi	Busozo	1897	178		1897	3
Busozo	Busozo	1897	178		1897	3
Buyaga	Buyaga	1897	178		1897	2
Buyenzi	Buyenzi	1897	157	Rwabugiri	1872	1
Bwanacyambe	Bwanacyambe	1796	50	Gisanura	1720	1
Bashumba-Nyakare	Bwanamukari	1796	124		1796	1
Mwejuru	Bwanamukari	1796	124		1796	1
Rusenyi	Bwishaza	1867	160	Rwogera	1845	3
Kingogo	Cyingogo	1867	124		1796	3
Gihunya	Gisaka	1867	155	Rwogera	1850	3
Impara	Impara	1867	153		1867	3
Kabagari	Kabagari	1700	49	Ndori	1700	1
Kanage	Kanage	1867	153	Rwogera	1867	1
Kibari	Kibari	1796	125	Sentabyo	1796	1
Cyesha	Kinyaga	1867	160	Sentabyo	1801	3
Marangara	Marangara	1796	124		1796	1
Mayaga	Mayaga	1700	49	Ndori	1700	1
Migongo	Migongo	1867	153		1867	2
Mubari	Mubari	1897	178		1897	2
Bugarura	Murera	1867	159	Gahindiro	1845	1
Mulera	Murera	1867	159	Gahindiro	1845	1
Buganza North	Mutara	1897	1895	Rwabugiri	1895	
Mutara	Mutara	1897	1895	Rwabugiri	1895	
Ndiza	Ndiza	1796	114	Gisanura	1735	1
Ndorwa	Ndorwa	1897	167	Rwabugiri	1868	
Nduga	Nduga	1700	49	Ndori	1700	1
Nyantango	Nyantango	1796	114	Mazimpaka	1766	1
Rukaryi	Rukaryi	1796	124		1796	2
Rukoma	Rukoma	1700	49	Ndori	1700	1
Bwishaza	Rusenyi	1867	153		1867	3
Rwankeri	Rwankeri	1867	153		1867	3
Bukamba	Yomba/Jomba	1867	159	Gahindiro	1845	3

TABLE A19: LIST OF KINGS

<i>Name of king</i>	<i>Reign</i>
RUGANZA Ndori	around 1650
Some unknown kings	
MIBAMBWE Gisanura	after 1700-1735
YUHI Mazimpaka	1735-1766
KAREMERA Rwaka	1766-1770
CYIRIMA Rujugira	1770-1786
KIGERI Ndabarasa	1786-1796
MIBAMBWE Sentaboyo	1796-1801
YUHI Gahindiro	1801-1845
MUTARA Rwogera	1845-1867
KIGERI Rwabugiri	1867-1895
MIBABMWE Rutarundwa	1895-1897
YUHI Musinga	1897-1931

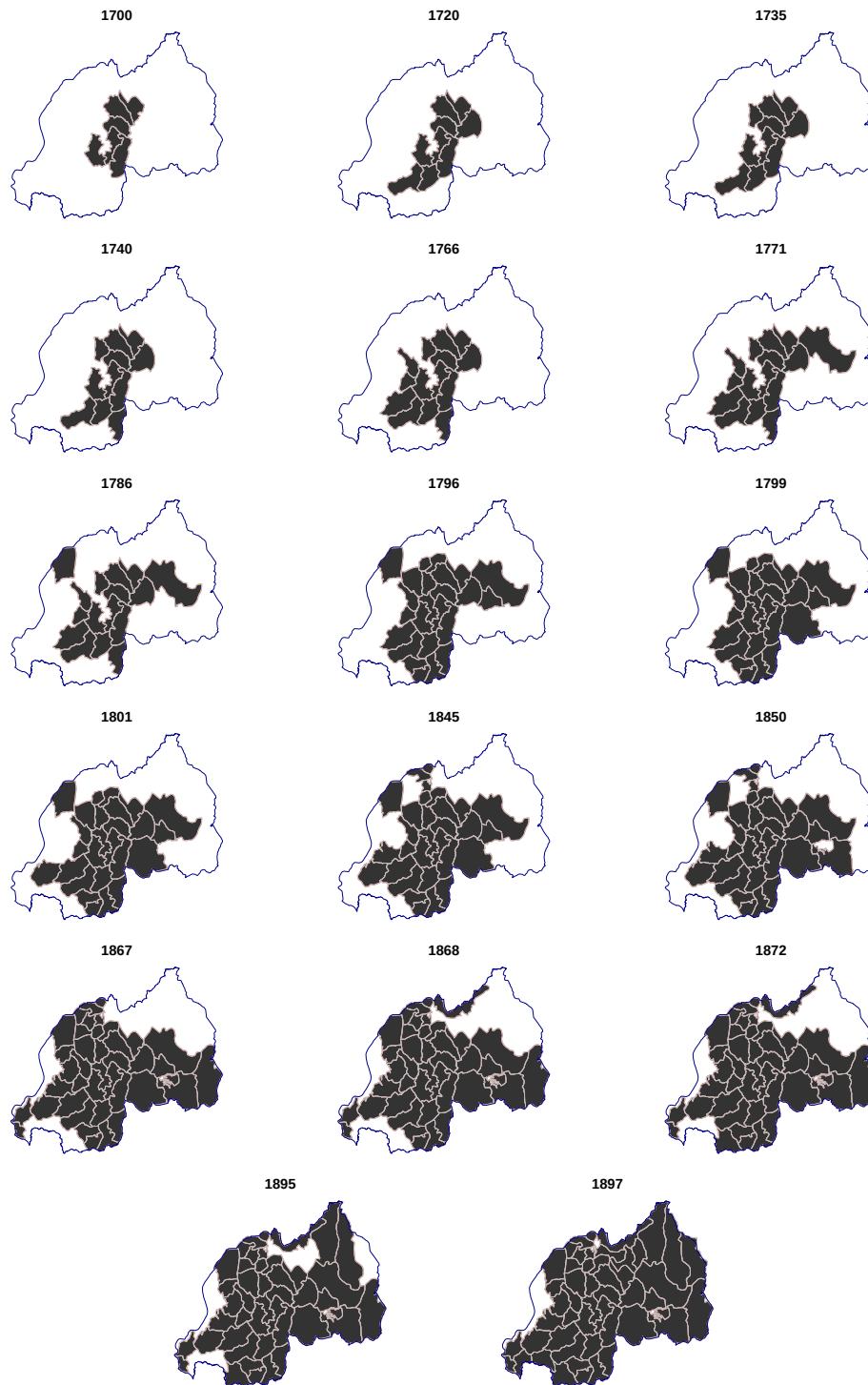
Notes: This table contains a list of royal succession in the Nyiginya kingdom. The names printed in lower case are the actual names of the kings. The names printed in upper case are the symbolic names, which are often used interchangeably with the actual names. Source: Vansina (2004).

FIGURE A1: MAP OF PRECOLONIAL DISTRICTS IN RWANDA, SHADED BY THE LENGTH OF STATE PRESENCE



Map of precolonial districts in Rwanda, shaded by the length of State Presence. The legend indicates the year of annexation to the Nyiginya kingdom. District names correspond to in table A16.

FIGURE A2: MAPS OF THE EXPANSION OF THE NYIGINYA KINGDOM



Maps of the expansion of the Nyiginya kingdom, by year of expansion. Districts names are in figure A1.

3 Data Sources

Variable	Source	Comment
Dependent Variables		
Genocide violence data, number of Gacaca courts	Gacaca courts report at http://www.inkiko-gacaca.gov.rw/En/EnLaw.htm	Website no longer operational as of March 1st, 2013.
Other violence data UCDP	UCDP project (Sundberg and Melander, 2013)	I use the following dataset: UCDP GED Conflict Polygons dataset version 1.1-2011 available at http://ucdp.uu.se/downloads/ , accessed February 1st, 2016.
Other violence data ACLED	ACLED project (Raleigh et al., 2010)	I use the following dataset: ACLED Version 3 (1997 - 2012) available at http://www.acleddata.com/data/ accessed March 27th, 2014.
Victims 2004	Guichaoua and Degni-Segui (2010)	These data vary at the commune level (n=142)
Victims 1996	Rwanda: Ministère de l'Enseignement Supérieur, de la Recherche Scientifique et de la Culture	Available at http://rwanda.free.fr/docs1_c.htm , accessed May 6th, 2016. These data vary at the commune level (n=142)
State Presence		
State presence	Vansina (2004)	Procedure described above
Distance variables		
Location of Nyanza		Historical Nyanza is in Nyabisindu village, close to modern Nyanza
Distance to Nyanza		Computed in ArcGIS
Cost distance to Nyanza (days)		Computed in ArcGIS using an elevation grid, see below, and Tobler's hiking formula (Tobler, 1993). I rescaled Tobler's function by 3/5 to account for unpaved terrain. A day is assumed to last twelve hours.
Cost distance to Nyanza – Özak (days)		Provided by Ömer Özak, using the methodology developed in Özak (2010, 2013). A day is assumed to last twelve hours.
Cost distance to nearest Nyiginya army location (days)	Army locations from Kagame (1963)	Computed in ArcGIS using an elevation grid, see below, and Tobler's hiking formula (Tobler, 1993). I rescaled Tobler's function by 3/5 to account for unpaved terrain. A day is assumed to last twelve hours.
Travel distance to Nyanza, Kigali along 1988 road	1988 road network from Rhineland-Palatinate (1988)	Distance along road network computed in ArcGIS, assuming route starts at closest point to destination point on the road network.
Distance to country border, nearest river		Computed in ArcGIS

Variable	Source	Comment
Other variables		
Population 2002	The 2002 Rwandan Census (Rwanda. National Census Service, 1992)	Available through at www.statistics.gov.rw and IPUMS international at https://international.ipums.org/international , accessed February 2015
Population 1991, number of Hutu and Tutsi 1991	The 1991 Rwandan Census (Ministère du Plan, 1992)	Available through at www.statistics.gov.rw and IPUMS international at https://international.ipums.org/international , accessed November 2013. Fractionalization between Hutu and Tutsi is computed using this data. Population growth 1978-1991 is also computed using this data. These data vary at the commune level (n=142)
Population 1978	The 1978 Rwandan Census (Ministère du Plan, 1982)	Population growth 1978-1991 is computed using this data. These data vary at the commune level (n=142)
Unable to meet caloric need of population 1980	Lamoure (1980)	These data vary at the commune level (n=142)
Public goods and fiscal capacity in 1980	Lamoure (1980)	These data vary at the commune level (n=142)
Local leader opposition	Guichaoua and Degni-Segui (2010)	These data vary at the commune level (n=142)
Radio ownership 1991	The 1991 Rwandan Census (Ministère du Plan, 1992)	Available through at www.statistics.gov.rw and IPUMS international at https://international.ipums.org/international , accessed November 2013. These data vary at the commune level (n=142)
Word Values Survey 2007 and 2012 waves		Available at www.worldvaluessurvey.org , accessed May 2014. Full citation for 2012: WORLD VALUES SURVEY Wave 6 2010-2014 OFFICIAL AGGREGATE v.20150418. World Values Survey Association (www.worldvaluessurvey.org). Aggregate File Producer: Asep/JDS, Madrid SPAIN. Full citation for 2007: WORLD VALUES SURVEY Wave 5 2005-2008 OFFICIAL AGGREGATE v.20140429. World Values Survey Association (www.worldvaluessurvey.org). Aggregate File Producer: Asep/JDS, Madrid SPAIN.
Colonial period variables		
Missions 1935	Parliament of Belgium (1935)	
Hospitals, Schools and Coffeepulping centers 1960	Government of Belgium (1960)	

Variable	Source	Comment
Geographical variables		
Elevation, Slope	CGIAR consortium at http://srtm.csi.cgiar.org/	Slope computed using elevation grid from CGIAR.
Inland rivers and water bodies	Digital Chart of the World available through www.diva-gis.org	Distances computed in ArcGIS
Suitability for Bananas	FAO at http://webarchive.iiasa.ac.at/Research/LUC/GAEZv3.0/	I used the rain-fed, low intensity, baseline period settings
Suitability for TseTse	FAO at http://www.fao.org/ag/againfo/programmes/en/paat/home.html	I use the Morsitans (Savannah) TseTse subspecies suitability data, since this is the only species that is endemic to Rwanda.
Experimental data		
Data generated in fieldwork		All data generated in the fieldwork, such as demographic observables, or compliance with government demands were observed in fieldwork in Summer and Fall 2014. The main text describes this fieldwork and the procedures used.

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Chapter 2:

The Persistence of State Capacity in Rwanda

1 Introduction

Economic prosperity across African countries has greatly diverged over the last decades. On the one end, countries like Botswana, Ethiopia and Rwanda have grown rapidly. Others, like the Democratic Republic of the Congo, are poorer in the 21st century than they were at independence. Growing evidence shows that a considerable share of this variation is explained by the organization of the precolonial African polities constituting these countries. Specifically, the degree of political centralization of historical states impacts current prosperity (Michalopoulos and Papaioannou, 2013, 2014), public good provision (Gennaioli and Rainer, 2007) as well as pro-social behavior (Lowes et al., 2014).¹ In this paper I combine individual level experimental data with a historical natural experiment to ask: What drives the long-run economic effects of these historical states?

In precolonial Rwanda a narrow elite composed of the King, the Queen mother, and a small number of military commanders held power. Yet the bureaucracy relied heavily on decentralized power structures and on norms enforcing sharing and redistribution within village communities (Vansina, 2004). Rwanda's precolonial polity is geographically virtually identical to modern Rwanda, and historians have pointed to the remarkable continuity of centralized government despite the fact that the ruling elites changed between the precolonial period, German and Belgian colonization and the post-colonial period. Filip Reyntjens, for instance, relates the remarkable resilience of the Rwandan bureaucracy after the 1994 genocide to this continuity of centralized government (Reyntjens, 2013, p. 25):

“An ancient state tradition played an undeniable role here: a mere two years after the extreme human and material destruction of 1994, the state was rebuilt. Rwanda was again administered from top to bottom.”

Long-run effects of state presence are not confined to Rwanda. Across countries or ethnic groups, a deeper tradition of statehood correlates positively with public good provision and negatively with conflict (Bockstette et al., 2002; Depetris-Chauvin, 2013). Several channels of persistence behind the long-run effects of historical states have been hypothesized in the literature. The capacity of the local state may, for instance, be driven by the tradition of statehood at a local level (Herbst, 2000; Michalopoulos and

¹The literature has not agreed on terminology. Political centralization is used interchangeably with state capacity and ethnic institutions. It is also conceptualized in different ways, from the ability to control territory, or the monopoly of violence (Weber, 1994) to the local presence of the government, or ‘infrastructural capacity’ (Mann, 1986). State capacity is measured in different ways too, from tax revenues over GDP (Besley and Persson, 2011; Dincecco et al., 2014) to the number of local offices in a particular area (Acemoglu et al., 2014) to the historical depth of the presence of the state (Bockstette et al., 2002; Dell et al., 2015; Heldring, 2015).

Papaioannou, 2014). A variant of this argument focuses on the quality of government, rather than its presence. Mamdani (1996) and Gennaioli and Rainer (2007) advance the hypothesis that chiefs that rule in historically centralized societies are more accountable today.

Other hypotheses attempt to explain persistence through factors that vary at the individual level. Historical states may have affected norms and beliefs that are held by individuals in a society. These norms persist and affect economic outcomes today, by guiding behavior in situations of uncertainty as a ‘rule of thumb’ (Nunn, 2012) by serving as focal points (Greif, 2006) or leading to general ‘pro-sociality’.² Historical states that raided slaves as part of the Atlantic slave trade, for instance, fostered a culture of mistrust that has persisted to today (Nunn and Wantchekon, 2011).³

In this paper I attempt to distinguish between these hypotheses as sources of persistence by studying the historical Rwandan state, called the Nyiginya kingdom. The Nyiginya kingdom was a strong state in the sense that it had a monopoly of violence, raised taxes, and provided external security. Importantly, historians (Vansina, 2004; Newbury, 1988) have identified in great detail how the Nyiginya kingdom interacted with individual Rwandans as well as how the Kingdom expanded. Before the establishment of the state, Rwandans were organized into small kinship groups, roughly coinciding with individual hills. Within these communities, norms of sharing and redistribution provided social insurance, restricted social and economic inequality social insurance and underpinned a tribute system based on first-occupier rights of land. Upon incorporation into the Kingdom, these kinship groups became part of the bureaucracy, and taxation was enforced through the same sharing norms, rather than through more formal institutions such as laws or a police force. Individual Rwandan experienced incorporation into the Nyiginya kingdom primarily through the introduction of a series of taxes on labor and output that flowed through lineage chiefs to the court. I therefore focus on compliance with a taxation demand as one relevant dimension of individual-level historical persistence.⁴ The expansion of the Nyiginya kingdom and its interaction with the population is illustrated in figure 1.

²For a general treatment of the evolution of social norms, see Young (1993, 2001).

³Yet other explanations of the persistence of states have been proposed. Guiso et al. (2008) advance the hypothesis that historically self-governing cities have fostered social and civic capital. In Africa, a variant of this argument considers ethnolinguistic variation. Countries that are more ethnolinguistically fractionalized underinvest in schooling, and experience persistent political instability and lower economic growth (Easterly and Levine, 1997). Another hypothesis is the degree of economic development itself. Centralized polities, the argument goes, were richer in the past, and this prosperity persisted (Claessen and Skalník, 1978). To the extent that these hypotheses are testable within Rwanda, I address them in this paper.

⁴The historical state plausibly affects a wide range of outcome variables through a variety of channels. Within the experimental design employed in this paper, I can measure most relevant individual level variables, such as income or education, as well as variables that vary at a more aggregated level, such as local public good provision, or the presence of the local government.

To obtain a modern measure of compliance, I designed a behavioral experiment which I implemented with 420 participants in rural Rwanda. This experiment measures the propensity of individuals to comply with a tax collection demand in the presence of financial incentives to steal, under anonymity and impunity, and is broadly based on the ‘resource allocation game’ (Hruschka et al., 2014; Lowes et al., 2014). Specifically, the experiment asks participants to repeatedly pay tax to the central government, based on a coin flip. I observe only money paid to the government, and infer compliance by comparing tax payments relative to the tax base implied by the fair coin. I compare individual responses in the random taxation game in a treatment-control setting by randomly sampling participants in districts on either side of a stretch of the Akanyaru river which cuts Rwanda longitudinally South of its capital, Kigali. This river, although now well within the borders of Rwanda, was for about one hundred years an outer border of the precolonial kingdom (from about 1700 to 1799). The kingdom then incorporated the district across the river, and since then both sides have been part of Rwanda. Figure 2 maps the expansion of the kingdom, the Akanyaru river, and the sample villages.

I exploit this variation in the length of exposure to centralized government as a natural experiment, comparing experimental responses of randomly selected participants in randomly selected villages on either side of the Akanyaru river, as the core of the empirical strategy of this paper. The validity of this approach as an identification strategy hinges on the random selection of the participants and on the exogeneity of the timing of crossing of the Akanyaru as an outer border of the expanding kingdom. The history of the establishment of this border (Vansina, 2004; d’Arianoff, 1952) shows that the timing of the expansion of the kingdom across the Akanyaru, which determines the differential exposure of villages on either side to state institutions, was not chosen by the state, but that the polity across the boundary collapsed as a result of a military conflict outside Rwanda’s borders (see section 2 for the historical background to the expansion), and the Nyiginya state simply filled the power vacuum by formally annexing the territory across the river. I nevertheless flexibly control for the position of sample villages relative to the Akanyaru river throughout all estimations in this paper. I furthermore show that pre-determined characteristics of village on either side of the river, such as terrain elevation, the geographical suitability for banana (Rwanda’s staple crop) and the density of prehistorical archaeological finds balance both across the river and within the sample area. Finally, I artificially move the river as a placebo exercise. The estimated effects are smaller and insignificant as I move the river from its true position.⁵

⁵The use of a river as a boundary involves a trade-off. There are no precolonial maps of Rwanda which forces me to recon-

As a first result I show that participants who today live on the side of the river that has been part of the kingdom longer (I refer to being on this side of the river as having an ‘early state’) voluntarily pay more taxes. A natural concern when using the presence of the state in a geographical area is pre-existing differences in geography and prosperity as well as subsequent differential migration. I show that the effect of historical exposure to state institutions is, however, robust to several measures of migratory status and that geography and pre-existing prosperity, measured by the density of archaeological findings that date from before the establishment of the kingdom balance.

I subsequently test for the channel of persistence. Since I have individual level variation, I can test hypotheses that vary at an individual level, such as the presence of a cultural norm conducive to tax compliance or membership of social groups as potential sources of third-party-punishment of deviations from a social norm. Because the presence of the historical state varies at a geographical level, I can also test for persistence through the presence of government institutions and the quality of these government institutions. The historical state plausibly affects modern development through many different channels (?) and the objective of this paper is not to pinpoint one specific channel. Rather, channels can be clustered broadly as institutional, generating persistence through rules and the presence of government institutions, and cultural, generating persistence through norms and beliefs. I provide suggesting that norms are the dominant channel of persistence driving the effect of the Nyiginya kingdom.

To measure norms internal to the individual as a potential channel of transmission, I rely on the design of the random taxation game. The random taxation game is designed to measure individual tax compliance in an anonymous environment. As part of the design of the game, there is no opportunity for the researcher, the Rwandan government nor anybody else to link individual tax contributions to individual participants (see section 3.2). Since any money allocated to the government is framed as a tax, I interpret contributions than zero as a measure of compliance with a government demand. Post-fieldwork survey questions indicate show that participants felt unmonitored. A natural concern is whether any observed compliance in the random taxation game is due to pro-sociality towards the government or the experimenter, or to altruism more generally. Results from a dictator game and survey questions on voluntary donations to a government development fund show that potential confounders are not driving the results.

struct the Nyiginya kingdom’s administrative structure from secondary colonial sources. I therefore measure boundaries between precolonial districts with error, unless they coincide with features of the landscape, such as the Akanyaru river. Yet rivers are natural focal points and the Akanyaru river has been the boundary of postcolonial communes as well, which has implications for the interpretation of my results. I discuss these implications in section 3.3.

To measure the presence of the Rwandan government, I rely on cadastral mapping of local government offices and police stations. As part of the sampling procedure, some randomly selected respondents will live in a village that has an office of a higher level administrative unit, and for other villages, the local village leader will be the highest political authority. I code an indicator variable that is equal to one if a sample village has a local government office and a police office, and zero otherwise. To measure local accountability, I rely on a published survey of local corruption of government officials, as well as on a phone survey that measures the responsiveness of local government.

I use these measures in a series of tests to distinguish between the institutions and culture channel of the historical persistence of the Nyiginya kingdom. I first use the presence and quality of local political institutions (as well as measures of other hypotheses) as dependent variables, and I find balance across all measures. I then include each measure in a horse race regression. None of the measures of alternative explanations are statistically significantly different from zero nor are any of the estimated effect sizes economically significant. None of the competing explanations statistically significantly move the estimated effect of norms on compliance.⁶

Although it is impossible to fully assess all potential mechanisms, the evidence in this paper suggests that a norm of compliance rather than the quality or presence of government institutions is the central mechanism behind historical persistence of the Nyiginya kingdom.

This paper is closely related Gennaioli and Rainer (2007) and Michalopoulos and Papaioannou (2013) who show that precolonial political centralization at the level of the ethnic group is associated with more public good provision and greater prosperity today. I contribute to this literature by considering several hypotheses that drive these results, and explore their effects at an individual level. Furthermore, I contribute to the broader literature on state capacity (Besley and Persson, 2011; Acemoglu et al., 2014) by providing evidence for norms of behavior as a channel of persistent effects of differences in capacity. The results in his paper furthermore closely relate to studies of other explanations of persistence, such as social

⁶I similarly investigate measures of social capital, human capital, altruism and income. Including measures of these concepts does not statistically significantly move the estimated coefficient, nor are they statistically significant individually. I finally study the effect of the colonial state and postcolonial shocks. Blouin (2014) show that areas of Rwanda more suitable for growing coffee show less inter-ethnic trust today. I use the geographic suitability for growing coffee as well as the number of coffee pulping stations in a sector in 1960 as measures of the impact of the colonial coffee sector. To measure the effect of the 1994 genocide I use data on the number of individuals prosecuted for genocide related crimes in the Gacaca court system (Verpoorten, 2011). In the aftermath of the genocide, in which around 800,000 Tutsi and moderate Hutu were killed, a system of local courts was instituted to judge genocide perpetrators. These courts have recorded prosecutions and I use the number of prosecutions per sector as a measure of the local intensity of the genocide.

capital (Acemoglu et al., 2014; Dell et al., 2015), the accountability of local chiefs (Mamdani, 1996; Genaioli and Rainer, 2007) or the persistence of the presence of local state infrastructure (Michalopoulos and Papaioannou, 2014). The recent contribution by Lowes et al. (2014) is the closest study to this paper. They study the persistent effect of the historical Kuba kingdom on pro-sociality in Kananga in the Democratic Republic of Congo and find that individuals from villages that are historically part of the Kuba kingdom behave less pro-socially today. My results complement theirs by focusing on differential exposure to the same state, rather than on exposure to the state relative to no state. Furthermore, I am able to directly control for the effects of the modern state. By focusing on an experimental outcome variable, my paper contributes to a small but growing literature in economic history using field experiments (Lowes et al., 2014; Blouin, 2014).

This paper proceeds as follows. The next section discusses the historical background necessary to the identification strategy of this paper. It also introduces taxation as a central part of the precolonial kingdom's capacity. Section 3 presents the data used in the paper and the estimating framework for the empirical results in the rest of the paper. Sections 4 and 5 present results on the persistent effects of the historical Early State on modern voluntary tax compliance. Section 6 considers alternative channels of persistence. Section 7 concludes.

2 Historical background

This section details the historical and institutional background to the establishment and expansion of the Nyiginya kingdom, precolonial fiscal capacity, and the particular history of the establishment of centralized rule in the study area, the banks of the Akanyaru river in Southern Rwanda.

The main source of knowledge about Rwanda before colonization is a large compendium of historical tales and poems that were maintained at the royal court and that were transcribed by early colonial officials and anthropologists. About 300 historical tales and 175 dynastic poems survive (Vansina, 2004, p. 221, footnote 2). The historical tales are summarized in d'Hertefelt and Coupez (1964), the dynastic poems in Kagame (1951) and the dynastic list of Kings in Vansina (2004) and Rennie (1972). These sources have subsequently been combined with extensive anthropological and archaeological fieldwork to reconstruct the history of the kingdom by Alexis Kagame (Kagame, 1975, 1963), Jan Vansina (Vansina, 2000, 2004, 2012) and several other authors (Maquet, 1961; Lemarchand, 1970; Lugan, 1997). I rely on their

work for the historical background in this section.

2.1 Rwanda pre-1650

Before the establishment of the Nyiginya kingdom, Rwanda was inhabited by patriarchal lineages. The natural political unit was the hill (*musozi*) which was inhabited by several kinship groups in scattered dwellings.⁷ Larger political units were formed by coalitions of several hills, or clans.⁸ The lineages that first cleared the land, the *abasangwa butaka*, had customary rights to settle disputes and extract tribute.⁹ Lineages or coalitions had Kings, who were ritualists who were thought to hold magical powers over the fertility of the soil and the fecundity of cattle. These Kings held no central authority, and lineages did not maintain armies nor attempt to establish a monopoly of violence. When attacked, all male members of the lineages would mobilize to defend. Within the lineages, norms and sharing and redistribution provided social insurance and enforced tribute payment. These norms have been documented in societies across the world (Flannery and Marcus, 2012; Platteau, 2000) and norms of reciprocity are also observed in lab settings today (Fehr and Gächter, 2000).

Wealth was measured in cattle, and there was inequality between lineages based on their wealth in cattle. To escape poverty, lineages could become clients of richer lineages. This arrangement, called *ubugabire*, involved transferring cows from rich patrons to poor clients, in exchange for labor services and calves at regular intervals. This arrangement was also known in Burundi and elsewhere in the region, but only in Rwanda it would evolve into the basis of precolonial taxation in the later Nyiginya kingdom. In Burundi, this system survived well into the colonial period and was described by ethnographers in the early twentieth century (Vansina, 1961; Louis, 1963).

2.2 The foundation and expansion of the Nyiginya kingdom

The Nyiginya kingdom was founded around 1650 by Ndori. Ndori came from Uganda and used his wealth in cattle to buy the allegiance of several chiefs around Gasabo to the North West of Kigali, Rwanda's modern capital. Ndori was a political entrepreneur intent on expansion, but being an outsider he had to

⁷Hills tended to be delimited by marshes in the valleys between the hills, demarcating separate natural political units. The first census figures from the 1920's suggest an average population of about 100 to 1000 individuals per hill.

⁸Around 1950, when the first systematic survey of clans was made, there were between 20 and 30 clans in Rwanda (d'Hertefeldt, 1971). It is however likely that historically there were many more clans, and that over time, and as part of the state formation process, clan identities were consolidated (Newbury, 1980).

⁹The rights that this precedence established were called *ubukonde* and required newly arriving lineages to swear fealty to the incumbent lineages. The newcomers are called *abagererwa* or 'land-tenure clients' (Vansina, 2004, p. 39).

first bind leading local chiefs to him, and coopt the local kinship based social institutions into his state building project.

As a means of cementing his relations with the chiefs, Ndori transformed the *ubugabire* relation into an arrangement called *ubuhake*. Under *ubuhake* the client was still responsible for working for the patron (or, for political positions, be loyal to his patron) but upon dissolution of the arrangement the client not only had to return the transferred cattle but also all other cattle he owned (Vansina, 2004, p. 47). This change increased the permanence of the relationship and the dependence of the client on the patron. Ndori's main institutional innovation, however, was establishment of a professional standing army. He appointed his *ubuhake* clients as generals, and introduced age sets in the army. Rwanda did not have age sets, an institution common in Africa, which bind individuals of similar age in horizontal communities who are supposed to progress through life together (as opposed to the 'vertical' kinship groups).¹⁰ Young men were initiated into the military and organized into age cohorts which would fight together and train with older cohorts. This innovation in military technology aimed to transfer loyalty to the age group, and thereby to the King, rather than to the lineage or clan. Individual armies composed of several age groups were positioned throughout the country, but generally along the outer borders of the kingdom, away from the capital (Kagame, 1963). The generals of these armies, on the other hand, were expected to spend extended periods of time at court. This way, the King balanced territorial control by armies with personal control over military commanders. These organizational innovations created a military advantage large enough to conquer neighboring polities and expand the kingdom. Interestingly, archaeological incidence of luxury pottery increases with the arrival of Ndori and the establishment of a military/economic elite (van Noten, 1983).

Through its superior military, the Nyiginya kingdom expanded rapidly over the two centuries after Ndori's death. Incorporation of a new territory into the kingdom was often initiated by raiding for cattle (Vansina, 2004), but after initial plundering a new district was incorporated into the Nyiginya administrative hierarchy. First, an army would remove any opposition and establish a monopoly of violence. Second, army generals set themselves up as 'great chiefs', now in charge of both the military and the bureaucracy. The great chiefs then appointed district chiefs, usually government officials from the administrative center of the kingdom. These district chiefs, over time, coopted the lineage chiefs into the court

¹⁰Shaka Zulu's main military innovation which led to the formation of the Zulu state, was the introduction of age set based military organization, the *impi* (Morris, 1965).

system, completing the bureaucratic hierarchy between King and individual households (see below). This process is summarized in Figure 2.

2.3 Fiscal capacity in precolonial Rwanda

At the top of the Nyiginya bureaucratic hierarchy were the King and the Queen mother, the latter of whom was in charge of palace affairs and of tax collection. The great chiefs and the district chiefs formed the next bureaucratic layers. The district chiefs were, in turn, the patrons of the heads of local hill lineages. By the late eighteenth-century, the cadre of district chiefs had specialized into three ‘classes’, each responsible for different taxes. ‘Chiefs of the land’ were responsible for collecting in-kind taxes on land (called *ubutaka*), ‘chiefs of cattle’ collected taxes on cattle (*ubuhake*, among others), and ‘chiefs of the people’ collected labor prestations and provided conscripts (*ingabo*). All chiefs were allowed to keep up to one third of all taxes collected and the rest was to be passed up the hierarchy to the court.

Naturally, these chiefs did not rely on third-party withholding, prison sentences or other modern forms of tax enforcement. Precolonial Rwanda had no formal code of law, no formal courts and no means of appealing decisions. Rwandans also didn’t use money, nor were there any roads. Instead, compliance was enforced through a combination of direct use of force and a network of patron-client relationships and the ensuing social obligations.¹¹ The most important of these arrangements was *ubuhake*. Between a richer and poorer individual, the patron would give one or more cows in return for portage, menial services, cultivation and tax collection work. In return, the client had usufructury rights over the milk and the offspring (but not over the first calf, which belonged to the patron). Between the king and chiefs the arrangement was different in the sense that cattle was still transferred but in return the chief acted as a bureaucrat, raising taxes or overseeing the armies in a distant province. Recall surveys from the mid-twentieth century suggest that about eight percent of the population acted as either patron or client in an *ubuhake* relation (Saucier, 1974).

Between the local bureaucrats and the individual tax payer, taxation demands from the central state were enforced through violence and through pre-existing patron-client relations (see section 2.1). Local chiefs provided protection and security in exchange for support and payment of taxes that were, in turn, passed on to the central government.

¹¹In contrast, the neighboring Buganda state in Uganda built extensive road networks and had developed a legal system (Reid, 2002).

Within a lineage, the legitimacy of customary taxes was rooted in norms about land tenure. First-occupier rights entitled a land-owner to claim tribute. The kings used *ubuhake* to expand these tributes and, more importantly, they used their armies to formally claim all land and give it back to their original owners under an *ubuhake* agreement.¹² By the mid-eighteenth century formally all land thus belonged to the King, and he had the customary right to extract tribute.¹³ Around 1870, another arrangement, called *ubureetwa*, developed in which a client (or a lineage) transferred cattle to a patron, in return for protection and political representation at court. This arrangement importantly also entitled the patron to unpaid labor by clients.¹⁴ By the time of colonization the Nyiginya state therefore taxed both output and labor.¹⁵

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How much did the precolonial state tax? In the early eighteenth century, taxation was incidental, and aimed at providing supplies for armies. Gradually, however, both agricultural production and labor were taxed, but labor tax was the most demanding. Under the *ubureetwa* arrangement, which was introduced well after the kingdom had reached its modern extent in Rwanda, around 1870, every Rwandan farmer was required to perform two days of unpaid labor for the state out of every five (Newbury, 1988). In addition, labor duties for a *ubuhake* patron were virtually unlimited. They included labor on the patron's land, portage and tax collection on behalf of the patron. Lineages also owed cattle payments to lineage patrons (usually one cow a year), and in-kind taxes to the King.¹⁷ Finally, there were smaller taxes such

¹²Making political positions independent of a local power base was a centralizing move also seen in Buganda, where chiefs were replaced by 'King's men', see Reid (2002).

¹³The need to work within the legitimate authority of the King and the local chiefs was obvious to the Belgian colonizers. When describing the design of indirect rule Pierre Ryckmans, the colonial governor, wrote "... dismissing a bad chief and ... appointing in his place one more amenable to European influences is tantamount to submitting impotence for insubordination. Legitimacy is a moral factor of incalculable importance" (Dorsey, 1989, p. 44). Later he wrote "Legitimacy is more powerful than violence. The only smoothly functioning organ between us and the masses is the legitimate chiefs. They alone, because they are legitimate, can induce acceptance of necessary innovation." (Dorsey, 1989, p. 45).

¹⁴There was demand for this relationship because population was increasing and land rights were uncertain. In addition to uncertainty resulting from the fact that chiefs of dominant lineages could reassign lands, an increasing fraction of agricultural land was assigned as *igikingi* domain by the King. *igikingi* land was designated for occupation by a member of the royal elite should he choose to move to a particular village. Ownership of an *igikingi* domain also gave the right to labor prestations by farmers. As the patronage network of the King grew more and more land was given out as *igikingi* and, as a result, land tenure uncertainty increased. This arrangement was abolished in 1929 but did not disappear until 1961 (Dorsey, 1989, p. 69).

¹⁵Under both *ubuhake* and *ubureetwa*, clients could in principle be asked to perform unlimited unpaid labor services, but exploitation was limited by the option to seek out a new (and more powerful) patron which would protect against the old patron. For instance, to escape from a demanding *ubureetwa* patron, clients could seek protection from a *ubuhake* patron.

¹⁶These arrangement were also becoming increasingly associated with a class of wealthy bureaucrats and cattle owners, the Tutsi, and a class of farmers, called Hutu, who were clients of the richer cattle owners. It is important to note that until the Belgians started denoting ethnicity in passports, poor Tutsi could lose their status and become Hutu, and upwardly mobile Hutu could become Tutsi. Both groups also owned cattle, although since cattle was a store of wealth, Tutsi had on average far more cattle than Hutu. Lineages as a group were also identified as Hutu or Tutsi. The King was always chosen from either one of two Tutsi lineages, the *Abanyiginya* or the *Abega* (Vansina, 2004).

¹⁷In 1926, around 350.000 tax liable Rwandans produced, among others, 3186 hoes, 20.595 kilos of peas and beans, 3420 kilos of wheat, 1039 pots of honey, 122 sacrificial bulls, 225.000 footrings, and 11.000 strings of glass beads, see Rubbens (1940).

as a tax on the first harvest and incidental labor taxes (Rubbens, 1940). The online Appendix A2 provides background to the tax raised by the Belgians. In the same appendix, I compute the tax rate that could have prevailed in the Nyiginya kingdom. This exercise suggests an average tax rate of around 40%.

In conclusion, by the time of the German occupation of Rwanda in 1897, the Nyiginya kingdom operated a centralized bureaucracy that was able to maintain an army and raise taxes without money, infrastructure or writing (Vansina, 2004). It did so through a series of institutional innovations, such as the army, the bureaucracy and through sharing norms within hill-based lineages. These aspects of the Rwandan kingdom are central to the empirical strategy in this paper, and the connections between the expansion of the kingdom, the norms that governed tax collection and the empirical strategy in this paper will be made explicit in subsequent sections.

2.4 Using the expansion of the kingdom as a measure of historical centralization at a local level

Establishing the Nyiginya bureaucracy in a newly incorporated territory took time because it was built on patron-client relationships and cooptation of social norms (Vansina, 2004). Therefore, tax collection was difficult in newly incorporated areas and fiscal capacity was built up slowly over time. There is little direct precolonial evidence for this assertion, but there is a large body of evidence on the difficulties of establishing and maintaining central rule in districts that were only recently incorporated when the Germans annexed Rwanda into German East Africa. At this time, recently incorporated districts still regularly rebelled against Nyiginya bureaucratic control, refused to pay taxes and submit to chiefly authority. In fact, German soldiers were almost continuously involved in re-establishing Nyiginya control in the newly incorporated areas in the North and South-West of Rwanda¹⁸ (see Louis (1963) for narrative evidence from German colonial reports, Des Forges (2011) for anthropological evidence for the North of Rwanda, and Newbury (1988) for anthropological evidence for the South-West of Rwanda. For detailed local studies of individual rebellions against taxation by the centralized government, see Newbury and Newbury (2000), Des Forges (1986) and Newbury (1987)).

The gradual establishment of centralized rule introduces variation in the exposure to centralized government of different areas in Rwanda, and I use this variation as part of my identification strategy in this

¹⁸In 1913 there were five German administrators in Rwanda, and about fifty soldiers for about one million Rwandans (Dorsey, 1989).

paper. Figure 1a traces the expansion of the Nyiginya kingdom at the level of the precolonial district. After Ndori's death, the kingdom expanded over the course of the next 200 hundred years until it included all of modern Rwanda when the Germans formally established their rule in 1897. The data section below contains a full description of the reconstruction of this expansion.

2.5 The establishment of the Akanyaru river as an outer border of the expanding kingdom, and its subsequent incorporation

As the Nyiginya kingdom expanded, former borders of the country became boundaries between districts. One such boundary (indicated in white in Figure 1a and in black in Figure 1b) was established as the Eastern frontier of the kingdom when it expanded South in the early eighteenth century. It remained the Eastern boundary of a district called *Mayaga*. The kingdom expanded across the river a hundred years later and incorporated the adjacent district, called *Bugusera*. In 1897, when Rwanda became a German colony, Bugusera had been part of the centralized kingdom for about 100 years, and Mayaga for about 200 years.

The boundary between Mayaga and Bugusera coincides with a stretch of the Akanyaru river, which is a minor river feeding into Rwanda's main river, the Nyabarongo. Situated on the East side of the river, Bugusera was a small polity that extended into Burundi and depended on the Rundi king in Burundi. Bugusera's King lived outside modern Rwanda in Northern Burundi (d'Arianoff, 1952). The history of the incorporation of Bugusera, the East side of the river, into the Nyiginya kingdom has been documented from oral histories maintained at the Rwandan court in two versions (d'Arianoff, 1952; Vansina, 2004). The first version recounts that the Rwandan part of Bugusera was annexed to the Nyiginya kingdom when a group of herders crossed the Akanyaru river and established themselves. When they encountered very little resistance, a Nyiginya army moved in and claimed the land. The second version claims that a madman came to complain to the Rwandan court that he had gone to Bugusera to buy food but had obtained little. When he was dismissed, he sounded the war drums and hungry Rwandans invaded Bugusera in search for food. The Nyiginya state then formally annexed it. The first version seems of course more plausible, but what is important here that in either story the timing of the conquest was not chosen purposefully by the state, nor was the annexation of Bugusera precipitated with events in Bugusera. In fact, the King of Bugusera, who lived outside of Rwanda in Northern Rwanda, had gotten into a quarrel with the Rundi king in the Southern part of his Kingdo, which was within Burundi. Having

to defend his polity, his authority in the North was weakened (d'Arianoff, 1952). The Rwandans moving into the territory encountered, therefore, no organized opposition, and the timing of the expansion of the Nyiginya kingdom is plausibly unrelated to a decision made at court. Indeed, Jan Vansina, the leading historian of precolonial central Africa, notes "The .. conquest .. illustrates the role of serendipity and private initiative in the process" (Vansina, 2004, p. 155).

2.6 Conclusion

This section has outlined the necessary historical background to the use of the banks of the Akanyaru river as a natural experiment in local exposure to centralized state institutions, as well as to the nature of fiscal capacity in the Nyiginya kingdom. The Nyiginya kingdom interacted with individual Rwandan through the pre-existing structure of chiefs. In line with the literature on the persistent effect of historical states in Africa, I expect there to be a persistent effect of the presence of the Nyiginya kingdom across the Akanyaru river.

3 Data and Estimating framework

This section describes the data used in this paper as well as the estimating framework for identifying the long-run impact of centralized rule in Rwanda. The core of the estimating framework is the combination of experimental data generated in the random taxation game with quasi-experimental variation resulting from the expansion of the Nyiginya kingdom.

3.1 Sampling

In order to exploit the natural experiment created by the expansion of the Nyiginya kingdom that halted at the Akanyaru river, I have selected administrative districts on either side of this river in contemporary Rwanda as a 'focus area'.¹⁹ Within these districts and within sectors – the next administrative division –, I randomly selected villages based on an administrative map available from the Rwandan Bureau of Statistics. This sampling resulted in 8 villages on the 'untreated' side of the river, and 13 on the 'treated' side. I then randomly sampled 20 participants per village. After restricting to individuals over 18 years of age who signed a standard informed consent form, the individual level sample used in this paper contains 420 individuals. Each village was visited twice, once to sample participants, and once for the fieldwork.

¹⁹The districts are Bugusera on the Eastern bank, and Kamonyi, Ruhango and Nyanza on the Western Bank.

The districts and villages used in the sampling frame are mapped in figure 1b.

3.2 Experimental Data

In section 2 I described the process of establishment of central authority as the Nyiginya kingdom expanded. I also suggested a plausible link with individual compliance historically. This section details the experimental games that I implemented across the Akanyaru river that aim to measure compliance with government demands today. I focus on a taxation demand since the historical evidence clearly suggest that taxation was introduced upon incorporation into the Nyiginya kingdom. I have modified the ‘resource allocation game’ (Hruschka et al., 2014) to measure compliance with a government demand to pay taxes. I have implemented this game, as well as a standard dictator game and a survey, over the course of summer and fall 2014. On the first visit, inhabitants were informed that they were selected to participate in a research project and about how much they could earn should they agree to participate. Upon agreeing to participate, the date and time of the second, full-day, visit was announced.

On the second visit, the participants were asked to meet at a pre-specified location, which would serve as the experimental ‘lab’ for the day. To find this location, I paid the village leader to identify a location which 1) was not a government office nor owned by the government and 2) would guarantee anonymity of the participant when making choices within the experiment. By and large, this location turned out to be a room in the village bar, which in Southern Rwanda serves as both a restaurant and a hotel. These rooms were generally lit by a window but sufficiently private to assuage any worries the participants might have about being monitored.²⁰ Figure A1 in the online Appendix provides a photograph of one of these locations.

The actual fieldwork proceeded in several steps. The participants were first asked to participate in a survey, which was rewarded with a sitting fee of RWF1500, in three bills of RWF500. RWF1500 is roughly equal to two day’s unskilled wages. This sitting fee could then be shared in a dictator game. Second, the participants played the random taxation game, the focal game of the fieldwork. Upon completion of the fieldwork, there was a second survey as well as a survey of the village. The village survey mainly recorded the presence of government institutions.

²⁰Survey responses at the end of the fieldwork suggest that only a handful of participants felt monitored or felt that their responses would be known by the government. All reported results are robust to dropping these participants from the sample.

The dictator game proceeds as follows. Each participant, the sender, is told that they can share part of their sitting fee with an anonymous receiver. When the sender has decided how much to send, the game ends. The receivers were randomly selected beforehand at the village level and every participant was asked to share with only one receiver. The receiver could be a random member of his/her village, an anonymous citizen of the capital, an anonymous representative of the local sector government²¹ or an anonymous representative of the central government.

Upon completing the dictator game, participants were invited to participate in the main game, measuring voluntary compliance with a government taxation demand. This game is a modified version of the resource allocation game pioneered by Hruschka et al. (2014) and recently applied in the Democratic Republic of the Congo (Lowes et al., 2014). The game asks participants to pay tax at a rate that is known in advance, but payment will not be enforced and play is anonymous. In addition, there are financial incentives weighing against complying with the taxation demands. The game proceeds as follows: participants, who participate individually, are escorted into the closed 'lab' described above. In this lab, there is a table that has been prepared beforehand and features a number of items. First, an endowment of 6000 Rwandan francs (about 5 times an unskilled daily wage) which is divided into 30 stacks of two coins of 100 francs. Second, two envelopes which are only marked with the participant's experimental ID (see below). Finally, a single coin. The game then proceeds as follows. First, the participants associate one envelope with the government and one envelope with his/herself. Second, the participant flips a coin. Depending on the outcome of the coin flip, the instructions that the participant received before the start of the experiment, prescribe whether a tax payment is due. Third, the participant decides how to distribute a stack of coins between the envelopes. Steps two and three are repeated for each stack of two coins. The game then ends. Participants keep the envelope designated for themselves but hand the envelope with tax contributions back to the enumerator. Since over a large population a fair coin would come up heads 15 times in expectation, the implicit tax rate in this game is 25%.

The setup of this game emphasizes anonymity and impunity, through the instructions, the experimental location and the use of participant IDs. At the beginning of the fieldwork every participant was assigned a number, their participant ID, and the only key between this number and their name was handed to the participant. Every step in the experiments was then carried out using the participants IDs as personal identification. The participants only had to use their real names when signing a standard informed

²¹The sector is an administrative division in Rwanda. There are on average about 30 villages per sector.

consent form. This setup makes it impossible to trace individual actions on these games back to individual participants. Since, as in the resource allocation game, the random taxation game is designed to guarantee anonymity to the individual respondent, I expect that participants will disregard the instructions, and keep the full endowment.²² I take the contribution of a participant (if any) divided by what the fair coin predicts a participant should pay (or the ‘tax base’) as my main measure of compliance throughout this paper²³

There may be several reasons why the random taxation game may not measure compliance with a government demand to pay taxes. First, the game may just measure general pro-sociality towards the government, the enumerators or researchers more generally. As I show in section 6, this is not the case. Several survey measures of altruistic behavior as well as sharing behavior in the dictator game are uncorrelated with historical state status. Second, it may be the case that poorer Rwandans do not pay taxes. Most Rwandans, however, pay VAT on purchases and employed Rwandans pay income tax through their employers. All results in this paper are robust to controlling for employment status, which is the most direct proxy for paying income taxes available. Finally, it may be the case that anonymity was insufficiently guaranteed in the random taxation game, such that compliance with the fair coin is no longer voluntary. In a post-fieldwork survey, 2.4% of participants indicated that they thought were monitored. All results in this paper are robust to omitting these participants.

3.3 Quasi-experimental variation

I have collected experimental data in villages that are close to the Akanyaru river in Southern Rwanda (see Figure 1). On average, sample villages are about five kilometres away from the river. As described above, the river was an outer boundary of the expanding kingdom for about one hundred years before it was crossed and the district on the other side was incorporated as well. I use the difference in exposure to centralized rule resulting from the staggered introduction of centralized government as a natural experiment to understand the drivers of persistence of centralized government in Africa.

For villages incorporated later to be a valid counterfactual for the experience for villages incorporated earlier, several assumptions need to be met. First, the timing of expansion has to be plausibly exogenous.

²²Respondents in (Hruschka et al., 2014) and Lowes et al. (2014) do share less than prescribed by the design of the game, although few take the full endowment.

²³The key difference between the resource allocation game (Hruschka et al., 2014) and this game is that the voluntary contributions made to the other party are framed as a tax to the government.

The historical evidence on the expansion of the kingdom presented in the previous section suggests the timing of the expansion was an outcome of a conflict between Bugusera, the polity located across the Akanyaru and the kingdom of Burundi in the South. In other words, the timing of the expansion was not chosen by the Nyiginya king. Yet it may be the case that when Mayaga, the bank of the river that was incorporated earlier, was conquered the King could have pressed on but he stopped because the other side of the river was particularly unattractive for incorporation. I explore this issue in section 5 and find that opposite banks of the river look similar in terms of geography and pre-Nyiginya density of archaeological finds.

Second, factors beside state presence vary smoothly across the boundary. Although geographical variables balance, if the river is a the boundary between administrative districts, policies may also discontinuously change at the boundary. Up to a large administrative reorganization in 2002, the study boundary coincided with the border between three communes in Bugesera and four communes in Mayaga. After the 2002 redrawing of boundaries, Bugesera became one district and Mayaga is subdivided into three districts. These districts are mapped in Figure 1b. I can therefore not rule out that post-2002 policies in Bugesera are differently from policies in the three district in Mayaga. I do, however, extensively control for the presence and accountability of the government at the sector level (the administrative level below the post-2002 districts), which are in charge of executing district level policy.²⁴

3.4 Dependent Variables

3.4.1 Tax compliance

I obtain my main outcome variable, voluntary tax compliance, from the random taxation game. I re-express the tax contributed by each participant as a fraction of the tax base (i.e. 25% of the endowment of 6000 RWF).

3.4.2 Channels

To measure the presence of the modern government, I conducted a village-level survey in the sample villages. In Rwanda there are five levels of local government: the province, the district, the sector, the cell

²⁴A natural robustness check would be to use a boundary that does not coincide with a natural landscape feature. This is unattractive, however, since precolonial boundaries were not exact, except where they coincide with natural boundaries.

and the village. All levels but the village have physical government offices. Since I randomly sampled villages, some villages in my sample will have a cell office, and others will not. I exploit the presence of a cell office as my measure of the presence of the government, coding an indicator variable equal to one if a particular village happened to have a cell office. Similarly, I have coded an indicator that is equal to one if an experimental village is home to a police office, using data from Rwanda's cadastral office to find all police offices in the sample area. Villages are very small, however, and the presence of a police office that is only a few hundred yards away in the neighboring villages may have the same influence on behavior in either village. I therefore also measure the distance to both the nearest government office as well as the nearest police office. I measure corruption using data from the Rwandan ombudsman (www.ombudsman.gov.rw, current as of September 1st, 2015). The ombudsman reports corruption involving government officials at a village level. Although the independence of the ombudsman or the criteria by which corruption is measured are hard to verify, the database reports in detail the amounts of money involved in the corruption as well as the professions and positions of the parties involved. I use the number of corruption cases filed against inhabitants of a village as a measure of local corruption.

To measure the effectiveness of the local government, I implemented a phone survey in the spirit of Chong et al. (2014), who mis-addressed letters and measure return time. I measure the total number of calls it takes to reach the lowest level government official that has an office, the cell executive secretary. All calls to a specific government official were made within the same day by a native Rwandan. In order to reach the cell executive secretary it is necessary to call the district office and obtain the cell phone number of the sector executive secretary who, in turn, has the contact details of the cell executive secretary. At the district level, there is generally a dedicated person to pick up the phone, but at lower levels, the executive secretary himself answers the phone. When a call is answered I ask for relevant phone number. To not raise suspicion, I ask about the number of employees at the relevant government level. This number is regulated by law and was the same in all offices I called (nine individuals at the sector level, and two at the cell level). As my measure of responsiveness I use sum of the number of calls it takes to reach the sector executive secretary and the number of calls it takes to reach the cell executive secretary. I consider a person reached when the call is either answered or returned.

To measure social capital, I asked participants for their membership of a series of social groups. I asked if the participant was a member of a sports group, a neighborhood group, a religious group, a community group, a cultural group, an NGO, or a political party, generating an indicator variable for each group

equal to one if the participant reported to be in one of these groups. Each of these groups are known in Rwandan society and play a role in rural social life. I use the sum of the individual indicators as a measure of social capital.

I obtain measures of religious attendance, equivalent daily income and education from a survey carried out before the behavioral games section of the fieldwork.

3.5 The expansion of the Nyiginya kingdom

In order to identify the difference in exposure to centralized rule across the Akanyaru river, I reconstructed the expansion of the Nyiginya kingdom across all of Rwanda. The historical data for every precolonial district and the method of identifying the precise year of incorporation for each district are described in Heldring (2015) and Vansina (2004). For every precolonial district, this method identifies the number of years of exposure to centralized government. From this data, I code an indicator variable, that is equal to one in the experimental sample if the village inhabited by participant p is on the West side of the Akanyaru river, the ‘early state’ side. This side was part of a precolonial district called Mayaga, which was incorporated into the Nyiginya kingdom in 1700. This indicator is equal to zero if his/her village was part of the precolonial Bugusera district which was incorporated in 1799.

3.6 Estimating framework

Section 5 studies the persistent effect of the Nyiginya kingdom on individual outcomes today, measured by voluntary tax compliance in the random taxation game. The identification strategy in this paper combines random selection of subjects, mitigating the effect of unobserved heterogeneity at the level of the individual participant with a natural experiment across the Akanyaru river, controlling flexibly for the location of the randomly selected villages to account for unobserved heterogeneity in the attractiveness of incorporation into the Nyiginya kingdom of a particular village (see section 4.1). I implement this strategy by estimating the following baseline relationship:

$$y_{iv} = \alpha + \beta_D \cdot D_{iv} + \mathbf{x}'_{iv} \cdot \boldsymbol{\beta}_X + f(location) + \varepsilon_{iv} \quad (1)$$

Here y_{iv} is the dependent variable of interest for individual i in village v . D_v is a dummy equal to one if village v had an early state such that $\hat{\beta}_D$ is the main coefficient of interest, the measured effect of being on the side of the river with a deeper history on voluntary tax compliance. $f(location)$ is a function of the

location of village v . In most specifications, this function is a linear function of latitude and longitude. $\mathbf{X}_{iv}$ includes all controls at the individual or village level such as age, gender or the distance to the modern capital, Kigali. Finally, ε_{iv} is an error term. I estimate equation (1) using Ordinary Least Squares.

3.7 Descriptive Statistics

Figure 2 contains a histogram of the raw difference in voluntary tax compliance across participants on either side of the Akanyaru river. The distribution of compliance across the Akanyaru river suggests that individuals in places with a deeper state history are more compliant today, which is the basis of validity of my approach to studying channels of persistence of historical state capacity.

4 Results: The persistent effect of state history

This section is aimed at understanding the persistence of tax compliance in Rwanda. The results below show that there is a robust persistent effect of historical state capacity on compliance. In the most conservative specification the effect size is about 9.8 percentage points, or about one seventh of the mean of the dependent variable.

4.1 The effect of state history on compliance

Table 1 explores the persistent effect of the Nyiginya kingdom by presenting estimates of equation 1. The first row presents estimates of $\hat{\beta}_D$, the estimated effect of being incorporated into the historical Nyiginya for one hundred years longer on compliance with the tax demand in the experimental game. Following Deaton (2010) I use heteroskedasticity robust standard error to account for differential variance across treatment status. Following Young (2016), I also report p-values from a permutation test.

Column (1) report the raw difference across the river (both $\mathbf{X}_{iv}$ and $f(\text{geographical location})$ are empty vectors). Column (2) includes latitude and longitude in $f(\text{location})$. Column (3) adds demographic controls, as well as latitude and longitude. $\mathbf{X}_{iv}$, includes age, age squared and a gender dummy in this specification. To account for the reach of the modern Rwandan central government, column (4) adds the distance to Kigali, Rwanda's modern capital, as the only covariate in $\mathbf{X}_{iv}$.²⁵ Column (5) reports an estimate of equation 1 which includes distance to Kigali, age, age squared, gender in $\mathbf{X}_{iv}$ as well as latitude

²⁵Kigali was founded in 1905 by Richard Kandt, well after colonization by the Germans. Kigali did not become Rwanda's capital until independence. Today, with over one million inhabitants, it is Rwanda's largest city.

and longitude in $f(location)$. This is my preferred specification, and I use it as the baseline specification going forward.

Throughout columns (1)-(5) I find a positive and significant effect of the historical state on compliance. Relative to both the mean and the standard deviation of the dependent variable, the estimated effect size is economically meaningful. To take the estimated effect in column (5), $\hat{\beta}_D = 9.832$ (s.e. = 4.457), which is equal to about one seventh of the mean and equal to about one third of a standard deviation of compliance.

4.2 Specification checks

This section performs several specification checks. Specifically, I vary $f(geographical\ location)$ in estimates of equation 1 to show robustness of the result presented in table 1 to different ways of accounting for the location of respondents relative to the Akanyaru river. I also show that artificially moving the river in a placebo exercise reduces the size and significance of the estimated effects in table 1.

Varying $f(geographical\ location)$. In panel IA and IB of table 2 I vary the functional form of $f(geographical\ location)$. In Panel IA I consider a linear spline in distance to the Akanyaru river and in panel IB I consider both this linear spline as well as latitude and longitude. Columns (1) - (5) repeat the specifications used in table 1. The estimated effects of historical state capacity are positive and significant, and quantitatively similar to the estimated effects in table 1.

Placebo regressions. Panels IIA and IIB of table 2 report estimates of $\hat{\beta}_D$ from equation 1 including the baseline set of controls in $\mathbf{X}_{itv}$ as well as latitude and longitude. Panel IIA artificially moves the Akanyaru river 1KM to the West, changing the treatment status of about 10% of the sample. Panel IIB moves the river 5KM to the West, changing the treatment status of about 30% of the sample. Columns repeat the specifications used in table 1. In both Panel IIA and Panel IIB, the estimated effect of the historical state is positive but imprecisely estimated. Importantly, the estimated effect, $\hat{\beta}_D$, fall relative to the corresponding estimated effect for all specifications. This result lends credence to the empirical setup of this paper, and the use of the Akanyaru river as a relevant margin in state history.

4.3 Robustness: Geography and pre-Nyiginya settlement

This section tests the robustness of the main result presented in Table 1 to accounting for differences in geography. To the extent that, for instance, varying geography factors into the attractiveness of a particular area for incorporation into the Nyiginya kingdom, geography could confound the observed effect in table 1. It may furthermore be the case that pre-existing population density made one side of the river a much more attractive target for incorporation. I find, however, that all pre-characteristics of the sample area balance across treatment status as I restrict the sample to villages closer to the Akanyaru river. I report results for elevation, which is mapped in Figure 2a, at geographical suitability for growing banana, Rwanda's staple crop, Figure 2b and the density of pre-Nyiginya archaeological finds, mapped in Figure 3.

Balance tests. It may be the case the sample region is heterogeneous geographically, and that one side of the river was geographically much more attractive for incorporation into the kingdom than the other side. If this were the case, the control group of respondents living on the side of the Akanyaru that was incorporated later are no longer a valid counterfactual for those incorporated earlier. To assess this possibility, I use elevation data and data on the geographical suitability for banana, the main staple crop in Rwanda. It may furthermore be the case that pre-Nyiginya levels of population density were radically different across treatment regions, and that this difference influenced the attractiveness for different areas to be incorporated into the Nyiginya kingdom. To assess this possibility, I use a map indicating the number of prehistoric archaeological finds that indicate population density above the hunter-gatherer level (Prioul and Sirven, 1981).

For each of the geographical variables, as well as the number of archaeological finds, table 3 reports balance tests. Columns report dependent variables, and panels restrict the sample to villages closer to the Akanyaru river. Archaeological finds are rare in Rwanda, so I only test for balance in the sample of villages that are within 10KM from the river. Both banana suitability and the density of prehistorical settlement balance in all samples. Terrain elevation is unbalanced in the samples within 5 and 10 KM from the river, but balances in the sample within 3KM and within the experimental sample. These results indicate that it is unlikely that the expanding kingdom either stopped expanding at the river because the other side was unattractive or incorporated one side earlier because of its relative attractiveness.

4.4 Robustness: Migration and Altruism

This section investigates whether the observed effects in table 1 can be explained by differential migration or altruism. In Rwanda's recent history there have been large population movements, primarily during and after the 1959 coup and the 1994 genocide. In addition, the *imidugudu* villagization program has forcibly moved many ordinary Rwandans. If these rates of migration differentially affect the treatment area, the estimated effects in table 1 become hard to interpret. It may be, for instance, that Rwandans differentially emigrated from areas with a deeper state history because the state taxed more, as Scott (2009) finds in highland South-East Asia. In my sample, 48% of respondents have migrated within their lifetime. 29% of respondents, or 62% of migrants have moved within the sample area, and 3% of respondents or 5% of migrants have migrated across the Akanyaru boundary. Furthermore, as observed in section 4, the random taxation game may measure altruism or prosociality. If this is the case, I can not interpret the observed effects as being informative about compliance.

Table 4 reports balance tests for both migration and altruism. In column (1) the variable of interest is an indicator variable equal to 1 if a respondent has migrated. In column (2) the variable of interest is an indicator variable equal to one if a respondent migrated into the sample area from elsewhere in Rwanda. I find no significant differences in migrant rates across treatment status, nor are the estimated effect sizes economically meaningful. To take the estimated difference in column (2), 0.0534 (s.e. 0.0439), respondents in an area with a deeper state history are 5% more likely to have immigrated into their current village. This effect, however, cannot be statistically distinguished from zero. Rwanda has instituted a sovereign wealth fund, the 'Agaciro development fund' to which private individuals as well as groups of people can make donations. 64 participants report to have contributed to this fund individually, and another 64 report to have contributed as a community. Of the 64 individual contributors, 18% has also contributed as part of a community. Since private donations can be made anonymously (but do not have to), I view individual donations as a measure of altruism towards the government. Communal contributions are generally reported in local media, and I do not consider these contributions as altruism. I code an indicator variable that is equal to one if a participant reports to have contributed as an individual, and similar indicator for contributions as a community. I also report contributions from a standard dictator game as a measure of altruism. After having completed an initial survey, participants were given a sitting fee equal to 1500RWF. One quarter of participants was asked if they'd be willing to share some of this money with an anonymous member of their village. Another quarter was asked to share with an anonymous member

of the capital, Kigali. The two final groups were asked to share with an anonymous representative of the local or the central government. I report results of the last two groups here although the results for the first two groups are very similar. I use the amount (out of 1500RWF) shared as a dependent variable. 177 out of 421 participants decided to not share anything, and 3 participants shared their entire sitting fee. Columns (3) through (6) of table 4 report balance results. All altruistic contributions, whether self-reported or in the dictator game, balance.

Geography, pre-Nyiginya settlement, migration and altruism as covariates. Table 5 reports estimates of equation 1 including terrain elevation and banana suitability as covariates in columns (1) and (2) respectively. In columns (3) and (4) I include both measures of migration status and columns (5) - (8) include all four measures of altruism. All coefficients are standardized to facilitate comparison of effect sizes. Note that, although all covariates balance, the migration and altruism measures are bad controls in the sense that they are plausibly outcomes of the independent variable of interest. All estimated effects of the covariates are statistically insignificant as well as economically insignificant (relative to the early state dummy), with the exception of the amount shared with an employee of the local government, which is positively related to tax compliance. A one standard deviation increase in the amount shared with an anonymous sector employee in the dictator game results in a 0.1 standard deviation increase in compliance. The estimated effect of the early state remains positive, significant and even increases in size.

Taken together, the results in this section suggest that the estimated effect of state history on compliance is robust to accounting for the underlying geography of the sample area, as well as to accounting for migration and altruism.

5 Results for expectations and attitudes

Before moving on to understanding the effect of the modern state on compliance, this section uses survey answers within the experimental subject sample as well as evidence from the World Values Survey for all of Rwanda to show that Rwandans living in areas with a deeper state history do not expect to gain more from paying taxes. The World Values Survey results show that a deeper state history is associated with greater value attached to obedience to rulers and tax compliance.

I first consider two survey questions in the experimental sample, asking about the benefits of paying

taxes. Answers to this question may capture expected future public good provision, beliefs about the accountability of the local and central government, or understanding of the tax bureaucracy. To the extent that these questions capture forward looking expectations about the return to paying taxes, these answers to these questions are of interest for understanding the way in which historical states impact beliefs about the state. In a recent contribution, for instance, Becker et al. (2015) find that a living in a place that was historically part of the Habsburg empire is associated with greater trust in government today. I consider here the following questions: “Does paying taxes benefit the country?” and “Does paying taxes benefit you individually?”. I furthermore consider two questions from the 2012 wave for Rwanda, which is part of the sixth wave of the World Values Survey. The first question reads: “Many things are desirable, but not all of them are essential characteristics of democracy. Please tell me for each of the following things how essential you think it is as a characteristic of democracy. Use this scale where 1 means ‘not at all an essential characteristic of democracy’ and 10 means it definitely is ‘an essential characteristic of democracy’: People obey their rulers”. This question is aimed at understanding the extent to which individuals think obeying their rulers in an essential characteristic of democracy. I also use question V201. This question reads: “Please tell me for each of the following actions whether you think it can always be justified, never be justified, or something in between: Cheating on taxes if you have a chance”. This question, too, has all integers between 1 and 10 inclusive as answer categories. However 10 on this scale indicates ‘never justifiable’ and 1 ‘always justifiable’. The sample for the World Values Survey has 1203 respondents. For each respondent the WVS reports their district of residence. I have matched these districts to the precolonial district in the Nyiginya kingdom and I have recoded the Early State dummy to be equal to one if a district was incorporated before 1799 (the year in which the Akanyaru was crossed). Since there are a smaller number of modern district than there are precolonial districts (30 vs. 50) most modern districts are composed of several historical districts. I take the average year of incorporation across modern sectors ($n=416$) within a modern district to get a measure of the year of incorporation for the district. Since sectors are much smaller than precolonial district, virtually all sectors are fully within a precolonial district.

Table 6 reports results. Columns (1) and (2) report estimates of 1 in the experimental sample. Being part of the historical state for longer is not systematically associated with a belief that taxation is beneficial, either to the country or the individual. These results should be interpreted with caution, however, since the means of the variables are 98 and 95 percent, respectively. Moving on to the World Values Survey results, being part of a centralized polity longer is associated with a higher propensity to think that

obedience is an essential part of democracy and with a higher propensity to think that cheating on taxes is not justifiable. Note that the economic magnitudes are considerable as well. The mean of these variables is, respectively, 7.3 and 2.1 and the estimated effects of the historical state are 0.73 (s.e. 0.199) and -0.22 (s.e. 0.103). In both cases the estimated effect is about one-tenth of the mean of the dependent variable. These last results suggest that part of the package of norms that the Nyiginya kingdom left is a norm of obedience to the government and a belief that it is not justified to cheat on taxes.

6 Testing for the Channel of Persistence

The previous sections suggest that the presence of the Nyiginya kingdom has had a persistent effect on compliance today. The next section tests several plausible channels of persistence of this effect. The results in the following sections suggest that plausible candidate channels do not explain the observed effect. In the discussion section, I argue that these results collectively suggest that an internal norm of compliance, rather than the presence or the quality of local political institutions, drives the main result of table 1.

The results in this section follow a standardized pattern. I first use competing channels as dependent variables and test if they vary systematically with the depth of centralized government in a balance. I subsequently use measures of each channel as a covariate in estimates of equation 1.²⁶

6.1 Results for local government

A prominent series of papers has argued that the persistence of political centralization, and indeed the persistence of most economic outcomes in Africa, works through institutions. These institutions could be the reach of the centralized government, which does not project authority across its full territory in many African countries (Herbst, 2000; Michalopoulos and Papaioannou, 2014) or the accountability of local chiefs (Mamdani, 1996; Gennaioli and Rainer, 2007; Acemoglu et al., 2014). In the context of Rwanda, it may be that the presence or the quality of the local bureaucracy drives the persistence of tax compliance, or that norms of tax compliance, or norms of cooperation with the state more generally, are enforced by the presence of the government (Lowes et al., 2014). In this section I focus on the effect of the presence and the quality of local government. To account for the reach of the central government, I include the distance to the national capital as a covariate throughout.

²⁶Although channels are by definition an outcome of the variable of interest, these specifications show the robustness of the main results to directly including measures of channels in the baseline specification.

6.1.1 Results for the presence and accountability of the local government

Rwanda is divided into 5 provinces, about 30 districts, about 400 sectors, about 1500 cells and about 15000 villages. Each of these levels has salaried government officials. Indeed, in many villages in Rwanda, the government office is the focal building, before the village shop and bar (Purdeková, 2011). Below the village level, there are informal government representatives per as few as 10 individuals (Purdeková, 2011). Since I randomly sample villages, some villages will happen to have a physical government or police office of a higher administrative level within its boundaries whereas others will not. I exploit this to test the effect of the presence of local government. In my sample, eight villages have a cell office. Only one village has a police station. Sector offices and police offices are mapped in Figure 4. In addition to the location of an office, I consider distance to the nearest government and police office. I also consider the hypothesis that areas with a longer tradition of centralized government build up more accountable local political institutions (Gennaioli and Rainer, 2007). I test this idea as a channel within my sample by looking at local corruption, and at the effectiveness of local government measured by the number of calls it takes to reach to cell executive secretary. I find that local corruption or the effectiveness of the local government is not a significant driver of the persistent effect of the historical Nyiginya kingdom. As part of the phone survey described above, all officials were eventually reached, although the number of calls necessary to reach the sector executive secretary varies between 1 and 6 (mean: 2.09), and the number of calls needed to reach the cell executive secretary varies between 1 and 4 (mean: 1.9). The total number needed to reach the local government therefore varies between 1 and 10 (mean: 3.99).

Using these measures, I present balance tests in table 7. In panel I the sample is restricted to all villages that are within the precolonial districts bordering the Akanyaru river, *Mayaga* and *Bugusera* (see section 2). In panel II I restrict the sample to the experimental villages. To account for size effects, I show balance conditional on 2002 population and the area of the administrative sector the village is part of. Aside from distance to the nearest police office, presence of the government balances across the Akanyaru. Villages with a deeper state history, however, appear on average closer a police office. Corruption and the number of calls it takes to reach the local government balance across the Akanyaru river, in both samples.

Motivated by these findings, I re-estimate equation 1 including these measures of the presence of the local government as covariates. Table reports results. Aside from a weakly statistically significant effect of the presence of a police office, all measures are not significantly different from zero. The estimated effect

of the historical state on voluntary tax compliance is unchanged (in a statistical sense), and the standard errors on the individual estimates do not increase. These findings, as well as the balance tests in table 8, suggests that the presence of the local government is not a significant driver of the persistent effect of the historical Nyiginya kingdom.

Rwanda's current government projects its authority throughout the entire country (Reyntjens, 2013), and it therefore not surprising that there are no differential effects the local government in the narrow strip of territory I consider in this paper. I rather interpret the results in this section as suggestive of the idea that the compliance measured in the main experimental game is not driven by the effect current institutions have on individual voluntary compliance, but rather by a norm that developed through longer exposure to centralized rule historically. Before returning to this interpretation, I consider further alternative hypotheses.

6.2 Results for civil society and socio-economic advancement

Strong historical states could leave a legacy through social capital. If, for instance, historical centralized rule was implemented through village level institutions, a tighter social fabric could drive persistence of historical outcomes (a case in point is Vietnam, see Dell et al. (2015)). In section 2 I provided evidence that the historical state implemented taxation through sharing norms operating locally. It may be the case that tighter local networks of social ties, or in other words, higher social capital, are driving the observed results. It may furthermore be the case that the persistence of precolonial state capacity persists through 'socio-economic advancement' (Gennaioli and Rainer, 2007). Observed outcomes today correlate with historical centralization, the argument goes, because more centralized places were more advanced and this head start persists.

In my sample, only 36 out of 420 participants report to not be a member of any social organization. 177 participants report to be part of more than two social groups. I have asked whether participants were part of a neighborhood group, a cultural group (such as a dancing group), a political party, a religious group, an athletic association, or whether the respondent was associated with an NGO. I take the total number of groups an individual self-identifies with as a measure of social capital. I also explore religiosity, measured by the frequency of church visits over the last full month before the fieldwork, as a potential channel of transmission. Only 21 participants report that they did not go to church once in the past

month. Most people report to have gone four times, and further bunching occurs at eight and twelve. I measure individual socio-economic advancement by the daily income and number of years of schooling.²⁷ Daily income is constructed by asking participants about income in major categories (wage employment, money made by selling agricultural products etc.), and leaving open the time window (daily, weekly, yearly). Each reported income has been recalculated into an equivalent daily wage.

Table 9 reports balance tests. Social capital, church attendance and income balance, but individuals on the early state side of the Akanyaru are more educated. Table 10 introduces social capital as a covariate in column (1) and religiosity as a covariate in column (2), re-estimating equation 1. Religiosity enters with a small and insignificant coefficient. Social capital enters negatively and significantly. Importantly, however, the effect of the historical state is unchanged, both in terms of significance as well as in terms of estimated effect size and standard errors, across both columns. When including income and education in columns (3) and (4) produces small and insignificant effects, without moving the estimated effect of the historical state dummy. The results in tables 8 and 9 suggest, therefore, that social capital, religiosity and socio-economic advancement are not the main drivers of the persistent effect of the Nyiginya kingdom.

6.3 (Post)colonial history

This section considers Rwanda's colonial and postcolonial history as channels of persistence driving the effect of the Nyiginya kingdom on modern voluntary tax compliance. The Belgian colonial government is considered to have been repressive, especially through forced labor in the coffee sector (Newbury, 1988; Blouin, 2014), and through the warping of ethnic identity (Mamdani, 2002). The 1994 Rwandan genocide, in which as many as 1,000,000 Tutsi and moderate Hutu were killed, was a significant shock to the Rwandan countryside (Straus, 2006). In previous work I've shown that genocidal violence in places with a deeper state history (Heldring, 2015).

I use data on the geographical suitability for coffee in sample villages from the Food and Agricultural Organization as well as data on the number of coffee pulping centers in existence in 1960 in administrative sectors that contain one of my sample villages published by the Belgian government (Belgium, 1960) as measures of the impact of colonization. I use data on the number of perpetrators per sector that contains one of my sample villages published by the Gacaca courts. Gacaca courts were local law courts instituted after the genocide to try genocide survivors all over Rwanda (see Verpoorten (2011) for further

²⁷Note that schooling may also be seen as a means whereby the government can socialize individuals. For example, Cantoni et al. (2014) show the attitudinal changes resulting from a government-initiated textbook reform in China. In Rwanda, the most striking example, perhaps, is the effect of the hate radio in mobilizing Rwandan citizens for the 1994 genocide (Yanagizawa-Drott, 2014).

background).

Table 11 reports balance tests. Both the geographical suitability for growing coffee as well as the number of coffee pulping center balance in the experimental sample, but not in the historical sample. Motivated by this finding, Table 12 includes both measures as covariates in estimates of equation 1. The estimated effects for both the suitability for growing coffee as well as the number of coffee pulping centers are small and insignificant. The estimated effect of the historical state is stable and significant in all estimations.

Table 11 and 12 also report results using the genocide data. Column (3) of table 10 reports a balance test, and (3) of table 11 includes the number of prosecuted individuals as a covariate. In line with Heldring (2015) the number of prosecuted individuals does not balance, with the difference being significant at the 10% level. When including the number of prosecuted individuals as a covariate, I find a positive and significant effect of the number of prosecuted individuals on voluntary tax compliance. This finding may point to the idea that participation in the genocide was associated with greater obedience to authorities, see e.g. Hintjens (1999) and Prunier (1995). Importantly, however, the effect of the Early State dummy is significant and the estimated effect is stable.

7 Concluding Remarks

This paper has provided several results aimed at understanding the drivers of historical persistence in Africa. Focusing on the Rwandan Nyiginya kingdom, I have considered a natural experiment arising from the expansion of the precolonial kingdom across the Akanyaru river in central Rwanda. This river was the outer border of the expanding precolonial Nyiginya kingdom, which subsequently annexed the lands across the river after a war in Burundi left a power vacuum.

I implemented a fieldwork exercise across this boundary measuring voluntary compliance with a taxation demand. This type of games has been implemented recently in a variety of contexts to measure rule following. It is difficult to disentangle the precise motivation in such games, whether compliance is driven by a norm of compliance, or by norms of honesty, or yet other internal motivation. I have ruled out one such interpretation, the idea that individuals may feel altruistic or pro-social towards the (local) government. Using measured compliance in this game, I have provided evidence for a persistent effect of

a deeper state history on contemporary rule following. This effect is robust to several potential geographical confounders, as well as to accounting for migration and altruism. I interpret the main effect is being driven by a norm internal to the individual participant. This interpretation is motivated by the setup of the fieldwork experiment, which creates an anonymous experimental setting, and more generally guarantees anonymity and impunity. Since individual and village-level confounders balance, as shown by a series of balance tests, I interpret differences in compliance rates in villages that are geographically very close, but differ in their historical exposure to centralized rule as the persistence of a social norm.

This interpretation is further supported by the historical narrative presented in section 2. The establishment of the precolonial state involved cooptation of local social norms surrounding sharing and tribute into the state bureaucracy and, importantly, into the tax bureaucracy. Given the relative absence of formal institutions such as law, a legal system, or a police force, government control was exercised through the local social norms that operated before the expansion of the kingdom Vansina (2004).

Next, I exploited the random selection of villages to understand drivers of the persistent effect of the Nyiginya. Importantly, it may be the case that a deeper state history leads to greater presence or accountability of the current government and this, in turn, explains the observed compliance differences. Measuring local state presence and corruption, as well as the responsiveness of the local government, I show that this is not the case. Within the sample area, there is no differential presence of the local government nor do I find support for the idea that the modern government is more accountable. Similar exercises show that civil society or colonial history are not the primary drivers of the persistent effect either.

While in the empirical set up of this paper it is never fully possible to exclude all possible explanations for the observed effect, I have found a robust and stable effect of the depth of historical rule on rule following in an anonymized environment. The most plausible competing explanations for this effect, the local government or local social groups as alternative enforcers of 'compliant behavior' do not vary within my sample nor do they weaken the observed effect of the Nyiginya kingdom. Taken together, the results in this paper support the hypothesis that the historical Nyiginya left a persistent individual level effect on compliant behavior today. This effect is plausibly driven by a social norm that was built up during the precolonial period.

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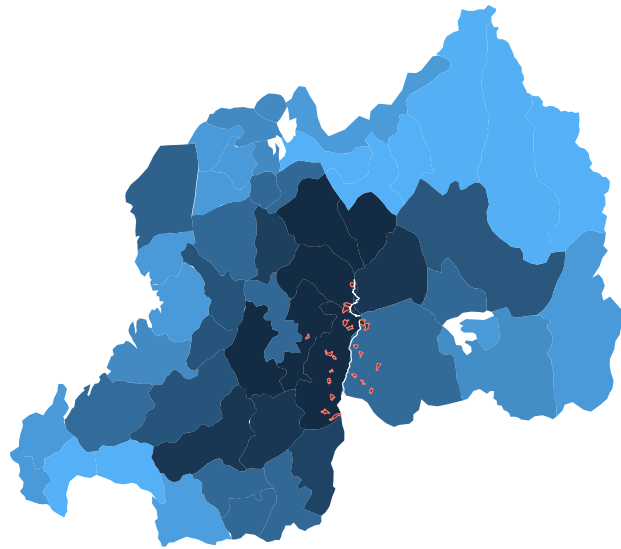
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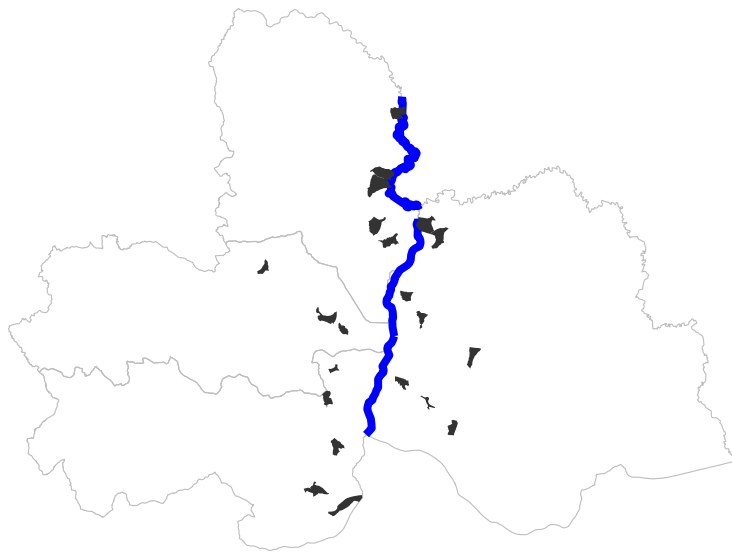
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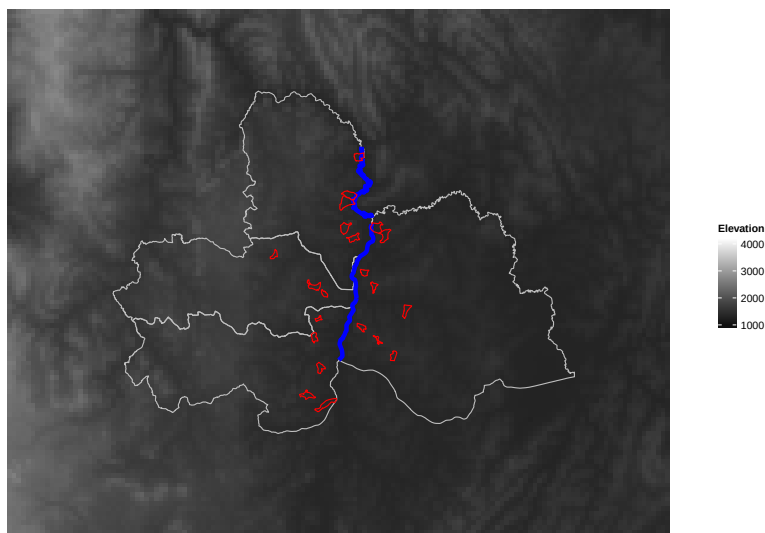


(a) This map displays precolonial districts. A darker shade indicates a deeper history of centralized rule. In white, this map displays the stretch of the Akanyaru river which defines the natural experiment exploited in this paper. Polygon outlines demarcate sample villages.

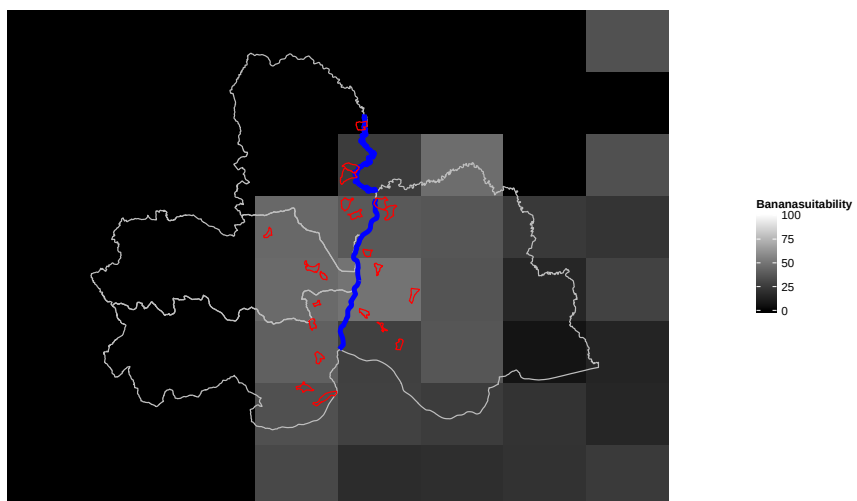


(b) This map displays the sample districts in grey, sample village in black polygons and the Akanyaru river.

Figure 1: The expansion of the Nyiginya kingdom and sample villages.

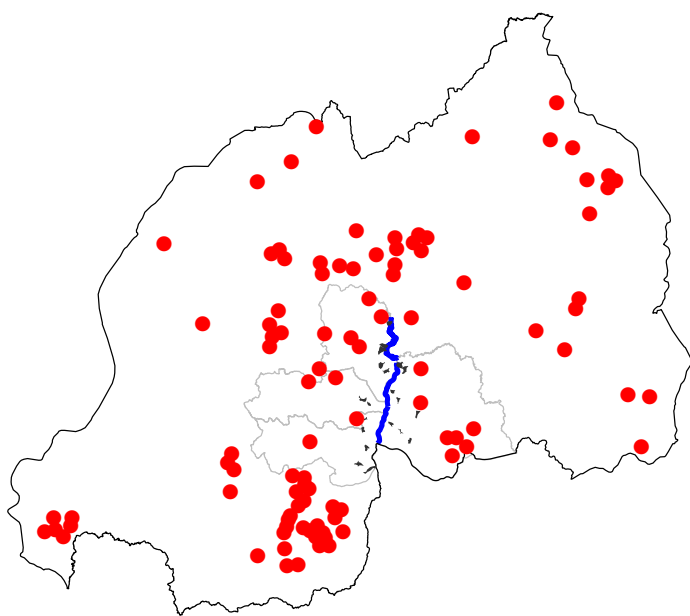


(a) This map displays the sample districts in grey, sample villages, the Akanyaru river and terrain elevation as the background raster.



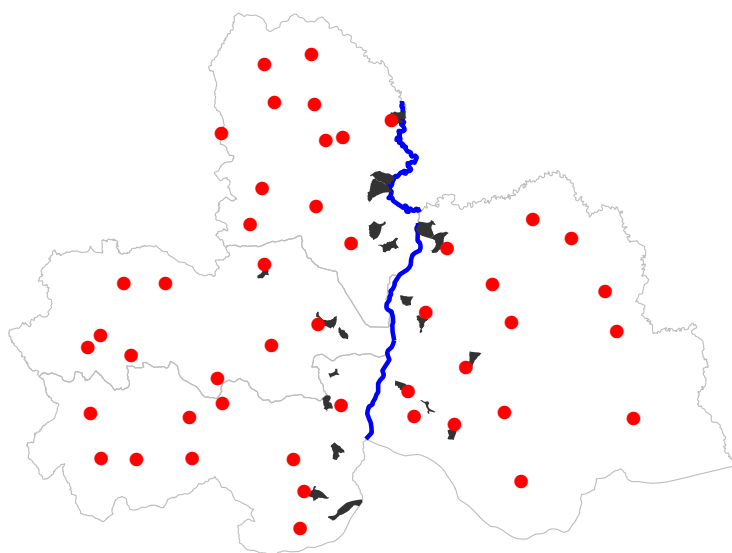
(b) This map displays the sample districts in grey, sample villages, the Akanyaru river and soil suitability for growing banana as the background raster.

Figure 2: Elevation and banana suitability.

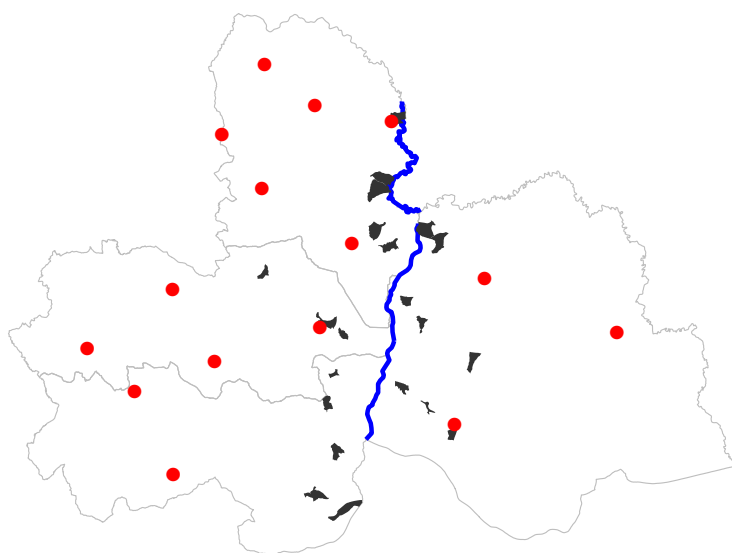


(a) This map displays the outline of Rwanda in black, sample districts in grey, sample villages, and the Akanyaru river. Dots indicate pre-Nyiginya archaeological sites.

Figure 3: Archeological sites in Rwanda.



(a) This map displays the sample districts in grey, sample villages and the Akanyaru river. Dots indicate sector offices.



(b) This map displays the sample districts in grey, sample villages and the Akanyaru river. Dots indicate police offices.

Figure 4: Local government office and police offices.

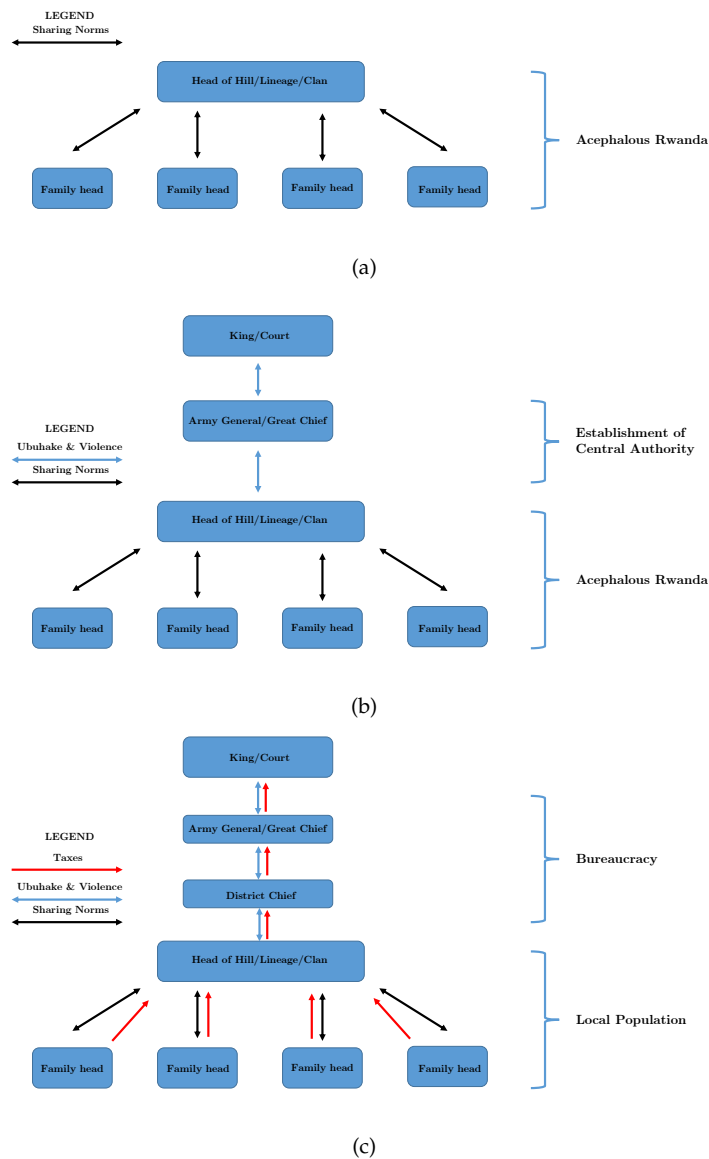


Figure 5: Schematic representation of the establishment of central authority in Rwanda. Subfigure (a) represents the situation in Rwanda before the establishment of the Nyiginya kingdom. Individual families form lineages and clans, which operate under internal norms of sharing and tribute. There is no political authority. In subfigure (b) conquest establishes the army commander as the local political authority, and he uses his monopoly of violence as well as transfers of cattle to start coopting the lineage level norms into a nascent bureaucracy. In subfigure (c) the Nyigina bureaucracy has been established, and taxes flow through the bureaucracy to the Court. Not that among the local population the same norms are still in operation, the bureaucracy has been superimposed. See section 2 for the sources and history behind this figure.

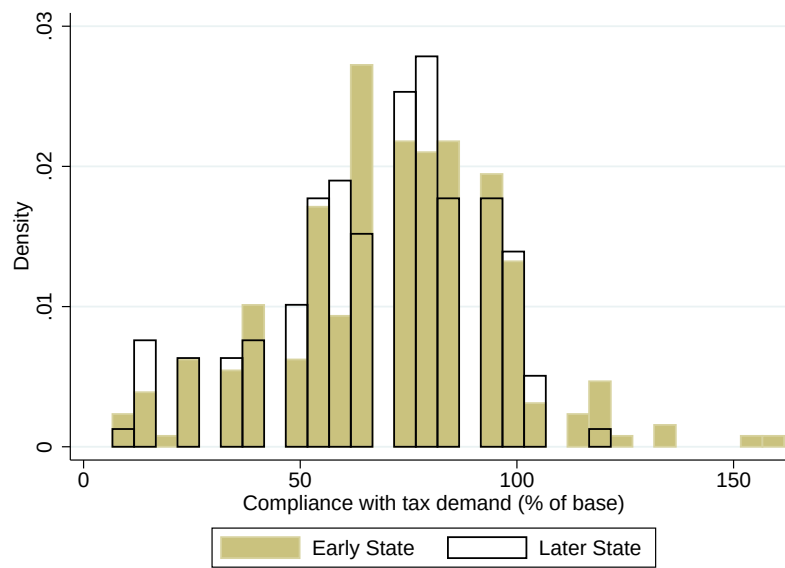


Figure 6: Distributions of voluntary tax contributions on the West side of the Akanyaru river (Early State) and the East side.

Table 1: The Nyiginya kingdom and rule following

<i>Dependent variable:</i>	Compliance with tax demand (% of base)				
	(1)	(2)	(3)	(4)	(5)
Early State	4.416*	8.838**	9.424**	9.110**	9.832**
<i>Robust s.e.</i>	(2.609)	(4.492)	(4.424)	(4.513)	(4.457)
<i>Permutation test p-value</i>	0.095	0.053	0.029	0.028	0.023
Mean dependent variable	71.34	71.34	71.34	71.34	71.34
Sd dependent variable	27.30	27.30	27.30	27.30	27.30
Demographic controls	N	N	Y	N	Y
Distance to Kigali	N	N	N	Y	Y
<i>f(location)</i>	None	Latitude & longitude	Latitude & longitude	Latitude & longitude	Latitude & longitude
Observations	416	416	414	416	414
R^2	0.006	0.013	0.036	0.014	0.038

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Compliance with tax demand (% of base) is the tax paid by an individual in the random taxation game, divided by the theoretical tax base, 1500 Rwandan Francs. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 2: Specification checks

<i>Dependent variable:</i>		Compliance with tax demand (% of base)				
		(1)	(2)	(3)	(4)	(5)
<i>Panel I: Alternative versions f(location)</i>						
Panel IA: Linear spline in distance to Akanyaru						
Early State		4.416*	9.692**	9.495**	9.221**	9.037**
	<i>Robust s.e.</i>	(2.609)	(4.365)	(4.343)	(4.308)	(4.280)
	<i>Permutation test p-value</i>	0.088	0.025	0.0278	0.0266	0.033
Panel IB: Linear spline, latitude & longitude						
Early State		4.416*	10.33**	10.70**	11.34**	11.03**
	<i>Robust s.e.</i>	(2.609)	(4.606)	(4.561)	(4.762)	(4.667)
	<i>Permutation test p-value</i>	0.0948	0.0242	0.0174	0.0198	0.02
<i>Panel II: Placebo</i>						
Panel IIA: Move river 1 KM						
Placebo Early State		1.561	3.706	2.583	4.878	3.912
	<i>Robust s.e.</i>	(2.660)	(4.428)	(4.245)	(4.539)	(4.401)
	<i>Permutation test p-value</i>	1	1	1	1	1
Panel IIB: Move river 5 KM						
Placebo Early State		1.544	6.896	6.727	6.711	6.451
	<i>Robust s.e.</i>	(3.095)	(6.098)	(6.012)	(6.208)	(6.113)
	<i>Permutation test p-value</i>	1	1	1	1	1
Demographic controls		N	N	Y	N	Y
Distance to Kigali		N	N	N	Y	Y
Observations		416	416	414	416	414

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Compliance with tax demand (% of base) is the tax paid by an individual in the random taxation game, divided by the theoretical tax base, 1500 Rwandan Francs. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 3: Geography and pre-existing settlement differences: balance

<i>Dependent variable:</i>	Terrain elevation	Banana suitability	Archeological sites
	(1)	(2)	(3)
Within 10 KM of Akanyaru			
Early State	36.08*** (4.895)	-0.693 (0.872)	0.00596 (0.00904)
Observations	391	391	391
R^2	0.126	0.002	0.001
Within 5 KM of Akanyaru			
Early State	15.77** (6.792)	0.114 (1.113)	
Observations	164	164	
R^2	0.033	0.000	
Within 3 KM of Akanyaru			
Early State	4.775 (8.720)	0.379 (1.307)	
Observations	82	82	
R^2	0.004	0.001	
Experimental sample			
Early State	32.88 (20.37)	-3.565 (3.519)	
Observations	21	21	
R^2	0.119	0.051	

Notes: All regressions are estimated using OLS. The unit of observation is a village. Rows restrict the sample to lie within modern district bordering the Akanyaru river, and to successively narrower bands around it. Terrain elevation is the elevation in meters under the centroid of the village the respondent lives in. Banana suitability is the geographical suitability for growing bananas in the respondent's village. Archeological sites is the number of archaeological sites indicating prehistorical human settlement from Prioul and Sirven (1981) and van Noten (1983). Early State is an indicator equal to one if a village is situated to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 4: Migration and altruism: Balance

<i>Dependent variable:</i>	Immigrant	Immigrant from outside sample area	Contributed to Agaciro as a person	Contributed to Agaciro as a community	Amount shared with sector employee	Amount shared with national government employee
	(1)	(2)	(3)	(4)	(5)	(6)
Early State	-0.0486 (0.0503)	0.0534 (0.0439)	-0.0466 (0.0372)	0.0240 (0.0356)	6.592 (16.58)	-31.60 (21.81)
Observations	420	422	420	420	422	422
R^2	0.002	0.004	0.004	0.001	0.000	0.006

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Immigrant is an indicator variable equal to one if the respondent immigrated into the sample village. Immigrant from outside area is an indicator variable equal to one if the respondent immigrated into the sample village from outside the sample districts Bugusera, Kamonyi, Ruhango and Nyanza. Contributed to Agaciro as a person is an indicator variable equal to one if the individual reported to have made a personal contribution to the Agaciro wealth fund in the year preceding the fall 2014. Contributed to Agaciro as a community is an indicator variable equal to one if the individual reported to have made a communal contribution to the Agaciro wealth fund in the year preceding fall 2014. Amount shared with sector employee is the amount shared (out of RWF 1500) with an anonymous employee of the local administrative sector in which the sample village was located in a dictator game. Amount shared with national government employee is the amount shared (out of RWF 1500) with an anonymous employee of the national government in a dictator game. Early State is an indicator equal to one if a village is situated to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 5: Geography, pre-existing settlement differences, migration and altruism

Dependent variable:		Compliance with tax demand (% of base)							
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Early State		0.170**	0.190**	0.171**	0.175**	0.178**	0.179**	0.217***	0.178**
	<i>Robust s.e.</i>	(0.0802)	(0.0946)	(0.0802)	(0.0798)	(0.0812)	(0.0795)	(0.0783)	(0.0795)
	<i>Permutation test p-value</i>	0.015	0.043	0.021	0.018	0.016	0.017	0.003	0.018
Geography									
Terrain elevation		-0.0236							
		(0.0509)							
Banana suitability			0.0197						
			(0.0626)						
Migration									
Immigrant				-0.0321					
				(0.0504)					
Immigrant from outside sample area					0.00439				
					(0.0457)				
Altruism									
Contributed to Agaciro as a person						0.00994			
						(0.0426)			
Contributed to Agaciro as a community							-0.0614		
							(0.0439)		
Amount shared with sector employee								0.111**	
								(0.0450)	
Amount shared with national government employee									0.0395
									(0.0479)
Demographic controls		Y	Y	Y	Y	Y	Y	Y	Y
f(location)		Y	Y	Y	Y	Y	Y	Y	Y
Observations		414	414	414	414	414	414	414	414
R ²		0.039	0.039	0.039	0.038	0.038	0.042	0.049	0.040

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. All coefficients are standardized. Terrain elevation is the elevation in meters under the centroid of the village the respondent lives in. Banana suitability is the geographical suitability for growing bananas in the respondent's village. Archaeological sites is the number of archaeological sites indicating prehistorical human settlement from Prioul and Sirven (1981) and van Noten (1983). Immigrant is an indicator variable equal to one if the respondent immigrated into the sample village. Immigrant from outside area is an indicator variable equal to one if the respondent immigrated into the sample village from outside the sample districts Bugusera, Kamonyi, Ruhango and Nyanza. Contributed to Agaciro as a person is an indicator variable equal to one if the individual reported to have made a personal contribution to the Agaciro wealth fund in the year preceding fall 2014. Contributed to Agaciro as a community is an indicator variable equal to one if the individual reported to have made a communal contribution to the Agaciro wealth fund in the year preceding the fall 2014. Amount shared with sector employee is the amount shared (out of RWF 1500) with an anonymous employee of the local administrative sector in which the sample village was located in a dictator game. Amount shared with national government employee is the amount shared (out of RWF 1500) with an anonymous employee of the national government in a dictator game. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. f(location) is a linear function of latitude and longitude. Distance to Kigali is included as a covariate in all regressions. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 6: Attitudes towards obedience and taxation

<i>Dependent variable:</i>	Does paying taxes benefit the country (Y/N)	Does paying taxes you individually (Y/N)	Essential to Democracy: Obedience to rulers (1-10)	Justifiable: Cheating on taxes (1-10)
	(1)	(2)	(3)	(4)
Early State	0.00166	0.00453	0.730***	-0.223**
<i>Robust s.e.</i>	(0.0190)	(0.0347)	(0.199)	(0.103)
<i>Permutation test p-value</i>	0.855	0.939		
Sample	Experimental	Experimental	WVS	WVS
Individual Controls	Y	Y	Y	Y
f(location)	Y	Y	N	N
Literacy dummy	N	N	Y	Y
Province fixed effects	N	N	Y	Y
Observations	404	404	1203	1203
R^2	0.002	0.001	0.024	0.043

Notes: All regressions are estimated using OLS. The unit of observation in columns (1) and (2) is an individual respondent in the fieldwork sample. The unit of observation in columns (3) and (4) is the individual respondent to the World Values Survey 2012 Rwanda round. In columns (1) and (2), Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. In columns (3) and (4), Early State is an indicator variable equal to one if a district inhabited by respondent r was incorporated into the Nyiginya kingdom before 1799. Parentheses give heteroskedasticity robust standard errors. Individual controls include age, age squared and a dummy for gender. Province fixed effects indicate fixed effects at the level of the modern administrative province. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. f(location) is a linear function of latitude and longitude. In columns (1) and (2), distance to Kigali is included as a covariate in all regressions. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 7: Local state presence and accountability: balance

<i>Dependent variable:</i>	Local gov- ernment office dummy	Police office dummy	Distance to nearest local gov- ernment office	Distance to nearest police office	Corruption	Calls to reach local gov- ernment
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel I: Historical sample</i>						
Early State	-0.00766 (0.00796)	0.0116 (0.00936)	304.6 (370.3)	-4271.2*** (1327.0)	1.603* (0.936)	
Observations	880	880	880	880	880	
R^2	0.000	0.003	0.073	0.333	0.256	
<i>Panel II: Experimental sample</i>						
Early State	-0.160 (0.293)	0.200 (0.187)	451.6 (538.6)	-3594.2** (1701.7)	1.537 (1.085)	-0.404 (1.100)
Observations	21	21	21	21	21	21
R^2	0.101	0.176	0.129	0.446	0.249	0.007
Control for population	Y	Y	Y	Y	Y	N
Control for village area	Y	Y	Y	Y	Y	N

Notes: All regressions are estimated using OLS. The unit of observation is a village. Rows restrict the sample to lie within precolonial districts bordering the Akanyaru river (Bugusera and Mayaga), and to sample villages. Local government office dummy is an indicator variable equal to one if a sample village has a sector office (column (1)) or a cell office (column (2)) within its boundaries. Police office dummy is an indicator variable equal to one if a sample village has a police station within its boundaries. Distance to nearest local government office is the distance in meters to the nearest sector office (Panel I) or cell office (Panel II). Distance to nearest police station is the distance in meters to the nearest police office. Corruption is the number of corruption cases recorded by the Rwandan ombudsman involving village government in 2010-2013. Calls to reach local government is the number of business-hour phone calls it takes to reach the sector and cell secretaries in December 2015. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. Control for population is the total population in a village in 2002. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 8: Local state presence and accountability

<i>Dependent variable:</i>		Compliance with tax demand (% of base)					
		(1)	(2)	(3)	(4)	(5)	(6)
Early State		0.173**	0.231***	0.169**	0.182**	0.177**	0.178**
	<i>Robust s.e.</i>	(0.0791)	(0.0812)	(0.0815)	(0.0789)	(0.0784)	(0.0796)
	<i>Permutation test p-value</i>	0.017	0.004	0.024	0.006	0.016	0.015
Local government presence							
Local government office dummy		(0.0509)					
Police office dummy		-0.130* (0.0664)					
Distance to local government office		0.0178 (0.0462)					
Distance to police office		0.0321 (0.0687)					
Local accountability							
Corruption		-0.00535 (0.0871)					
Calls to reach local government		0.0333 (0.0608)					
Demographic controls		Y	Y	Y	Y	Y	Y
f(location)		Y	Y	Y	Y	Y	Y
Observations		414	414	414	414	414	414
<i>R</i> ²		0.039	0.047	0.039	0.039	0.038	0.039

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. All coefficients are standardized. Local government office dummy is an indicator variable equal to one if a sample village has a sector office (column (1)) or a cell office (column (2)) within its boundaries. Police office dummy is an indicator variable equal to one if a sample village has a police station within its boundaries. Distance to nearest local government office is the distance in meters to the nearest sector office (Panel I) or cell office (Panel II). Distance to nearest police station is the distance in meters to the nearest police office. Corruption is the number of corruption cases recorded by the Rwandan ombudsman involving village government in 2010-2013. Calls to reach local government is the number of business-hour phone calls it takes to reach the sector and cell secretaries in December 2015. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. f(location) is a linear function of latitude and longitude. Distance to Kigali is included as a covariate in all regressions. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 9: Civil society and socio-economic advancement: balance

<i>Dependent variable:</i>	Social capital	Monthly church attendance	Eq. daily income (RWF)	Education in years
	(1)	(2)	(3)	(4)
Early State	0.0404 (0.124)	-0.0409 (0.558)	-273.9 (639.3)	1.340*** (0.316)
Observations	420	420	420	420
R^2	0.000	0.000	0.001	0.159

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Social capital is the number of civil society organizations a respondent is a member of. Monthly church attendance is the number of times the respondent went to church in the last full month preceding the survey date, September or October 2014. Eq. daily income (RWF) is the equivalent daily income earned by a respondent. Education in years is the total number of years a respondent has received fulltime education. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 10: Civil Society and socio-economic advancement

<i>Dependent variable:</i>	Compliance with tax demand (% of base)			
	(1)	(2)	(3)	(4)
Early State	0.173**	0.167**	0.175**	0.174**
<i>Robust s.e.</i>	(0.0791)	(0.0808)	(0.0795)	(0.0792)
<i>Permutation test p-value</i>	0.018	0.022	0.018	0.018
Social Capital	-0.101**			
	(0.0455)			
Monthly church attendance		-0.0509		
		(0.0491)		
Eq. daily income (RWF)			-0.00295	
			(0.0138)	
Education in years				-0.0620
				(0.0451)
Demographic controls	Y	Y	Y	Y
f(location)	Y	Y	Y	Y
Observations	414	414	414	414
R^2	0.048	0.041	0.038	0.042

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. All coefficients are standardized. Social capital is the number of civil society organizations a respondent is a member of. Monthly church attendance is the number of times the respondent went to church in the last full month preceding the survey date, September or October 2014. Eq. daily income (RWF) is the equivalent daily income earned by a respondent. Education in years is the total number of years a respondent has received fulltime education. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. f(location) is a linear function of latitude and longitude. Distance to Kigali is included as a covariate in all regressions. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 11: The colonial state and the 1994 genocide: balance

<i>Dependent variable:</i>	Soil suitability for coffee	Number of coffee pulping centers 1960	Prosecutions for 1994 genocide violence
	(1)	(2)	(3)
<i>Panel I: Historical sample</i>			
Early State	9.231*** (0.432)	0.0516*** (0.0131)	2872.3*** (472.9)
Observations	880	880	23
R^2	0.284	0.032	0.672
<i>Panel II: Experimental sample</i>			
Early State	4.416 (2.994)	0.154 (0.105)	432.7* (248.0)
Observations	21	21	21
R^2	0.089	0.065	0.109

Notes: All regressions are estimated using OLS. The unit of observation is a village. Rows restrict the sample to lie within precolonial districts bordering the Akanyaru river (Bugusera and Mayaga), and to sample villages. Soil suitability for coffee is the geographical suitability of a village for growing coffee. Number of coffee pulping centers 1960 is the number of coffee pulping centers active in 1960. Prosecutions for 1994 genocide violence is the number of individuals prosecuted for participating in the 1994 genocide as part of the Gacaca court proceedings. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. Parentheses give heteroskedasticity robust standard errors. Control for population is the total population in a village in 2002. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 12: The colonial state and the 1994 genocide

<i>Dependent variable:</i>	Compliance with tax demand (% of base)		
	(1)	(2)	(3)
Early State	0.203** (0.0889)	0.173** (0.0813)	0.254*** (0.0821)
<i>Robust s.e.</i>			
<i>Permutation test p-value</i>	0.034	0.05	0.003
Soil suitability for coffee	0.0700 (0.0804)		
Number of coffee pulping centers 1960		0.0110 (0.0482)	
Number individuals prosecuted for genocide crimes			0.286*** (0.0815)
Demographic controls	Y	Y	Y
f(location)	Y	Y	Y
Observations	414	414	414
R^2	0.040	0.040	0.067

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. All coefficients are standardized. Soil suitability for coffee is the geographical suitability of a village for growing coffee. Number of coffee pulping centers 1960 is the number of coffee pulping centers active in 1960. Prosecutions for 1994 genocide violence is the number of individuals prosecuted for participating in the 1994 genocide as part of the Gacaca court proceedings. Early State is an indicator equal to one if a respondent lived to the East of the Akanyaru river in October 2014. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the observed early state dummy across 5000 permutations of the early state dummy. Demographic controls include age, age squared and a dummy for gender. f(location) is a linear function of latitude and longitude. Distance to Kigali is included as a covariate in all regressions. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Appendix to:
The Persistence of State Capacity in Rwanda

1 Further results

Table A1: Summary Statistics

	N	Mean	Standard Deviation	Min	Max
Unit of observation: village. Sample: historical districts					
Early State	880	.3409091	.4742844	0	1
Distance to Kigali	921	34.34198	10.93117	11.17928	60.04089
Terrain elevation	921	1434.351	63.89286	1310	1664
Banana suitability	921	37.09403	10.9002	0	48.59
Archeological finds	921	.009772	.1184687	0	2
Local government office dummy	921	.0238871	.1527803	0	1
Police office dummy	921	.0054289	.0735206	0	1
Distance to local government office	921	3667.205	1776.143	88.28998	9681.598
Distance to nearest police office	921	8043.614	4051.997	322.37	20068.87
Corruption	921	.6178067	1.052672	0	4
Soil suitability for coffee	921	34.97889	8.216898	7.08	48.95
Number of coffee pulping centers 1960	921	.0184582	.1346744	0	1
Number of individuals prosecuted for genocide crimes	23	4033.87	1705.714	1473	8071
Unit of observation: village. Sample: villages included in fieldwork					
Early State	21	.6190476	.4976134	0	1
Distance to Kigali	21	29.82938	12.70635	7.520863	52.05747
Terrain elevation	21	1446.476	47.42217	1360	1540
Banana suitability	21	39.76571	7.847312	25.46	48.59
Archeological finds	21	0	0	0	0
Local government office dummy	21	.3333333	.4830459	0	1
Police office dummy	21	.047619	.2182179	0	1
Distance to local government office	21	1066.554	871.0438	0	2738.301
Distance to nearest police office	21	7602.264	4814.07	891.8403	17859.45
Corruption	21	.8571429	1.49284	0	6
Calls to reach local government	21	4	2.32379	2	10
Soil suitability for coffee	21	34.67857	7.351012	20.66	44.94
Number of coffee pulping centers 1960	21	.0952381	.3007926	0	1
Number of individuals prosecuted for genocide crimes	21	1515	652.277	750	3024
Unit of observation: individual. Sample: individuals included in fieldwork					
Compliance with tax demand (% of base)	416	71.34615	27.29979	6.666667	300
Male dummy	422	.450237	.498108	0	1
Age	420	39.9119	13.53734	18	94
Immigrant	420	.4761905	.5000284	0	1
Immigrant from outside sample area	422	.7535545	.4314525	0	1
Contributed to Agaciro as a person	420	.152381	.3598184	0	1
Contributed to Agaciro as a community	420	.152381	.3598184	0	1
Amount shared with sector employee	422	56.87204	166.243	0	1000
Amount shared with national government employee	422	82.93839	204.4467	0	1500
Social capital	420	2.2	1.248579	0	5
Monthly church attendance	420	5.980952	5.540445	0	38
Equivalent daily income (RWF)	420	1261.986	5116.758	0	100000
Education in years	420	5.454762	3.462772	0	14

Data sources are given in the main text.

Table A2: Evolution of Tax Rates in Rwanda up to decolonization

Year	Tax Base	Rate	Comment	Reference
1914		1 Rupee	The first German head tax	p. 160
1917	Labor	2 out of every 5 days	Reduction of <i>ubureetwa</i> labor prestations	p. 48
1917	Labor		Introduction of <i>akazi</i> forced labor for Belgian colonial authorities	p. 41
1917		5 francs	Introduction of head tax	p. 54
1920	Cattle	10 francs	Flat tax on owners of 5 or more cattle	p. 55
1921	Cattle	7.50 francs	Flat tax on owners of 10 or more cattle	p. 55
1923		3.5 francs	Reduction of head tax	p. 54
1924		15 francs	Head tax - Europeans only	p. 54
1924		5 francs	Head tax increase for Rwandans living close to Europeans settlements	p. 55
1924	Labor	42 days a year	Reduction of labor prestations for the king	p. 70
1925			Reduction of various customary taxes	p. 70
1925	Labor	15 days per year	Reduction of labor prestations for chiefs and subchiefs	p. 71
1926		5 francs	Head tax increased for all Rwandans	p. 55
1927		7.50 francs	Head tax increased	p. 55
1927	Labor	1 out of 7 days	Reduction of <i>ubureetwa</i> labor prestations	p. 88
1928	Cattle	1 francs	Unclear if levied per head of cattle or as flat tax	p. 55
1928	Labor	48 days per year	Reduction of labor prestations for community	p. 71
1928	Labor	5 individuals per community	Reduction of right of chiefs to requisition full time labor for personal use	p. 71
1929	Polygamy		Polygamy tax extended to entire population, not just Kiswahili merchants	p. 85
1931			Conversion of several labor prestations into money payments	p. 156

Data for 1914 from Louis (1963). All other data from Dorsey (1989).

2 Further background on taxation in Rwanda

2.1 German and Belgian colonial occupation and the evolution of fiscal capacity

Oscar Baumann was the first European to visit Rwandan in September 1892 (Baumann, 1894) even though the country was granted to Germany at the Conference of Berlin in 1885.¹ Subsequent visits of Lieutenant von Goetzen in 1894 (Von Goetzen, 1899) and von Ramsay to the court of the King resulted in the formal submission of the king to the German colonial authorities.² The Germans subsequently affirmed the border with the Belgian Congo (Von Bethe, 1899) and with Burundi (Von Parish, 1904). The Germans do not raise any taxes around this time due to an extended famine and insufficient control over the King and his bureaucracy. In 1906, 1907, 1909, 1910 and 1911, several outlying provinces refused to pay traditional prestations or provide labor services to the king, whose authority they perceive to be weakened by the Germans (see the case study references in section 2.4). The German colonial army intervened in each instance to restore the King's authority. Around this same time, Richard Kandt and Jan Czekanowski undertake the first ethnographic surveys in Rwanda and start codifying the court histories from which the history described in the previous subsections has been reconstructed (Kandt, 1905; Czekanowski, 1917).

The Germans did not have the capacity to raise any taxes until the introduction of a fixed head tax in 1914, which was raised in proximity to German settlements. After several struggles around the Congo-Rwanda border in 1914-1916, the Belgians invade from Belgian Congo and annex Rwanda as a Belgian colony in 1916. The Belgians raise their first head tax in 1917, at a rate of 2,50 Belgians Francs, which was about three day's wages, for those employed in the formal sector. In 1918 cattle owners in two provinces pay a levy of 5 Belgian Francs and in 1919 the first comprehensive head tax is raised through the indigeneous chiefs. The Belgians introduced money by requiring that taxes in kind were instead paid in Belgian francs. Raising taxes was done through the Nyiginya bureaucracy, although the Belgians consolidated the different tax chiefs into one position, the *akazi* chief.³ They also reduced the fractions that local chiefs could take from one third to five percent (with another five percent going to the King). Every chief was

¹For an overview of the German occupation of Rwanda and the negotiations at the conference between Belgium, England and Germany over Rwanda, see Louis (1963). Since no one had made a map of Rwanda before the conference, the initial boundaries of Rwanda were drawn as a straight line through the heart of the country. When the Germans found out about the Nyiginya kingdom they renegotiated the boundaries between Uganda, Rwanda and the Democratic Republic of the Congo to coincide roughly with the boundaries of the Nyiginya kingdom (Louis, 1963). These negotiations were finally concluded in 1910. See Botte (1985a) and Botte (1985b) for an exact chronology.

²The annexation of kingdom coincided with a dynastic succession struggle and a large rinderpest epidemic. These factors and the fact that a Rwandan army had been decimated by Germans guns in 1894 and by Belgian guns near the DRC in 1896, reduced the capacity of the Nyiginya kingdom to resist colonization (Louis, 1963).

³In 1929 there were 241 Europeans in Rwanda, of which 58 were administrators and 106 were missionaries (Dorsey, 1989, p. 89).

assigned a secretary to help with tax administration, and these secretaries were rotated annually. All tax collection had to be documented through receipts, and monthly collections were delivered to the King's court with appropriate receipts. These innovations primarily reduced labor taxes since individual Rwandans could now produce receipts and were therefore less susceptible to arbitrary demands by their chiefs and patrons (Dorsey, 1989).

2.2 Taxation after independence

In 1959 the Tutsi king was overthrown, and in 1963 Rwanda declared independence as a Hutu majority-led republic. Government revenue was primarily raised through trade taxes. Verwimp (2013) computes that the average tax rate for a Rwandan farmer was between fifteen and twenty one percent in 1985, including indirect consumption taxes. This rate also includes the implicit taxes that resulted from the fact that the government paid a much lower producer price for coffee, the dominant export crop, than the world market price. In 1990, the first year for which the World Bank reports data, tax revenue as a percentage of GDP is eight and a half percent.

Today, Rwanda raises personal income taxes, corporate income taxes and a variety of other taxes, including VAT. Increasingly, the Rwandan government has introduced modern tax enforcement techniques, such as third-party reporting and electronic tax return filing (Moore, 2014). These innovations have increased fiscal capacity. In 2013, the latest year for which the World Bank has data, Rwanda raised thirteen percent of GDP in taxes. Since the Rwandan Patriotic Front (RPF), the ruling party, conquered Kigali to end the 1994 genocide, the legitimacy of the government has however been problematic. The Rwandan Patriotic Front is led by the children of Tutsi refugees who fled Rwanda in 1959. The party's strong hold on public office, its rigging of elections, and its repression of political opposition has estranged the government from the Hutu majority, and there is evidence that Rwandan Tutsi see the RPF as Ugandan Tutsi, not representing their interests (Reyntjens, 2013).

2.3 Computing precolonial tax rates

This section follows Newbury (1988) and the overview of precolonial taxes rates in Figure A2 in an effort to compute precolonial tax rates. Catherine Newbury (Newbury, 1988, p. 173) shows that the Belgians taxed several sources of income as well as labor and consumption. The Belgians levied 64 francs per year head tax, 43 polygamy tax, 19 franc cattle tax, in addition to payments for prestations in kind (5 francs).

These rates differed per province, and I have taken the modal rates for this example. Relative to the precolonial period, the Belgian colonial government added a new head tax, which is included in this calculation and abolished several taxes on labor, which are not. Nevertheless, a large part of precolonial and colonial taxes were labor taxes, in the form of corvée in the precolonial kingdom (portage, maintenance of the royal capital and cultivation) or labor prestations under colonialism (road building and crop cultivation), which are not included in this calculation. The total tax burden for an average Rwandan based on the rates in this paragraph is 131 franc. Assuming a 300 day working year, and an average unskilled wage of about one franc per day, the average tax rate is 44%, which is the figure given in the main text.

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Chapter 3:

State building in the lab: Preliminary Evidence

1 Introduction

States are central to development, and state building is therefore important for prosperity (Besley and Persson, 2011). Recent experimental research on states and their role in development has focused on understanding incentives and management public sector employees (Finan et al., 2015), the origins of the state (Sanchez de la Sierra, 2015) and the long-run effects of historical states (Lowes et al. (2014) and chapters 1 and 2 of this thesis). Less emphasis has been placed on experimentally testing strategies for incentivizing citizens to align their objectives with those of the state. In this paper, I test two strategies, persuasion and enforcement, regularly employed by modern states in a stylized lab-in-the-field experiment. I find consistently positive effects of enforcement on both the amount contribution to the public good as well as on the probability of contribution. I find positive effects of persuasion on the probability of contributing.

States do many things. States enforce laws, establish and maintain a monopoly of violence internally, and provide external security. They also ‘socialize’, through for instance education (Cantoni et al., 2014) and public awareness campaigns. More broadly, states build ‘civic capital’ (Guiso et al., 2010). I compare a treatment that threatens a monetary penalty for non-socially optimal behavior in a standard repeated public goods game to capture the enforcement aspect of state building (see Ledyard (1995) and Chaudhuri (2011) for reviews of public goods games). I read a message taken from a press release by the Rwandan government that reminds Rwandans that they have a nation building duty to capture the ‘soft’ aspect of state building. Importantly, the enforcement treatment changes expected payoffs in the game, whereas persuasion doesn’t. I have implemented this game with 320 participants in Southern Rwanda in 2014.

These treatments are, inherently, a simplified representation of the operation of the modern state. However, they do correspond broadly to the modern ‘nation state’, which both aims to have a monopoly of violence in society (Weber, 1994) and to foster individual identification with the goals of the state, broadly referred to as nation building (see f.i. Hobsbawm and Ranger (2012)). Furthermore, the enforcement treatment is in line with a large set of punishment treatments that have been shown to be successful at sustaining cooperation (Fehr and Gächter, 2000). The enforcement treatment moves beyond these punishments by letting the punishment be decided outside the game (mimicking the role of the government) rather than by fellow participants. The persuasion treatment is in line with previous contributions looking at the role of ‘suasion’ treatments more broadly (see the references in Chaudhuri (2011)). The persuasion

treatment explicitly associates the treatment with the government by letting the suasion take the form of a government press release.

I find that enforcement affects both the intensive and the extensive margin of contributions. Persuasion affects only the extensive margin. Individuals are persuaded to contribute to the public good if they otherwise wouldn't have, but they are not persuaded to give more, on average, than participants in the baseline group do. This suggests that persuasion is effective for activating citizens, but not incentivizing them to make above average contributions. Enforcement decreases the probability of non-contribution and increases the amount contributed.

I then consider heterogeneous effects by the proximity to Rwanda's capital, Kigali and by the antiquity of the local state. I find that enforcement is effective in places closer to the capital, and in places with shorter presence of centralized government. There are no heterogeneous treatment effects of persuasion by the distance to Kigali. There are interesting heterogeneous effects of persuasion by the presence of the historical state, however. In places with longer state presence, there is a negative treatment effect, whereas in places with a shorter state presence, there is a positive treatment effect. I review several explanations that are consistent with this results. Finally, participants played the public goods game anonymously and there was opportunity for participants to conceal money throughout the experiment. Although stealing happens throughout the experiment, there are no treatment effects on the amount stolen or the probability of theft occurring.

The results in this chapter are preliminary and understanding state building at an individual level requires more results from several samples and identification strategies. However, this paper does suggest that state building strategies can fruitfully be evaluated within an experimental framework. The next section describes the background to the experiment, sampling and the experimental design. Section three discusses identification. Section four presents the main treatment effects of persuasion and enforcement. Section five presents heterogeneous effects and section six concludes.

2 Background and experimental design

This section provides background to the sampling frame and the design of repeated public goods game implemented in this paper. The key difference in the design of the public goods game in this paper and other implementations of public goods game is the framing. In this paper, contributions to the public

goods games are framed as tax contributions towards a community project.

2.1 Sampling

I sampled individuals in villages South of Rwanda's capital, Kigali, in the fall of 2014. I stratified all villages by their modern district (see Figure 1a), randomly selecting villages from an exhaustive list of villages from the Rwandan bureau of statistics. I further stratified villages by their location on either side of a boundary of Rwanda's precolonial kingdom (see Figure 1b, and chapter 2 of this thesis). I then visited each villages and obtained lists of inhabitants from the village leader. Each village leader in our sampled village had a list of the inhabitants of his villages. I then randomly sampled individuals and visited their home to inform them that they had been selected to participate in a research project organized by the University of Oxford. If willing to participate and over 18 years of age, participants signed a standard informed consent form, were informed of the money they stood to make,¹ and were invited to participate in the actual fieldwork, usually the following day. In total, I have 320 participants in 17 villages.

2.2 Experimental Data

Before the start of the fieldwork, I paid the village leader to find a lab-in-the-field for the day. In most cases this was a side room attached to the local bar. Preference would be given to locations with several separate rooms allowing for simultaneous play. After an entry survey, participants were given a sitting fee equal to RWF1500, roughly equal to two day's unskilled wages.² The full experimental protocol is in the online Appendix.

After listening to a general introduction to the public goods game, participants were then assigned to four groups of five individuals. Individuals do not know which group they are in, they just know they are assigned to groups. The public goods game then proceeds as follows:

1. A participant will be called into the closed 'lab'. Here the participants receives full instructions.
2. An endowment of 2000 RWF is provided in bank notes of RWF 500. The enumerator steps out of the lab. The participant is now by him/herself.
3. The individual contributes to the public goods (see below for the exact terminology).

¹I the following information: "Everybody today will make some money. You will make at least RWF 1500, but you can make substantially more by participating in these games."

²After receiving the sitting fee, individuals participated in a standard dictator game as well as an experiment measuring rule following. Both these experiments are described in detail in chapter 2 of this dissertation.

4. The individual is escorted out of the lab to a different waiting area.
5. Steps 1-4 are repeated for every individual.
6. Upon commencement of the second round, the participant is again provided with 2000 RWF and an enumerator informs the participant about his earnings in the previous round.
7. At the end of five rounds, the participants is informed of his earnings in the game, which is a random draw of the earnings in one of the five rounds.
8. The game then ends.

Crucially, the individual contributions in every round are multiplied by 1.5 and split equally. This multiplication introduces a coordination problem: if every participants in a group of five contributes, everyone profits. However, it is individually rational to contribute zero. This public goods game is a standard repeated public goods game from the literature Ledyard (1995). Relative to the literature benchmark, I introduce two variations:

1. In the experimental instructions, I phrase the contribution to the public goods game as a 'tax contribution'. By framing the contribution to the public pool as a tax contribution, I explicitly associate this game with the government. Voluntary tax contributions towards the public good are common in Rwanda. The Agaciro wealth fund, which is a sovereign wealth fund directed at meeting Rwanda's development goals for 2020 gets regular private donations. In my sample, 24% of participants self-reports to have donated to this fund.
2. I introduce two treatments, a persuasion design and an enforcement design which I'll outline below.

2.3 Treatments

Treatments are randomized at the village level. Villages are randomized to be either in the baseline category, just receiving experimental instructions, or in either one of two treatment categories. The first treatment is a persuasion design. Before a participant starts the first round of play, I read the following message:

I would like to read the following message to you from the Rwandan revenue authority. Please listen carefully to this message from the Rwandan revenue authority: "Remember, we all have a responsibility to contribute to nation building and, meeting our tax obligations in time is one way of fulfilling that role."

This message is taken from a press release by the Rwandan revenue authority, Rwanda's tax collection authority. Similar designs have been implemented by Blair (2015) in Liberia. This treatment can be interpreted as measuring the legitimacy of the authority of the government in weakly institutionalized environments (Blair, 2015). Rwanda is not weakly institutionalized, however, and Rwandans regularly pay taxes. Furthermore, the government actively attempts to boost voluntary compliance with government objectives (Reyntjens, 2013). I interpret this treatment as the effect of a government appeal to an individual's civic duty, or a persuasion treatment.

The second treatment is an enforcement treatment. Before a participant starts the first round of play, I read the following message:

In this game, there is a chance that what you do will be checked. Out of every 10 people playing this game, one person will be checked. This person is selected randomly. It could be you, but it could also be somebody else. When you hand in your envelope, it will be opened by somebody else in the experiment. He or she will check what you put in the envelopes. If you contributed everything to the project, you will keep your own money and the profits from the project. If you did not contribute everything to the project, you will lose all your money in this part of the experiment. Just to be clear, out of every 10 people, one person will be checked. You might be checked, but it is also possible that you are not checked.

In the rest of this paper, I test the effects of these treatments, relative to the baseline of just receiving experimental instructions. I also test for heterogeneous effects by the distance to Rwanda's current capital city, Kigali and by the duration of the presence of central authority.

2.4 Dependent Variables

I consider four outcome variables in the empirical estimations in the paper. First, the average contribution to the public good, averaged over all five rounds of participation, or the intensive margin of contribution. Participants contributed on average 1108 RWF, or about half their endowment (control group mean = 1066). Second, an indicator variable equal to one if the participant did not contribute anything in any round, or the extensive margin of contribution. 25 out of 320 participants never contributed anything.

In addition, I measure stealing. At the end of every round of play, the participant handed envelopes back to the enumerator with his/her contribution to the public good and the amount left over of his/her endowment. The amounts of money in these envelopes has to add up to the endowment of 2000RWF. If not, then the participant stole some money during the fieldwork (recall that the participants are in the lab by themselves while making decisions to contribute). On average, an individual stole RWF36 (control group mean = 39.66). One individual stole RWF1400 on average in each round. Finally, an indicator variable is money was missing in one or more of the five rounds. 35 participants ever stole during the experiment.

3 Identification assumption: Balance

Conditional on successful randomization, I identify a causal effect of the persuasion and enforcement on outcome variables of interest. Although the randomization procedures were carried out carefully, it is important that participants balance on observables. Imbalance may still result from sampling variation, but randomization should result in balance on most observables.

Table 1 considers several observables. The first three columns consider age, gender and marital status. The next columns consider education, migratory status, income, church attendance, trust and social capital.³ Panel I considers balance between individuals receiving the persuasion treatment and individuals with either enforcement treatment status or baseline status. Panel II considers balance between individuals receiving the enforcement treatment and individuals with either persuasion treatment status or baseline status. By and large, there is balance on observables across treatment status, except for education, which is lower among individuals receiving the persuasion treatment.⁴

3.1 Estimating framework

The next section studies the effect of the persuasion and enforcement treatments on contribution and stealing in a repeated public goods game. I estimate the following baseline relationship:

$$y_{iv} = \alpha + \beta_P \cdot P_{iv} + \beta_E \cdot E_{iv} + \mathbf{x}'_{iv} \cdot \boldsymbol{\beta}_X + \varepsilon_{iv} \quad (1)$$

³Trust is an indicator variable equal to one if the respondent answered that most people can be trusted in the post-fieldwork survey. Social capital is the number of civil society organizations a respondent is a member of.

⁴In panel II, social capital is marginal higher for treated individuals. Including education and social capital as covariates does not change the results reported in the next section. Results not reported but available upon request.

Here y_{iv} is the dependent variable of interest for individual i in village v . P_{iv} is a dummy equal to one if individual i in village v received the persuasion treatment. E_{iv} is a dummy equal to one if individual i in village v received the enforcement treatment. $\mathbf{X}_{iv}$ includes covariates varying at the individual or village level such as age, gender or the distance to the modern capital, Kigali. Finally, ε_{iv} is an error term. I estimate equation (1) using Ordinary Least Squares.

3.2 Predictions

The persuasion treatment does not alter the expected payoff, for any individual player, in this game. If there is a treatment effect, therefore, it will affect non-material motivations. The Rwandan government has actively pursued such strategies in the past, especially in the context of post-genocide nation building. Blair (2015) finds a positive treatment effect of a similar treatment in Liberia. However, Liberia is very weakly institutionalized compared to Rwanda and his results speak to perceived legitimacy of the government. The treatment effect of persuasion is ambiguous *ex ante*. It may be that the Rwandan government projects authority effectively throughout the country (see Reyntjens (2013) and Purdeková (2011) for evidence on Rwanda's oppressive central government) and a persuasion by the government is therefore ineffective. It may also be that participants do not necessarily associate private public good provision with a service that the government should provide and are, therefore, susceptible to persuasion.

The enforcement treatment does change the expected payoffs in the game. It induces play away from the Nash equilibrium of the public goods game of zero contributions towards the socially optimal contribution of the full endowment. I therefore expect a positive treatment effect of enforcement.

4 Results: Main effects of persuasion and enforcement

This section reports the effects of the persuasion and enforcement treatments on the the amounts contributed and stolen, the intensive margins, and indicators for non-contribution and theft, the extensive margins.

Figure 1 reports histograms, comparing means across baseline and treatments for contributions. Figure 1a reports the extensive margin, and 1b the intensive margin. Persuasion has no effect over baseline contributions along the intensive margin but does reduce non-contribution. Enforcement increases contributions and reduces non-contribution. Figure 2 reports analogous histograms for stealing. Neither

treatment has an effect over baseline along either the intensive or the intensive margin for stealing.

Table 2 assesses the treatment effects of persuasion and enforcement by estimating equation (1). Columns (1) and (2) consider contribution to the public good and columns (3) and (4) consider stealing. I report heteroskedasticity robust standard errors in parentheses. Following (Young, 2016) I report p-values from a permutation test.⁵ Each regression controls for age, age squared, a dummy for gender and geodesic distance to Kigali, Rwanda's capital.

The results are qualitatively similar to the differences in means reported in the histograms. In line with the predictions in section 4, enforcement affects both the intensive and the extensive margin of contributions. Persuasion affects only the extensive margin. Interestingly, the estimated effects of both treatments are close to the control mean, indicating that both treatment reduce non-contribution almost to zero. Individuals are persuaded to contribute to the public good if they otherwise wouldn't have, but they are not persuaded to give more, on average, than participants in the control group do. This suggest that persuasion is effective for activating citizens, but not incentivizing them to make above average contributions. There are no effects on stealing.

5 Results: Heterogeneous effects

Historians have suggested that several modern African countries project little authority outside their capital cities (Herbst, 2000). Michalopoulos and Papaioannou (2014) provide empirical evidence for this idea. They show that the prosperity of ethnic groups further away from the capital is determined by ethnic group level institutions. For ethnic group close to the capital, national level institutions matter, too. In chapter 1 and 2 of this thesis, I furthermore show that the precolonial state in Rwanda, the Nyiginya kingdom, affects contemporary development. In this section, I test whether distance to Kigali and the depth of the historical state in Rwanda are sources of heterogeneous treatment effects.

I split the sample by the median geodesic, 'as the crow flies', distance to Kigali as well as by the location of an experimental village relative to the Akanyaru river. Villages to the East of this river, mapped in Figure 1a, are incorporated into the precolonial Rwandan kingdom around 1700, and villages on the West

⁵I run 5000 replications of equation (1) for each dependent variable and each treatment, for a total of $8 \times 5000 = 40,000$ regressions, randomly re-assigning treatment status. The p-value reported here is the number of permuted regressions that produce a t-statistic that is larger than the estimated t-statistic using the true treatment.

side of the river are incorporated around 1799 (Vansina, 2004). The location and timing of annexation of precolonial Rwandan districts is mapped in Figure 1b . See chapter 2 for further background to the establishment and history of this boundary.

Table 3 reports results. Panel I considers distance to Kigali as a source of heterogeneous effects, and panel II state history. If I break up the effects by proximity to Kigali, the only significant heterogeneous effect is for the enforcement treatment's effect on the intensive margin of public good contributions, columns (1) and (2). The positive effect of this treatment observed in the pooled regression is driven by individuals closer to Kigali. There are multiple plausible interpretations for this result. The first is that the Rwandan government does indeed project little authority further away from the government. Second, individuals further away from the capital may have less interaction with the government, or are less likely to pay taxes and are therefore less familiar with the source of the message. I test for these possibilities by including the geodesic distance to the nearest government office and an unemployment dummy (the best measure within my data for whether a person pays taxes) in equation (1), together with demographic controls and the two treatment dummies. When I include an unemployment dummy, the results are virtually unchanged. When I include the distance to the nearest government office, however, the positive effect in the subsample disappears (point estimate: -41.42, s.e. 86.51). This suggests that the proximity of the physical presence of the government is important for the effectiveness of enforcement threats. The main effects in table 2 are unchanged if I include the distance to the nearest government office as a covariate (results not reported). There are no differences across subsamples for the extensive margin of contribution nor for stealing.

If I break up the sample by historical state presence, the only significant heterogeneous effect is again for the intensive margin of contributions to the public good. Enforcement is only significantly associated with contribution to the public good in places with relatively recent state establishment. These results are consistent with a narrative in which the historical state creates pro-social or compliant behavior. I provide this narrative and empirical results in chapter two of this thesis. The treatment effect of enforcement is only effective in places that underprovide public goods privately. An alternative explanation is that the current Rwandan government is more active in areas with a less deep state history (because, for instance, the 1994 genocide claimed more victims there, see chapter one of this thesis). The threat of enforcement is therefore more credible. There is, however, much more evidence from different identification strategies necessary to conclusively establish this claim (for contrasting evidence, see Lowes et al. (2014)). For the

persuasion treatment, the treatment effects are opposite across subsamples. In places with a deeper state history, persuasion reduces contributions, and in places with a more recent state, persuasion has a positive effect on contributions. Although this plausibly explains the insignificant average effect observed in table 2, a variety of explanations are consistent with this results. For instance, in places with a recent state, baseline private public good provision is very low (the control group mean is significantly lower) whereas in places with longer state presence, the equilibrium split between private and public funds is the focal rate. It will take more research to fully explain these findings. There are no differences across subsamples for the extensive margin of contribution nor for stealing.

6 Concluding remarks

This paper investigates the effect of reminding individuals of their nation building duties, a treatment I term ‘persuasion’ and of threatening punishment for below socially-optimal contributions in an otherwise standard public goods game, called ‘enforcement’. This game is implemented in Southern Rwanda in 2014 with a sample of 320 Rwandans. The participants balance on a wide variety of pre-fieldwork characteristics, although the persuasion treatment group was less well educated.

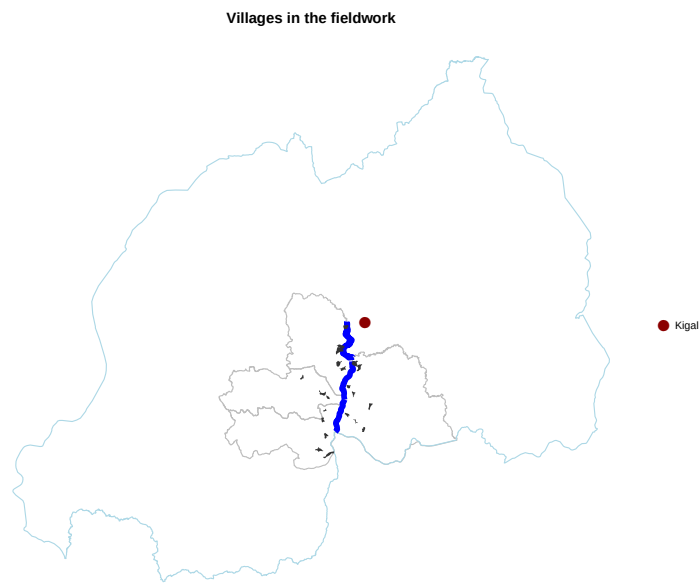
The treatments mimic, in a highly stylized way, policies that modern governments implement to induce citizens to comply with their objectives. Enforcement affects both the intensive and the extensive margin of contributions. Persuasion affects only the extensive margin. Individuals are persuaded to contribute to the public good if they otherwise wouldn’t have, but they are not persuaded to give more, on average, than participants in the baseline group do. This suggest that persuasion is effective for activating citizens, but not incentivizing them to make above average contributions. There are no effects on the intensive or extensive margin of a money missing during the experiment. I then explore heterogeneous effects by the presence of the current and historical states. I find several interesting heterogeneous effects suggesting several avenues of future research.

The results in this paper are preliminary. More research is needed to understand how government activate citizens, both at a macro level as well as at a micro, individual level.

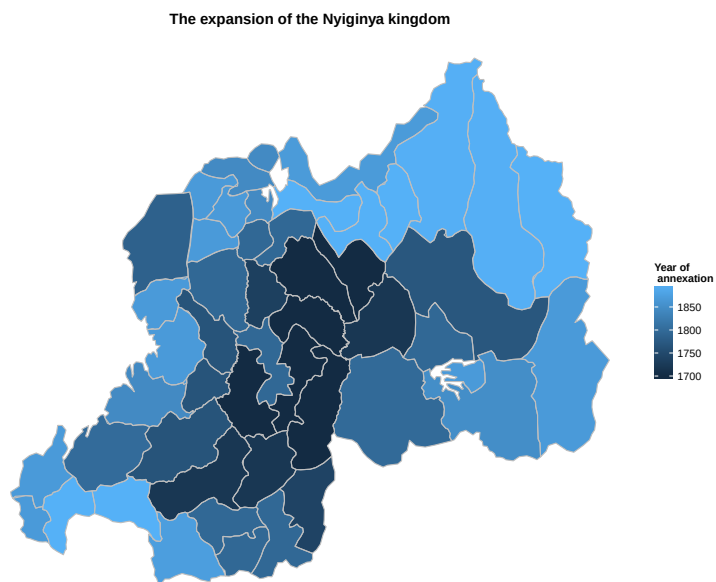
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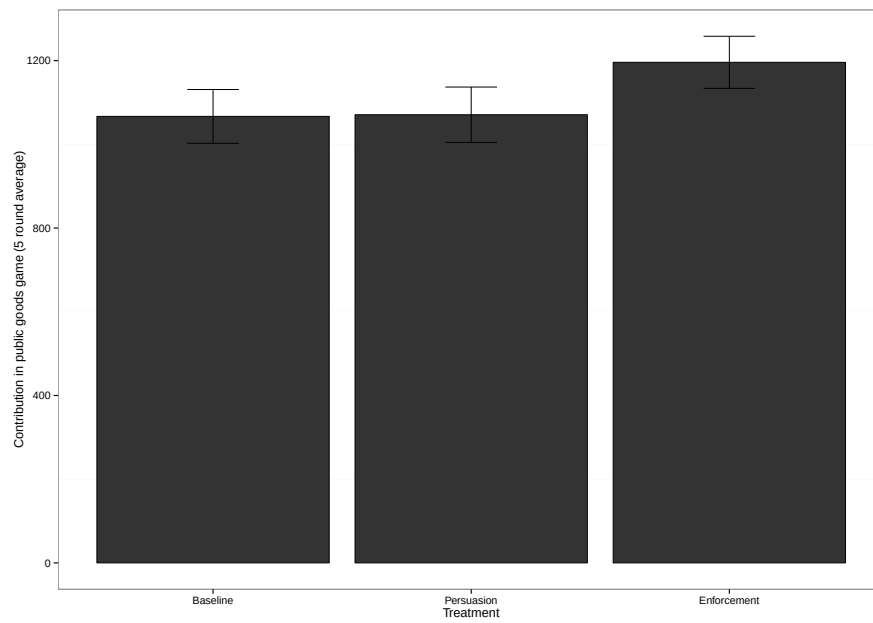


(a) This map displays the sample districts in grey, sample village in black polygons and the Akanyaru river. Kigali, Rwanda's capital is in red.

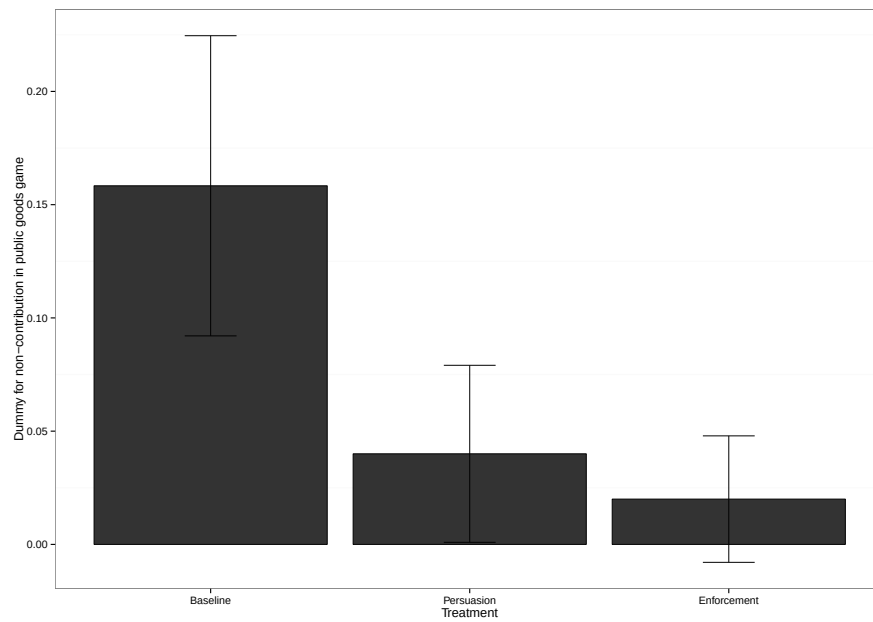


(b) This map displays precolonial districts. A darker shade indicates a deeper history of centralized rule. For the construction of this map, see Heldring (2015).

Figure 1: Sample villages and the expansion of the Nyiginya kingdom.

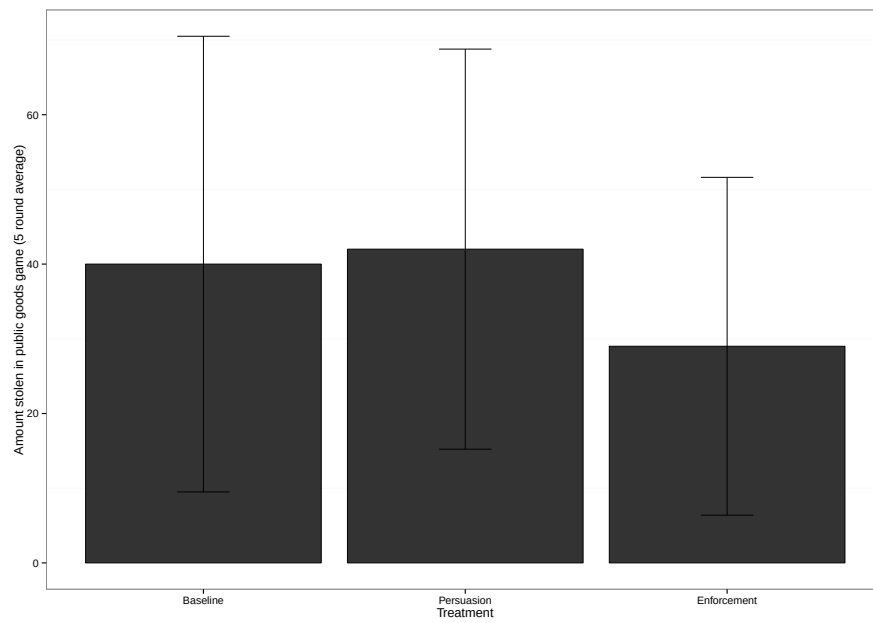


(a) Histogram of the mean contributions across all five round of the public goods game for different treatments.

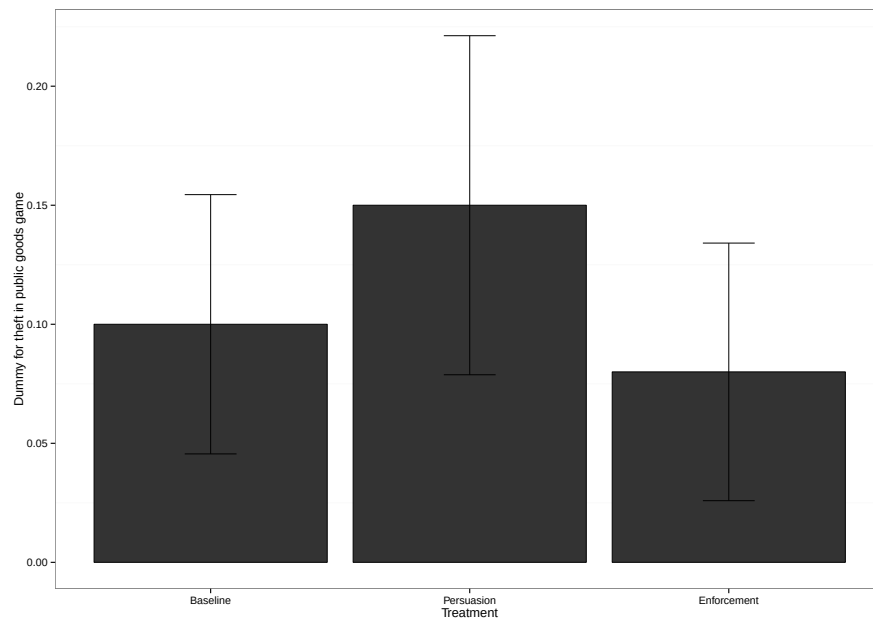


(b) Histogram of the probability of non-contribution across all five round of the public goods game for different treatments.

Figure 2: Treatment effects



(a) Histogram of the mean amount stolen across all five round of the public goods game for different treatments.



(b) Histogram of the probability of theft across all five round of the public goods game for different treatments.

Figure 3: Treatment effects

Table 1: Balance tests

<i>Dependent variable:</i>	Age	Male dummy	Married dummy	Education in years	Immigrant	Immigrant from outside sample area	Eq. daily income (RWF)	Monthly church attendance	Trust	Social capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel I: Persuasion Treatment</i>	2.299 (1.704)	-0.0385 (0.0600)	-0.0427 (0.0579)	-1.661*** (0.398)	0.0691 (0.0604)	0.393 (2.106)	86.15 (187.6)	1.563 (0.808)	0.0400 (0.0403)	-0.0264 (0.153)
<i>N</i>	320	322	320	320	320	320	320	320	320	320
<i>Panel II: Enforcement Treatment</i>	1.528 (1.585)	-0.0737 (0.0595)	0.0736 (0.0560)	-0.177 (0.412)	0.0545 (0.0604)	-0.247 (1.975)	-234.4 (163.7)	-0.983 (0.621)	0.0400 (0.0403)	0.337* (0.144)
<i>N</i>	320	322	320	320	320	320	320	320	320	320

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Immigrant is an indicator variable equal to one if the respondent immigrated into the sample village. Immigrant from outside area is an indicator variable equal to one if the respondent immigrated into the sample village from outside the sample districts Bugesera, Kamonyi, Ruhango and Nyanza. Eq. daily income (RWF) is the equivalent daily income earned by a respondent. Trust is an indicator variable equal to one if the respondent answered that most people can be trusted in the post-fieldwork survey. Social capital is the number of civil society organizations a respondent is a member of. Persuasion and Enforcement treatments are explained in the text. Parentheses give heteroskedasticity robust standard errors. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 2: Treatment effects

<i>Dependent variable:</i>	Mean contribution in PG game	Dummy non-contribution in PG	Mean amount stolen in PG game	Dummy for stealing in PG game
	(1)	(2)	(3)	(4)
Treatment 1: Persuasion	10.47	-0.110***	12.54	0.0539
<i>Robust s.e.</i>	(46.05)	(0.0393)	(17.88)	(0.0438)
<i>Permutation test p-value</i>	0.08172	0.0072	0.5112	0.2276
Treatment 2: Enforcement	130.1***	-0.131***	0.353	-0.0126
<i>Robust s.e.</i>	(45.41)	(0.0367)	(14.35)	(0.0382)
<i>Permutation test p-value</i>	0.005	0.001	0.9816	0.7502
Control group mean	1066	0.15	39.66	0.10
Observations	318	320	320	320
R^2	0.041	0.063	0.083	0.086

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Persuasion and Enforcement treatments are explained in the text. P-values of the permutation test give the fraction of t-statistics greater than the t-statistic of the estimated effect using the treatment dummy across 5000 permutations of the treatment dummy. Every regression includes age, age squared and a dummy for gender as well as the geodesic distance to Kigali, Rwanda's capital. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 3: Heterogeneous effects

<i>Dependent variable:</i>	Mean contribution		Dummy non-contribution in PG		Mean amount stolen		Dummy for theft	
	(1)	(2)	(3)	(5)	(5)	(6)	(7)	(8)
<i>Panel I: Distance to Kigali</i>	Far	Close	Far	Close	Far	Close	Far	Close
Treatment 1: Persuasion	-79.97 (70.50)	75.87 (61.54)	-0.0992* (0.0581)	-0.119** (0.0528)	10.88 (37.86)	11.46 (10.09)	0.0504 (0.0750)	0.0447 (0.0505)
Treatment 2: Enforcement	15.36 (79.62)	215.0*** (52.75)	-0.132** (0.0544)	-0.137*** (0.0515)	13.58 (34.05)	-6.678 (7.796)	0.0401 (0.0693)	-0.0576 (0.0440)
Control group mean	1039	1094	0.15	0.16	10	68	0.06	0.13
Observations	139	179	140	180	140	180	140	180
R^2	0.036	0.079	0.088	0.065	0.050	0.066	0.084	0.081
<i>Panel II: Historical state presence</i>	Yes	No	Yes	No	Yes	No	Yes	No
Treatment 1: Persuasion	-122.5** (59.26)	244.1*** (70.75)	-0.114*** (0.0401)	-0.115 (0.0754)	5.740 (27.88)	10.79 (13.76)	0.0384 (0.0596)	0.0517 (0.0601)
Treatment 2: Enforcement	-35.68 (60.40)	410.0*** (60.34)	-0.0960** (0.0443)	-0.203*** (0.0655)	-2.471 (21.85)	-0.176 (11.44)	-0.0348 (0.0541)	-0.00196 (0.0528)
Control group mean	1132	935	0.14	0.20	54.3	10	.12	0.05
Observations	198	120	200	120	200	120	200	120
R^2	0.047	0.256	0.050	0.126	0.040	0.032	0.091	0.017

Notes: All regressions are estimated using OLS. The unit of observation is an individual respondent. Persuasion and Enforcement treatments are explained in the text. Every regression includes age, age squared and a dummy for gender. In Panel I, the sample is split at the median distance to Kigali. In panel I, the sample is split by position relative to the Akanyaru river, see Figure 1 b. Historical state presence is an indicator equal to one if a village is to the East of the Akanyaru river, which corresponds to state presence since 1700 rather than since 1799. * indicates significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Appendix to:
State building in the lab: Preliminary Evidence

1 Experimental instructions: general instructions

Thank you all for taking the time to come today. Today's games may take most of the day, so if you think you will not be able to stay that long let us know now. Before we begin I want to make some general comments about what we are doing here today and explain the rules that we must follow. We will be playing some games with money. Whatever money you win in the games will be yours to keep and take home. We will be supplying the money. But you should understand that this is not our own money. It is money given to her by the University of Oxford in England to use for research. This research will eventually be part of a book.

Before we proceed any further, let me stress something that is very important. Many of you were invited here without understanding very much about what we are planning to do today. If at any time you find that this is something that you do not wish to participate in for any reason, you are free to leave regardless of whether we have started the game or not.

We will be playing two games. We are about to begin the (first) game. It is important that you listen as carefully as possible, because only people who understand the game will actually be able to play. We will run through some examples here while we are all together. You cannot ask questions or talk while here in the group. This is very important. Please be sure that you obey this rule, because it is possible for one person to spoil the game for everyone. If one person talks about the game while sitting in the group, we will not be able to play the game today. Do not worry if you do not completely understand the game as we go through the examples here in the group. Each of you will have a chance to ask questions in private to be sure that you understand how to play.

Everybody today will make some money. You will make at least RWF 1500, but you can make substantially more by participating in these games.

We will now start with a brief survey, please wait until you are called. After you have answered some questions, we will start with the games. You may talk among one another while we are busy, but please do not discuss the work today.

2 Experimental instructions: public goods game instructions

This first game is played by groups of 5 individuals. Each of you will play this game with other people from this community. However, none of you will know exactly with whom you are playing. Only Lean-

der Heldring knows who plays with whom, and he will never tell anyone. Leander Heldring will provide RWF 2000 to each player. Each player can make a voluntary tax contribution to a community project or keep the money. You will not know what the others contributed and the others will not know what you contributed. You can choose to contribute RWF 0, RWF 500, RWF 1000, RWF 1500 or RWF 2000 to the project. If you contribute RWF 0, you keep RWF 2000. If you contribute RWF 500, you keep RWF 1500. If you contribute RWF 1000, you keep RWF 1000, if you contribute RWF 1500 you keep RWF 500 and if you contribute RWF 2000, you keep RWF 0.

If anybody, you or any of the other players makes a voluntary tax contribution, I will multiply this by 1,5. I will sum all the contributions. This sum are all contributions to the project, multiplied by 1,5. The multiplication represents the profits of the project. The project then pays out the same sum to everyone. That is, everybody gets the same share of the profit of the project, irrespective of how much you contributed. We will play this same game for five rounds, and you will be paid out for one out of the five rounds, which will be chosen randomly. You can earn good money with this game.

This may sound unclear, and it is ok if you do not understand it yet. I will go through some detailed examples. Please do not ask questions now or talk to each other. Later, there will be an opportunity to ask questions.

We will now run through 8 examples to show you how the game might be played:

Here is an example. Here is the RWF 2000. Recall that you can choose to contribute RWF 0, RWF 500, RWF 1000, 1500 or RWF 2000 to the project. Imagine you are player 1 and you decide not to contribute anything. Everybody else contributes everything they have, RWF 2000. The total contributions are RWF 8000, nothing for you and RWF 2000 for all other players. I will then multiply this amount by 1,5 to RWF 12000. We then split this profit equally, so each player gets $12000/5=2400$. You did not contribute anything, and you got 2400. Everybody else contributed RWF 2000 and also got 2400. You had RWF 2000 left, so in total you have $\text{RWF } 2000 + \text{RWF } 2400 = \text{RWF } 4400$. The others had nothing left, so they have RWF 2400.

Here is another example. Imagine you are player 1 and you decide to contribute everything you have, RWF 2000. Everybody else contributes nothing. We then have in total RWF 2000. RWF 2000 for you and

RWF 0 for everybody else. I will then multiply this amount to RWF 3000. We then split this profit equally, so each player gets $3000/5=600$. You contributed RWF 2000, and you got 600. Everybody else contributed nothing and also got 600. You had nothing left, so in total you have RWF 600. The others had RWF 2000 left, so they have $\text{RWF } 2000 + \text{RWF } 600 = \text{RWF } 2600$.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 500. Everybody else contributes RWF 500 as well. We then have in total RWF 2500, RWF 500 for you and RWF 500 for everybody else. I will then multiply this amount to RWF 3750. We then split this profit equally, so each player gets $3750/5=750$. You contributed RWF 500, and you got 750. Everybody else contributed RWF 500 and also got 750. You had RWF 1500 left, so in total you have $\text{RWF } 750 + \text{RWF } 1500 = \text{RWF } 2250$. The others also had RWF 1500 left, so they have RWF 2250 too.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 1000. Everybody else contributes RWF 1000 as well. We then have in total RWF 5000, RWF 1000 for you and RWF 1000 for everybody else. I will then multiply this amount to RWF 7500. We then split this profit equally, so each player gets $7500/5=1500$. You contributed RWF 1000, and you got 1500. Everybody else contributed RWF 1000 and also got 1500. You had RWF 1000 left, so in total you have $\text{RWF } 1000 + \text{RWF } 1500 = \text{RWF } 2500$. The others also had RWF 1000 left, so they have RWF 2500 too.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 2000. Everybody else contributes RWF 2000 as well. We then have in total RWF 10000, RWF 2000 for you and RWF 2000 for everybody else. I will then multiply this amount to RWF 15000. We then split this profit equally, so each player gets $15000/5=3000$. You contributed RWF 2000, and you got RWF 3000. Everybody else contributed RWF 2000 and also got 3000. You had RWF 0 left, so in total you have $\text{RWF } 0 + \text{RWF } 3000 = \text{RWF } 3000$. The others also had RWF 0 left, so they have RWF 3000 too.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 500. Everybody else contributes RWF 1000. We then have in total RWF 4500, RWF 500 for you and RWF 1000 for everybody else. I will then multiply this amount to RWF 6750. We then split this equally, so each player gets $6750/5=1350$. You contributed RWF 500, and you got 1350. Everybody else contributed RWF 1000 and also got 1350. You had RWF 1500 left, so in total you have $\text{RWF } 1500 + \text{RWF } 1350 = \text{RWF } 2850$. The others had RWF 1000 left, so they have $\text{RWF } 1000 + \text{RWF } 1350 = \text{RWF } 2350$.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 2000. Everybody else contributes RWF 500. We then have in total RWF 4000, RWF 2000 for you and RWF 500 for everybody else. I will then multiply this amount to RWF 6000. We then split this profit equally, so each player gets $6000/5=1200$. You contributed RWF 2000, and you got 1200. Everybody else contributed RWF 500 and also got 1200. You had RWF 0 left, so in total you have RWF 0 RWF 1200 = RWF 1200. The others had RWF 1500 left, so they have RWF 1500 + RWF 1200 = RWF 2700.

It is important to understand that every player makes their own decisions. To see this, we will have one more example.

Here is another example. Imagine you are player 1 and you decide to contribute RWF 1000. Player 2 also decides to contribute RWF 1000. Everybody else contributes RWF 0. We then have in total RWF 2000, RWF 1000 for you, RWF 1000 for player 2 and RWF 0 for everybody else. I will then multiply this amount to RWF 3000. We then split this profit equally, so each player gets $3000/5=600$. You contributed RWF 1000, and you got RWF 600. Player 2 contributed RWF 1000, and also got RWF 600. Everybody else contributed RWF 0 and also got RWF 600. You and Player 2 had RWF 1000 left, so in total you got RWF 1000 + RWF 600 = RWF 1600. The other players had RWF 2000 left, so they got RWF 2600.

We will now call each of you in turn to play the game. You will meet with [assistant's name] in private. They will explain the game again and ask you to work through a couple of examples to be sure that you understand. You will then play the game for real. Please do not talk about the game while you are waiting.

Remember, if anyone talks about the game we will have to stop the game.

3 Experimental instructions: individual instructions, baseline

Please tell me if you have questions you did not ask before? If not, I will explain the game again. At this point, please feel free to ask questions anytime. I may not be able to answer all questions, but I will help you as much as possible.

You get the opportunity to make a voluntary tax contributions of RWF 500, RWF 1000, RWF 1500 or RWF 2000 to a project, or to contribute nothing. You keep everything you do not contribute. When you contribute, your contribution adds to the project. The contributions of the other players contribute to this same project. The project yields a profit. For every RWF 500 contributed to the project yields RWF 250 profit, for a total of RWF 750. Irrespective of how much you contributed, the profit of the project is equally shared.

You will have to make five tax contribution decisions. Every round, you start again with RWF 2000. At the end of the work today, one round will be selected randomly, and you will be paid what you did not contribute plus the profits you make from the project. You will work with envelopes. You put the money you want to contribute and the money you want to keep in envelopes that I will give you. Nobody will ever know what you put in the envelopes. Only the head researcher, Leander Heldring, will know and he will never tell anyone. I will also not know what you put in the envelopes, because I will turn around when you put the money into the envelopes. Afterward you can give them to me.

We are now ready to begin. I will give you two envelopes, one for the contributions and one for you. You have to deposit the francs in the envelopes. At the end of the work today, you will get paid.

4 Experimental instructions: individual instructions, persuasion

Please tell me if you have questions you did not ask before? If not, I will explain the game again. At this point, please feel free to ask questions anytime. I may not be able to answer all questions, but I will help you as much as possible.

You get the opportunity to make a voluntary tax contributions of RWF 500, RWF 1000, RWF 1500 or RWF 2000 to a project, or to contribute nothing. You keep everything you do not contribute. When you contribute, your contribution adds to the project. The contributions of the other players contribute to this same project. The project yields a profit. For every RWF 500 contributed to the project yields RWF 250 profit, for a total of RWF 750. Irrespective of how much you contributed, the profit of the project is equally shared.

You will work with envelopes. You put the money you want to contribute and the money you want

to keep in envelopes that I will give you. Nobody will ever know what you put in the envelopes. Only the head researcher, Leander Heldring, will know and he will never tell anyone. I will also not know what you put in the envelopes, because I will turn around when you put the money into the envelopes. Afterward you can give them to me.

I would like to read the following message to you from the Rwandan revenue authority. Please listen carefully to this message from the Rwandan revenue authority:

“Remember, we all have a responsibility to contribute to nation building and, meeting our tax obligations in time is one way of fulfilling that role.”

We are now ready to begin. I will give you two envelopes, one for the contributions and one for you. You have to deposit the francs in the envelopes. At the end of the work today, you will get paid.

5 Experimental instructions: individual instructions, enforcement

Please tell me if you have questions you did not ask before? If not, I will explain the game again. At this point, please feel free to ask questions anytime. I may not be able to answer all questions, but I will help you as much as possible.

You get the opportunity to make a voluntary tax contributions of RWF 500, RWF 1000, RWF 1500 or RWF 2000 to a project, or to contribute nothing. You keep everything you do not contribute. When you contribute, your contribution adds to the project. The contributions of the other players contribute to this same project. The project yields a profit. For every RWF 500 contributed to the project yields RWF 250 profit, for a total of RWF 750. Irrespective of how much you contributed, the profit of the project is equally shared.

You will work with envelopes. You put the money you want to contribute and the money you want to keep in envelopes that I will give you.

In this game, there is a chance that what you do will be checked. Out of every 10 people playing this game, one person will be checked. This person is selected randomly. It could be you, but it could also be somebody else. When you hand in your envelope, it will be opened by somebody else in the experiment.

He or she will check what you put in the envelopes. If you contributed everything to the project, you will keep your own money and the profits from the project. If you did not contribute everything to the project, you will lose all your money in this part of the experiment. Just to be clear, out of every 10 people, one person will be checked. You might be checked, but it is also possible that you are not checked.

We are now ready to begin. I will give you two envelopes, one for the contributions and one for you. You have to deposit the francs in the envelopes. At the end of the work today, you will get paid.

Chapter 4:

The Long-Run Impact of the Dissolution
of the English Monasteries*

*This chapter is joint work with James A. Robinson and Sebastian Vollmer.

1 Introduction

There is consensus amongst economists and economic historians about the significance of the British Industrial Revolution. They agree that it was a broad movement which featured technological innovation in key areas such as textile manufacture and metals, in new forms of inanimate power such as the steam engine, in novel methods of the organization of production, such as the introduction of the factory system, and new methods of transportation, such as the railway.

A large class of theories has been advanced to explain these facts (see Mokyr, 2010, Clark, 2014 for overviews). The most venerable hypothesis is that Britain was blessed by an advantageous resource endowment, particularly the presence of coal, iron ore, and streams that had potential for water power (Pomeranz, 2000, Clark and Jacks, 2007, Crafts and Wolf, 2014, Fernihough and O'Rourke, 2014). Allen (2009) added to this by arguing that in addition Britain's uniquely high real wages stimulated labor saving technological innovation. Other theories make causal connections between the Industrial Revolution to other complementary events such as the slave trade and globalization (Williams, 1944, Inikori, 2002, Findlay and O'Rourke, 2009) or an agricultural revolution.

Other theories focus on institutions. For example, North and Thomas (1973), North and Weingast (1989), Acemoglu, Johnson and Robinson (2005), Pincus (2011), and Pincus and Robinson (2014) instead emphasize political conflict in the 17th century, in particular the English Civil War of the 1640s and the Glorious Revolution of 1688, and ultimately institutional change. The variety of institutional hypotheses is much broader than this, however. In many of the above accounts it is taken for granted that Britain, and often Western Europe, had gone through a long slow process of institutional change that was a prerequisite for a particular type of theory. Allen (2009), for example, takes it for granted that mass labor coercion and serfdom did not characterize the labor market (even if it lingered until after the Industrial Revolution, Naidu and Yuchtman, 2013). Often implicitly assumed are the spread and integration of markets and the break-down in traditional forms of economic relationships (Polanyi, 1944) and the intensification of the 'money economy' (Postan, 1973, Coleman, 1977).

In this paper, we argue that while most of these theories attempt to explain cross-national facts, such as why did the Industrial Revolution happened first in Britain. Some of them can be evaluated using sub-national variation within Britain since there is a great deal of variation in the location of the industrial revolution. This is obviously not true of Allen's theory (2009) of high wages, or of arguments about

national political institutions.¹ It is true however about geographically based theories that emphasize the availability of natural resources and those that focus on other types of institutions, particularly economic institutions, at least to the extent that these vary within England.

Our main contribution is to propose a test of the role of the modernization of one sub-set of economic institutions on the industrial revolution. In the late medieval period the preponderance of land in England was held by the Crown, the Aristocracy and the Church. Though much was leased out, it was done so via various forms of archaic tenures such as copyhold (see for an overview). As we discuss, a great deal of evidence suggests that not only was this land farmed inefficiently, but there was no effective land market. In the 1530s however, the expropriation of the Monastic lands by Henry VIII threw about 1/3 of agricultural land in England onto the market. This land was then rapidly sold off, 2/3 by 1547 and most of the rest by 1554 during the reign of Edward VI (Clay, 1984, p. 145). Clay (1984, p. 144) notes about the period from 1500 to 1640

“The pattern of landownership ... was to undergo a profound change ... The single most important factor in bringing this about was the partial dismantling of the enormous estates of the Church ... from the 1530s onwards”

Historical evidence suggests that a much thicker market for land emerged (Habbakkuk, 1958) and the shock allowed for enhanced possibilities to renegotiate archaic forms of tenure. The impact of the Dissolution varied spatially within England since the Monasteries held lands in some places but not others. We therefore argue that the Dissolution can be regarded as a natural experiment that created exogenous variation in economic institutions. We hypothesize that ultimately these improved economic institutions should be connected to industrialization and that there should be a positive reduced form relationship at a sub-national (parish) level between the extent of land released by the Dissolution and industrialization.

Though we cannot measure economic institutions directly (except to the extent that our measure of the Dissolution captures the ‘thickness’ of land markets), we investigate several channels that may potentially link the change in economic institutions induced by the Dissolution to the Industrial Revolution. The first and most obvious connection is to agriculture and the English Agricultural Revolution. The first-order

¹Other prominent theses which are difficult to test in this way include Mokyr’s (2010), emphasizes on the role of the Enlightenment and intellectual and scientific change; Voth (2001) and de Vries’ (2008) argument that changes in tastes and preferences and the creation of a ‘consumer society’ were critical to stimulating labor effort and incentives; and Rosenthal and Wong’s (2011) thesis, which follows Tilly (1990) in arguing that warfare was a driving force behind institution building in Western Europe leading to urbanization and technological change.

effect of freeing up inefficiently used lands, creating a land market and changing tenancy relations ought to have been to move land into the hands of people who would use it more efficiently and to facilitate and encourage investment and innovation.

A second and complementary mechanism, first proposed by Tawney (1941a,b), is that the Dissolution led to a large change rural social structure that he characterized as the "rise of the gentry",² the rise of a new class of commercially minded rural entrepreneurs. Existing data strongly suggests that the gentry increased greatly in numbers and in the amount of land they controlled. Table 1, from Overton (1996, Table 4.8), shows that while in 1436 the Church held around 20-30% of land with the Crown holding 5%, the sum of these two numbers declined to 5-10% by 1688. Though the Crown did sell off its own land, this fall mostly represented the impact of the Dissolution. In the same period the landholdings of the middling and lesser gentry, the people relevant for Tawney's hypothesis, went from 25% to 45-50% of the total. Overton (1996, p. 169) concludes "it seems clear that the gentry class ... did grow considerably in numbers from the mid-sixteenth century."

Though this channel is clearly related to the first, the gentry could have been connected to industrialization through other mechanisms as well. Firstly, through a cultural mechanism such as that proposed by Doepke and Zilibotti (2008) who stress how the emergence of capitalism endogenously led to a divergence between the preferences of the middle classes and the aristocracy. Secondly, the gentry were enfranchised and able to sit in Parliament to get legislation favorable to their economic interests. As Heal and Holmes put it (1994, p. 204)

"In the Tudor period the gentry 'swarmed' into Parliament. Not only the county seats, but those of the old parliamentary boroughs, and those of towns newly enfranchised by the Crown, were taken by gentlemen. Some 80% of the 372 so-called 'burgesses' in the late Elizabethan House of Commons were country gentlemen."

Gentry were not just in a good position to sit in Parliament, they could also lobby it. For example, Daunton (1994, p. 13) notes how Birmingham industrialist Matthew Boulton enlisted the support of local gentry to lobby for a new assay office (see also Robinson, 1964). Finally, it is plausible that there was a connection between the rise of the gentry and proto-industrialization that is often argued to have been a critical step to the Industrial Revolution. That there were such local connections is suggested by the large

²Heal and Holmes (1994, p. 7) define the gentry as "all non-noble landowners with some claim to exercise lordship or jurisdiction" and significant landownership or wealth appear to be the key criteria. Though there is something of a subjective dividing line between richer yeomen and gentlemen, the holding of local offices, such as justice of the peace, has often been used to make the distinction. The possession of a coat of arms has also been used empirically to determine gentry status.

case study literature both on the gentry and on the Industrial Revolution that we discuss in section 3 of the Appendix.

In addition to evaluating the impact of the Dissolution of the Monasteries on industrialization and these channels we also test for the explanatory power of some of the most common geographical theories of the industrial revolution.

To investigate whether or not such conjectures are plausible we use several sources of data. Most important we digitized the 1535 Valor Ecclesiasticus (henceforth Valor), the great survey of monastic and more broadly ecclesiastic (non-monastic Church) incomes implemented by Henry VIII prior to the Dissolution. Though selected numbers from this survey have been presented and interpreted by scholars in the past, for example Schofield (1965) and Knowles (1979), to our knowledge this data has never been used systematically before. We describe the process via which the Valor was collected and the data it contains in section 3 and in section 4 of the Appendix. The Valor does not contain systematic evidence on the amount of land or property the Church held, but it does give the total value of income which was generated by these assets at the time of the Dissolution. We use this total as our basic measure of the impact of the Dissolution at the parish level. We hypothesize that in places where monastic assets generated more income, conditional on parish size, the Dissolution had a bigger impact, either in terms of redistributing more productive lands or greater amounts of land.

For outcome variables measuring the Industrial Revolution we use the first is 1838 Mill Survey commissioned by the British Parliament (and also recently used at the county level by Crafts and Wolf, 2014).

Our first main set of results show that there is a very robust reduced form relationship between monastic income in 1535 and our measures of industrialization. (In the empirical analysis we use the logarithm of $(1 + \text{monastic income})$ as the explanatory variable since some parishes have zero monastic income, for brevity we refer to this as ‘monastic income’). Monastic income is positively and significantly correlated with a dummy variable for the presence of a textile mill in a parish, a count variable which measures the total number of mills in a parish, and total mill employment.

The effects we estimate are quantitatively important. For example, a one standard deviation increase in monastic income as recorded in the Valor increases the number of mills by 0.09. The mean number of mills in a parish in our sample is 0.17. A one standard deviation increase in monastic income, therefore, increases the number of mills by about half its mean. Similarly, the average probability of having a mill, as recorded by the mill dummy is 0.04. A one standard deviation increase in monastic income increases

the probability of having a mill by 0.013, or about a third of its mean. When we consider the number of people employed in industrial mills, we find that a one standard deviation increase in monastic income increases employment by 8.3 people, or about half its mean.

We then examine the channels via which the Dissolution might have impacted industrialization and which can shed some light of some of the mechanisms we discussed above. First, we look at whether or not the Dissolution was associated with an agricultural revolution. We measure the latter by data in three ways. First, we use data on wheat yields per acre in 184x from Kain (1986). Second, we use data recently compiled by Dowey (2013) on the number of agricultural patents registered in a parish between 1700 and 1850. Finally, we use data on the structure of employment, in particular the proportion of the labor force in manufacturing, retail and agriculture from the 1831 British Census.

Second, we use a unique census from 1700 that records the number of gentry in each of 24,000 of the largest towns/cities and villages in England and Wales. To our knowledge, this data has never previously been analyzed systematically. Finally, we can examine directly one policy channel by using data compiled by Heldring, Robinson and Vollmer (2015) on the extent of parliamentary land enclosures at the parish level (Heal and Holmes, 1994, argue that the gentry were heavily involved in enclosing, see pp. 108-113). Using their data we show that monastic income is positively and significantly correlated with whether or not land in a parish was enclosed between 1750 and 1840.

We find that monastic income is positively and significantly correlated with wheat yields and with patenting, though the former finding is not completely robust. These results are consistent with the idea that the Dissolution created a more efficient allocation of resources in rural England and this helped to stimulate the Agricultural Revolution. The connection to the Agricultural Revolution is further supported by our results with the 1831 Census data where we find that monastic income is negatively correlated with the share of the labor force in agriculture but positively correlated with the share in manufacturing and retail. The traditional account of the agricultural revolution stresses that one of the impacts was to shed labor and substitute it with capital, which is consistent with what we find. We also find that monastic income is positively correlated with the number of gentry in a parish, consistent with Tawney's hypothesis and the emphasis of Doepke and Zilibotti (2008) on social change. Finally, we also find evidence for the public policy channel and the possible role of the gentry in Parliament since we find that monastic income is positively correlated with whether or not land was enclosed in a parish.

Figures 1 and 2 present two of our basic results using binned partial residual plots, which provide a convenient way of visually presenting correlations in large samples. After partialing out parish area and fixed effects at the level of the hundred, we use a linear fit to summarize the relationship between monastic income and the presence of a textile mill in 1838. We then divide the sample into 40 equal sized bins, average the residualized monastic income and presence of a mill dummy within these bins, and plot the resulting reduced sample. The size of each scatter point is proportional to the average number of gentry within the relevant bin. Figure 1 shows a positive relationship between monastic income and the presence of a textile mill, and for higher monastic income we observe more members of the gentry. Figure 2 shows a binned scatterplot using wheat yields instead. For higher monastic income, we observe a smaller share in agriculture, but a greater number of gentry.

Trying to interpret these findings as causal faces a number of challenges. Most obviously, the location of monastic land was not randomly assigned in 1535 and it could be that monasteries just happened to hold land in places which were attractive for industrialization for other reasons, thus creating potential omitted variable bias, at least to the extent we cannot control for these other factors.

We use five main strategies to address these concerns. First, we show our results are robust to a number of covariates which are plausible candidates for such omitted variables. These include measures of slope to capture suitability for water power, and the presence of coalfields, both potentially critical elements in the Industrial Revolution. We also control for distance to the coast, distance of a navigable river and distance the nearest market town. These results are of independent interest since they are related to an important class of theories and in this sense they complement and extend (Crafts and Wolf, 2014). Second, our results hold when we use a variety of fixed effects to control for omitted variables. Most stringently we are able to get down to a very low geographical level (below county) with the use of hundred fixed effects (in our sample there are 16243 parishes, 965 hundreds and 43 counties) so that we estimate our main effects using only within hundred and within county variation. Third, we digitized the Lay Subsidy of 1524/25, a mildly progressive tax on various types of income and matched the returns to our units of observation. The total amount of tax levied per parish gives us a useful pre-control for differences in productivity which are not an outcome of the Dissolution.³ Our results are all robust to this pre-control. Fourthly, we show that our baseline results are robust to the use of a nearest neighbor

³These returns have been widely used by historians, see Schofield (1965, 2004), Glasscock (1975), Darby, Glasscock, Sheail, Versey (1979), Husbands (1987), and Nightingale (2004).

covariate matching estimator which allows us to identify similar control parishes to compare with those where the Dissolution took place. Finally, while the location of Church lands had been fairly constant since the Anglo-Saxon period,⁴ therefore for at least 500 years prior to the Dissolution, the distribution of prosperity was not. Analyses by Schofield (1965) and Darby, Glasscock, Sheail and Versey (1979) suggest that between the Domesday Book of 1086 and the Tudor period there was a large change in the regional distribution of income in England. It cannot be true therefore that our results can be explained by the fact that the distribution of prosperity within England was highly persistent with the monasteries occupying the most productive lands where ultimately the Industrial Revolution took place. It also seems hard to imagine that the monasteries, whose location was determined 1,000 years prior to the Industrial Revolution and before the urbanization or commercialization of English society, just happened to be located in places which were subsequently attractive for industrialization.⁵

Why did the Dissolution of the monasteries have such large effects? The most obvious explanation is that the land held by the Church was initially utilized inefficiently. Though North (1981, p.125) argued that “Monasteries were often the most effective farming centers in the Middle Ages” (see also Ekelund, Hébert, Tollison, Anderson and Davidson, 1996), whether or not this is true empirically is controversial. The Church was the most sustained and strongest defender of feudal privileges in England in the wake of the Black Death.⁶ Swanson lists numerous incidents where monasteries fought to retain feudal privileges.⁷ The Church was also under pressure to adhere to non-economic practices. For example, marketing products was thought to be inappropriate and that monastic properties aimed for self-sufficiency (Swanson, 1989, pp. 229-230). While not denying that there are examples where the Church was an agricultural innovator (Bolton, 1980; Hare, 1985) the evidence that feudal agricultural practices and archais forms of

⁴Though the Norman conquerors expropriated the lands of the Anglo-Saxon elite (Fleming, 1991) the lands of the Church were only marginally affected. Thomas notes (2007, p. 68) that in 1066 “The Church collectively held about one quarter of the land in England. The Church’s share remained largely unchanged.” The quarter share is similar to that in 1436 in Table 1. Though there certainly was some change and Anglo-Saxon bishops were replaced by Norman bishops, Barlow (1979a) (see also Barlow, 1979b and Cownie, 2005) puts it like this “The great abbeys of the Anglo-Danish kingdom remained the great abbeys under the Normans and Angevins” (p. 315).

⁵It is also true that there seem to have been a large number of idiosyncratic shocks to the distribution of Church properties during the Anglo-Saxon period. Barlow (1999, p. 21) notes that during this period of political instability “In Britain the dioceses had perforce to coincide with the areas ruled by the local kings, and the sees to be situated in any convenient settlement. This expedient caused the area of the bishoprics to fluctuate as the boundaries of the petty kingdoms changed” (see also Blair, 2005). Such fluctuations also give one further confidence that we might be able to interpret our findings as causal.

⁶Swanson (1989) notes how the Church was more aggressive in opposing the changes which were forced on landowners by the collapse in their labor supply arguing that after the Black Death there was a “gradual decline (but not total abolition) of serfdom. Here again, ecclesiastics faced the same forces as their lay counterparts, but were seemingly less willing to give way” (Swanson, 1989, pp. 201-202).

⁷For example, Durham priory was drawing up lists of serfs until well into the 15th century, in 1497 Tavistock abbey was collecting servile dues and enforcing labour services and in 1502-3 the bishopric of Lichfield and Westminster abbey demesne leases were still demanding customary labor services from serfs. See MacCulloch (1988) on the widespread persistence of serfdom into early Tudor England.

tenure lasted longer on Church land is certainly consistent with them being less efficient economically. Moreover, canon law forbade the selling of Church lands while following the Statute of Mortmain in 1279 transfers of land to religious control had to have a royal license (Raban, 1974). This freezing of Church land stymied the emergence of a land market and might be thought naturally to lead to land being held by those who would not be able to use it best. To some extent tenancy might be able to mitigate this problem, but the entire modern theory of the firm stemming from the research of Williamson (1985) and Grossman and Hart (1986) suggests that when contracts are incomplete, ownership is of critical importance for incentives and productivity.⁸

If the gentry could not expand by buying Church land could they not have purchased land from elsewhere? They did do so from the Crown, but the most important alternative was the aristocracy (in Table 1 we see that the amount of land held by the aristocracy and greater gentry stays constant at about 15-20% between 1436 to 1688). Yet the Tudor aristocracy, like the Church, was still embedded in non-market social relations and maintained large armies of 'liveried retainers'. As late as the civil war of the 1640s aristocrats used such traditional loyalties to mobilize military forces (Holmes, 1974).

Our paper is related to quite a few other contributions in addition to those we have discussed above. Our results are consistent with Tawney's hypothesis.⁹ To see this visually, Figure 3 presents a binned scatterplot which shows the strong conditional positive correlation between monastic income in 1535 and the number of gentry in 1700 and the number of gentry is also positively correlated with our measures of agricultural productivity and innovation.¹⁰ Our paper is related to research on the geographical location of the Industrial Revolution. What consensus there is on this issue appears to suggest that this was a simple matter of geography, proximity of natural resources such as coal, or the closeness of markets (see the essays in Hudson ed., 1989, and Hudson, 2002, and Jones 2010). Crafts and Wolf (2014) for example, only examine geographical determinants of the location of textile mills within Britain. We too find significant and systematic relationships between geographical variables and industrialization. Institutional

⁸See Kosminsky (1961), Campbell (1983, p. 397) and Campbell (2006, pp. 179, 421) for other arguments about the relative efficiency of the church.

⁹Though few would now argue that the Civil War was a conflict of gentry against traditional elites, and Jha (2015) finds no evidence that being a member of the gentry predicts the propensity of a person to side with parliament in the Civil War. On the nature of the English Civil War, see Hughes (1998) and Richardson (1998) for good overviews. Stone (1972), Russel (1990) and Morrill (1993) are influential interpretations. Blackwood (1978) and Cliffe (1969) are detailed studies of the role of the gentry in the Civil War in the important cases of Lancashire and Yorkshire.

¹⁰Tawney's papers generated a large literature. This focused on a plethora of issues; whether or not the aristocracy had really declined in favor of a rising class of gentry (Stone, 1965a); whether or not gentry really were more commercial or efficient than large landowners (Heal and Holmes, 1994, Chapter 3 for this literature); and whether or not the gentry were the group who led the rebellion against Charles I. The consensus view of historians on these issues, as expressed by Clay and Overton above, now seems to be that indeed there was a big change in the distribution of land in 16th century England as a result of the dissolution and, moreover, it makes sense to talk about the rise of the gentry.

arguments have also appeared in this context, with Daunton (1995), for example, suggesting that the Industrial Revolution occurred in the north of England because it was outside the control of craft guilds who were organized better in the historically more prosperous south of the country. Our findings are also consistent with the literature on the Agricultural Revolution which has stressed that this was due to changes in economic institutions, particularly the spread of markets often in connection with enclosures (Jones, 1974, Overton, 1996). Though our evidence does not speak to the issue of the extent to which the Agricultural Revolution helped to cause the Industrial Revolution (see Clark, 2012) they are consistent with them being connected.

Also relevant is the large and heterogeneous literature on the impact of religion on economic development. Various arguments have been advanced for why the Medieval Church might have played positive roles in economic growth (Schumpeter, 1954, Berman, 1983, Moore, 2000, North and Gwin, 2010). More recently Andersen, Bentzen, Dalgaard and Sharp (2013) find that the presence of Cistercian abbeys in the Medieval period is positively correlated with long-run economic growth at the county level. When we break our monastic data into different denominations we in fact find no correlation between the dissolution of Cistercian properties and our outcome variables suggesting that indeed their properties were more efficiently utilized as these authors hypothesize. It is possible that the Reformation influenced economic growth other than through the channels we examine here. Becker and Woessmann (2009), for example, show in the German case that the Reformation led to educational expansion, though Cantoni (2014) found no impact on city growth and urbanization. Our emphasis is very different since we do not examine the impact of changing religious beliefs after the English Reformation on subsequent economic growth.¹¹

The paper proceeds as follows. The next section provides some important historical background including a discussion of the process of the Dissolution of the monasteries and what happened to monastic lands afterwards. Section 2 discusses the data in detail, particularly the collection of the Valor, and how we compiled this data. We also discuss the other variables we use in the analysis and present some of the descriptive statistics. In section 3 we describe our econometric model and the basic results. Section 4 presents results on the channels. Section 5 concludes.

¹¹Our paper is further related to studies which have examined the long-run impact of agrarian reforms. There is a general argument that agrarian reform in East Asia was important in stimulating agricultural productivity (see Griffin, Khan and Ickowitz, 2002, for an overview, and Bramall, 2004, for skepticism). A lot of this literature resonates with Tawney's analysis, in particular Dore (1959, 1965) argues that the beneficial impact of land reform in Japan was because land was redistributed from absentee landlords to more efficient commercially minded farmers. There is even revisionist research on the impact of 'Fast-Track Land Reform' in Zimbabwe (Scoones, Marongwe, Mavedzenge, Mahenehene, Murimbarimba and Sukume, 2010) which makes a similar case.

2 Historical Background

In 1530 there were around 825 monasteries in England and Wales, housing around 10,000 people.¹² Overall, the Church is thought to have held between a quarter and a third of all land in England and Wales, as Table 1 suggested (see further Mingay, 1976, p. 44; Woodward, 1966, p. 33).

In two acts passed in 1532 and 1534 Parliament made Henry VIII, who had become king in 1509, head of the Church. At first, Henry's objective was to redirect the revenues that the monasteries paid to the Pope to himself. In order to calculate the size of income generated on which these revenues were based, and know how much he was likely to gain, Henry ordered an assessment of the yearly income of all ecclesiastical possessions in England. The resulting reports are published in 1535 as the *Valor Ecclesiasticus*.¹³

In 1536, however, parliament passed the Dissolution of the Lesser Monasteries Act. This act expropriated monasteries that had 200 pounds yearly income or less, and transferred their ownership to the Crown.¹⁴ By the end of 1536, over two hundred monasteries had been 'dissolved'. Between 1537 and 1540 all remaining monastic houses, large or small, in England and Wales were expropriated. The Act for the Dissolution of the Greater Monasteries, passed in 1539, provided the legal basis for this effort.

The government sent around commissioners who would, together with locally appointed officials, who as we discuss in Section 3 of the Appendix often turned out to be local gentry, visit a monastery and record its possessions and dependants. This resulted in an official Act of Dissolution, detailing what was to happen to all possessions and dependants of the monastery. Valuables, such as church bells and precious metals were shipped to the Tower of London. Most importantly, the land the monasteries owned was first transferred to the Crown and subsequently sold (Woodward, 1966). These lands, as we show in the Appendix section 3, became disproportionately owned by a new class of commercial farmers, the gentry.

¹²Woodward (1966, p. 2) cites the number 825. There were many types of monastic religious establishments, such as nunneries, friaries, abbeys and priories. We use the term monasteries throughout this paper. The monks, aside from maintaining property and collecting rents, engaged in prayer and singing for the local community, were active in education, were expected to provide food and lodging to travelers and to distribute alms to the poor. Many monasteries also provided social insurance or retirement schemes in the form of annuities. The abbots of the larger abbeys generally had a seat in Parliament (Woodward, 1966, Ch. 2.). Much has been written on the dissolution and the reformation more generally, see for instance Gasquet (1899), Woodward (1966), Youings (1971), Knowles (1979) and Duffy (2005). Savine (1909) deals exclusively with the *Valor Ecclesiasticus*. See Haigh (1993) and Bernard (2007) on the Reformation more broadly, Scarisbrick (1968) on Henry VIII and Elton (1953) on Henry's government.

¹³The titles and specifics of the relevant acts, the state of the surviving Valor records, the methods of the Valor enumerators as well as our method of coding the Valor data are all described in Sections 3 and 4 of the Appendix. Section 4 also includes a description the Valor records for the manor of Helton, Lolbroke and Bell as an example.

¹⁴Dissolution of church property was not without precedent in England. During the Hundred Years War and throughout the later Middle Ages, the alien priories, priories that were dependent on a monastery in France, were dissolved. In 1520, Cardinal Wolsey, dissolved some twenty monasteries to pay for the foundation and endowment of an Oxford college and a school in Ipswich. On the continent, Swedish, German and Swiss rulers had successfully dissolved several catholic monasteries in the early sixteenth century (Woodward, 1966, p. 49).

3 Data and descriptive statistics

For our empirical specifications, we use parishes from the *GIS of the Ancient Parishes of England and Wales*, based on the work of Roger Kain and Richard Oliver (Kain and Oliver, 2001), as our unit of observation. Parish boundaries have changed very little between the Dissolution and the Industrial Revolution, but place names of individual villages within our parishes sometimes change considerably over time. Section 4 in the Appendix describes the procedure we followed to assign observations in different datasets to the appropriate parish.

3.1 The Valor Ecclesiasticus

We obtain our main independent variable, monastic income (the log of $(1 + \text{Monastic Income})$), from the Valor. We use a transcript of the surviving original returns made by the British Record Commission in the first half of the nineteenth century as our source (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). We exploit the fact that each individual revenue generating unit, such as a manor or an individual tenant, is located in a village and a parish and, therefore, has a place name (see the example return in Section 4 of the Appendix). This enables us in principle to identify each unit and attributed it to a parish, even though the owner of the unit, such as a monastery, may be located elsewhere. This way we attribute income to the location where it is generated instead of to the location to where it accrues. Figure 3 maps the spatial distribution of Monastic properties across England. Not all income can be attributed to a geographical location. The Valor records sources of temporal income, income derived from physical assets such as land, which can be geographically located and spiritual income, income derived from holding a particular ecclesiastical office, such as a tithe, for which we cannot locate the location because it is recorded where it is received. We therefore restrict our measure to temporal income.

The Valor also records non-monastic church income and in fact the monasteries were not the only ecclesiastical units to be dissolved. Chantries (private chapels) and shrines were also dissolved, as were hospitals and religious guilds (Youings, 1971, p. 90). Moreover, by the middle of the 17th century most of the non-monastic Church land was expropriated or effectively transferred into private hands (Heal, 2008). One might hypothesize that this would have similar long-run effects as monastic lands. In the main text however we keep these separate and investigate empirically whether monastic and non-monastic lands have different consequences. In the Appendix we show our results are robust to aggregating the two types of land.

Locating each entry in the Valor this way yields a dataset of ecclesiastical income that covers modern

England almost entirely. We record zero income for parishes not mentioned in the Valor.

3.2 Outcome variables

Section 2 of the Appendix reports binned scatterplots for each outcome variable in this section.

3.2.1 The Mills

In 1838 Parliament ordered a return of the ‘number of persons employed, of the description of the manufacture, and of the nature and amount of the moving power in all the Factories...’ (Parliament, 1839, p. 3). The return records each industrial mill in England indicating its manufacture (cotton, wool, worsted, flax or silk), whether it was water or steam powered and the number of people employed. For employment we take total employment which includes not just adults of both sexes but also children.¹⁵ Figure 5 below maps the distribution of the number of mills. As one would expect there are a large number of mills in Lancashire and northwest England. Comparing with Figure 4 we see that this is not an area where monastic incomes were concentrated. Nevertheless, as we noted above, many factors shaped where the Industrial Revolution happened and we use a variety of empirical methods (such as county and hundred fixed effects) to control for these differences. Hence the presence or absence of raw correlation in these maps is not the object of most interest.

3.2.2 Occupational structure

We use the digitized version of the 1831 Population Census (Gatley, 2005) to compute shares of adult male population above twenty employed in different occupational categories.¹⁶ We focus on the share employed in agriculture which, on average, equals 62 percent across our dataset of parishes, the share in manufacturing which is only around 3 percent on average and the share employed in retail which, on average, equals 18 percent. Other categories that are distinguished are people employed as laborers, people employed as bankers or in other skilled professions and a category for those not fitting one of these categories.

¹⁵For example in the 1838 data children aged 0-9 made up 0.4% of total employment. Children aged 9-13 were 8.3%. Children aged 13-18 were 38.4% hence children aged 0-18 made up 47.1% of total mill employment.

¹⁶The 1831 census is the first proper complete census in England, earlier returns in 1801, 1811 and 1821 are both incomplete and were collected indirectly (for example by asking local priests).

3.2.3 Agricultural Yield

We use agricultural wheat yield as a measure of agricultural yield from the 1836 tithe surveys, digitized by Kain (1986). As part of the tithe commutation act of 1836 which commuted the tithe into money payments, agricultural statistics were collected for large parts of England. After assigning parishes to individual yield observations in this dataset we obtain a sample of 4148 parishes for which we have wheat yield, measured in bushels per acre.

3.2.4 Agricultural Patents

We compute the number of patent holders from the returns of patent holders in Woodcroft (1854) and previously used by Dowey (2013). These returns record the place of residence of the patent holders and we used this place to geographically locate the patents. We use the count of patents in a particular place, not the count of patentees (there can be multiple patentees on one patent). The variable we construct is the total number of patents that were registered to people living in a parish between 1700 and 1850.

3.2.5 The Gentry

The data on the presence of the gentry come from John Adams' *Index Villaris, or an Alphabetical Table of all Cities, Market-towns, Parishes, Villages, Private Seats in England and Wales* (Adams, 1700) which is a systematic survey of the 24000 largest cities/towns/villages in England published originally in 1680. We use the total number of gentry living in a particular locality from the most up to date version published by Adams, from 1700. Figure 6 maps the distribution of the gentry.

3.2.6 Enclosures

We use data on the location of parliamentary enclosures from *A Domesday of English enclosure acts and awards* by William Tate (Tate and Turner, 1978) as compiled and analyzed by Heldring, Robinson and Vollmer (2015). We record parishes mentioned in each enclosure act and code a dummy that is equal to one if land in a parish was enclosed between 1750 and 1840.

3.3 Control Variables

3.3.1 The Tudor Lay Subsidies

As discussed above, we exploit the fact that we have a proxy for income from just before the Dissolution of the monasteries to control for pre-existing differences. The source for this measure are the Tudor lay subsidies analyzed by John Sheail (Sheail, 1968, see Hoyle, 1994, for a useful introduction to interpreting Tudor tax subsidies). The original Lay Subsidy was carried out in 1524/25 and records tax raised and the number of taxpayers by parish or village. It taxed, for each household, the most important source of income of the head of a household, defined as either personal property, landed incomes, or wages (Sheail, 1968, p. 111).¹⁷ Tax rates were: a flat rate of four pence per pound if the primary source of income was wage income, one-fortieth (six pence per-pound) on goods and one-twentieth (one shilling per pound) on landed incomes. If the goods were valued at more than twenty pounds, the rate increased to one-twentieth as well. Hence taxation was to some extent progressive. If the household did not earn at least one pound in wages per year, had one pound in landed income per year, or possessed two pounds worth of goods, it was not recorded in the survey. In practice, most people were taxed on the goods they possessed.¹⁸ We use total tax raised per parish as our measure of pre-existing differences in prosperity.

3.4 Other Covariates

Since our main explanatory variable is the level of monastic income reported in the Valor in all regressions we control for the area of the parish to provide a flexible way of normalizing monastic income.¹⁹

Throughout our analysis we use several geographical covariates. Using ArcGIS we compute the distance to London, the distance to the sea or the border with Scotland (whichever one is nearest) and the distance to the nearest river (we include here all rivers with year round water flow (perennial) since we care more about water as a source of power than transport). From the Food and Agricultural Organization we got data on wheat suitability and soil type.²⁰ In ArcGIS we then measure for each of our parishes the

¹⁷The returns cover the entire country except the counties Northumberland, Durham, Cumberland, Westmorland and Cheshire (all in the North). The Cinque Ports (Hastings, New Romney, Hythe, Dover and Sandwich) are also omitted. If there were several returns available (such as one for 1524 and one for 1525) we averaged over the available returns.

¹⁸For instance, in the Earsham hundred of Norfolk, 70 percent of all people were taxed on goods. Furthermore, taxes on goods accounted for 90 percent of the total tax paid in this hundred. For Happing hundred in Norfolk, 90 percent of taxes were levied on goods (Sheail, 1972, p. 112).

¹⁹An alternative normalization would be population. Though the Lay Subsidy does give one measure of population it is highly incomplete given that poor people were not taxed so we prefer the area of the parish as a normalization. For an attempt to estimate total population figures from the 1524/25 Lay Subsidy see Campbell (1981).

²⁰The FAO has classified the earth's land surface into 32 reference soil groups, based on observable characteristics such as accumulation of organic matter and porosity (for a full description, see IUSS, 2014). These classification has been published as a GIS raster file. The most common soil types in our dataset are Cambisols ("Soils with at least the beginnings of horizon differentiation in the subsoil, evident from changes in structure, colour, clay content or carbonate content", p. 143), Gleysols ("Soils with clear signs of

soil type and wheat suitability under the centroid in this parish. Ideally, we would like to average over the shape, but the granularity of the suitability and soil type grids is too coarse to enable us to do this. We also control for elevation and slope, again measured under the centroid. To obtain the distance to the nearest coalfield for each parish we digitized a map of the coalfields in England and Wales in 1912 (Strahan, 1912) and computed the distance in ArcGIS. Finally, we control for distance to the nearest market town in 1680. This measure controls for proximity to an urban center (see more on the influence of urban units below). The data come from John Adams' *Index Villaris* which is described above.

3.5 Descriptive Statistics

Table 2 contains the descriptive statistics of our main variables. The first two columns give the means and standard deviations of the variables.

The next two sets of columns break down the data by coding a dummy variable which is 1 if a particular parish had at least one monastic property and zero otherwise. The third column presents the means of the variables for parishes which do contain monastic properties and the fifth column does this for parishes with no monastic properties. Columns four and six present the respective standard deviations. Column 7 then presents the difference in the means between monastic and non-monastic municipalities while the last column gives the t-statistic of a two-sided t-test of this difference.

For example, in the first row we report the log of 1+ monastic income. This has a mean of 0.71 for the whole sample with a standard deviation of 1.28. The mean for those parishes with monastic properties is 2.18 while that for non-monastic parishes is 0.00 by construction. In the second row we record the means of the log of '1+non-monastic' Church income (henceforth non-monastic income) which is significantly higher in monastic parishes. In the third row we aggregate monastic and non-monastic incomes into Valor incomes since we use this sum for robustness checks in the Appendix.

The raw data shows some interesting patterns. Considering the main outcome variables, we can see that the textile mill variables are higher in monastic parishes, even if not highly significant (and even insignificant in the case of total mill employment). In terms of the mechanisms the raw data are more supportive of the hypotheses, although the census data do not show an obvious pattern. While the share of employment in agriculture is the same in monastic and non-monastic parishes, and the share in retail is

groundwater influence", p. 150), Luvisols ("Soils with a pedogenetic clay differentiation (especially clay migration) between a topsoil with a lower and a subsoil with a higher clay content, high-activity clays and a high base saturation at some depth", p. 156) and an "Urban, mining, etc." group. Soil groups differ in irrigation and drainage requirements, salinity, and fertility, and are therefore differentially suitable for agriculture. Cambisols, for instance, "generally make good agricultural land and are used intensively" (p. 144). For Gleysols, on the other hand, "the main obstacle to utilization is the necessity to install a drainage system to lower the groundwater table" (p. 150).

higher in monastic parishes, the share in manufacturing is in fact significantly lower in monastic parishes. The average number of gentry, enclosures and patents are all significantly higher in monastic parishes than in non-monastic parishes.

However, caution is required. The issue of balance between monastic and non-monastic parishes is particularly important. Here we see a complex pattern. For example, though the monastic parishes are on average further from a coalfield, have lower elevation and slope, so less suitable for steam or water power, and further from the nearest river, they are also closer to London and the nearest market town and have higher wheat suitability. Monastic parishes also had significantly higher Lay Subsidy revenues prior to the Dissolution. These mixed findings make the matching approach we take in section 3.2 even more valuable since they allow us to construct a better control group. We revisit the issue of balance then.

4 Main results

4.1 Reduced Form Results

We now turn to examine the reduced form relationship between monastic income and our main outcome variables, starting with the 1838 Mill Census and then moving to the channels. The econometric model we use here is simple and of the form

$$y_p = \gamma_f + \alpha_M \cdot M_p + \mathbf{X}_p' \cdot \alpha_X + \varepsilon_p \quad (1)$$

Here y_p is our dependent variable of interest in parish p which could be, for instance, the number of mill employees in 1838 or it could be the proportion of the labor force employed in agriculture. M_p is log of 1+monastic income in parish p so that α_M is the main coefficient of interest. γ_f is a fixed effect which will be either at the county or hundred level, $f \in \{c, h\}$. The vector $\mathbf{X}_p'$ always includes the physical area of parish p and in extended specifications also includes all our other control variables, for example distance to London, terrain slope or the geographic suitability for wheat. Finally ε_p is the error term. We estimate (1) with Ordinary Least Squares. For our baseline results, we compute two types of standard errors, heteroskedasticity robust standard errors, which we report in parentheses, and Conley (1999) standard errors, that are adjusted for arbitrary spatial correlation in our data, which we report in square brackets. In section 3.2 we compare our OLS results to results from a matching estimator.

4.1.1 Using the 1838 Mill Data

Table 3 presents the most parsimonious way of estimating (1). There are three sets of columns with different dependent variables. The first two, (1) to (2) use a dummy variable =1 if parish p has at least one mill, =0 otherwise. The second two, columns (3) and (4), use the number of textile mills as the dependent variable. Columns (5)-(6) use instead use the total number of mill workers in a parish. The main difference between the two columns within each subset is the level at which the fixed effects are. The first set of columns ((1), (3) and (5)) just uses county fixed effects, the next three ((2), (4), and (6)) use hundred fixed effects. All specifications control for the area of the parish as a normalization. The first row records the coefficient on $\log M_p$. For example in column 1 we see that $\hat{\alpha}_M = 0.00876$ with a heteroskedasticity robust standard error of 0.0016 and highly significant. Column (2) uses hundred fixed effects instead of the county fixed effects which is a much lower level of aggregation. The coefficient increases somewhat and is as precisely estimated and so is still highly significant. It is interesting to note in all the specifications that the use of hundred fixed effects significantly increases the R^2 of the regression as one would expect.

In columns (3) and (4) we then estimate the same model but with the total number of mills as the dependent variable. The findings here are very consistent across specifications with the use of hundred fixed effects again increasing the size of the coefficient when we use this more fine way of accounting for unobservables. For example, in column (4) when we use hundred fixed effects we find $\hat{\alpha}_M = 0.0671$ (robust s.e.=0.0249) and significant at the 1% level.

The final two columns then use the total number of people employed in mills as the dependent variable. Columns (5) and (6) show that there is a robust positive correlation between the monastic income and this variable and neither the estimated effects nor the standard errors vary much across specifications.

Comparing the Conley (1999) standard errors to the heteroskedasticity robust errors suggests that spatial correlation is not a potentially important issue and all the results discussed above are identical with the Conley standard errors.

These results suggest that there is a robust and positive correlation between the importance of monastic income in a parish in the 1530s and the subsequent extent of industrialization. As we noted in the introduction these effects are quantitatively important. A one standard deviation increase in monastic income as recorded in the Valor increases the number of mills by 0.09. The mean number of mills in a parish in England in our sample is 0.17. Increasing monastic income by one standard deviation increases the number of mills by about half its mean when we use the specification with county fixed effects (column (4)).

Table 4 examines further the robustness of our main results. As in Table 3 there are three sets of columns corresponding to the different dependent variables. We use hundred fixed effects in all specifications in the table, but we now report standardized coefficients to facilitate comparisons across point estimates. The three sets of columns have a structure similar to table 3. In the first column of each ((1), (4) and (7)) the only covariate is the log of Lay Subsidy revenues raised in that parish in 1524/25. In the second set of columns ((2), (5) and (8)) we control instead for non-monastic Church income. As we noted above, by 1650 most of this had also been expropriated so despite Tawney's hypothesis being about monastic incomes, it is interesting to examine the impact of this variable. Columns (3), (6) and (9) instead control for a set of geographical variables: terrain elevation and slope and wheat suitability, distance to nearest river, market town, to the border, to London and to the nearest coalfield and a vector of soil type dummies.

The main point of this table is to show that the results of Table 3 hold when we control for our proxy for pre-existing income differences across the parishes, non-monastic incomes and for the geographical variables. These could be picking up several things, for instance factors which might be influencing the intrinsic income of an area, perhaps through agricultural productivity, or alternatively factors that might influence industrialization, perhaps because they facilitate the use of water or steam power. They also capture transportation costs and proximity to large centers of demand, which again likely influenced the location of textile mills. We see that the Lay Subsidy in 1524/25 variable is typically positive and significant, but does little to alter the robustness of our basic results in Table 3. An interesting result is that the impact of non-monastic incomes on the mill outcomes tends to be positive and statistically significant and moreover is quantitatively larger than the monastic income. This is plausible since some of the choicest lands were held not by the monasteries but by cathedrals and bishops. For our purposes the most interesting finding is that controlling for non-monastic income has little impact on the coefficient of interest except that monastic income is not longer significant when the dependent variable is total mill employment.

Though they do little to alter the main coefficient of interest some of the estimated coefficients on the controls are interesting. For example, there are significant negative relationships between distance to market towns and coalfields and industrialization, precisely as one would hypothesize.

All in all the conclusion from Table 4 is that the basic results of Table 3, that there is a strong positive conditional correlation between the impact of the Dissolution of the monasteries in the 1530s and the presence of the Industrial Revolution in the early 19th century, are robust.

4.2 Matching

We have argued so far that we find it unlikely that, conditional on our set of covariates, there are unobservables that are correlated with the location of monasteries as well as the location of subsequent industrial activity. To further assess the validity of this claim, we now use these covariates to implement a matching exercise.

We define a monastic presence dummy which is equal to one if parish p has at least one monastic property in the Valor Ecclesiasticus, and equal to zero if parish p has church property in it, but no monastic property. This implies that we lose observations having neither, but enables us to construct a control group that is plausibly more similar to our monastic treatment group.

To match monastic parishes to church parishes, we implement a nearest neighbor match.²¹ We start by computing the Mahalanobis distance, D_{ij} , for every monastic parish i to each parish j without monastic presence. The Mahalanobis distance is defined as:

$$D_{ij} = \sqrt{(\mathbf{X}_i - \mathbf{X}_j)' \mathbf{S}^{-1} (\mathbf{X}_i - \mathbf{X}_j)} \quad (2)$$

Where $\mathbf{X}_k$ for $k = i, j$ is a vector of covariate data and $\mathbf{S}^{-1}$ is the variance covariance matrix of $\mathbf{X}_j$. We then proceed to match every parish i with monastic property to the parish j without monastic property that has the lowest Mahalanobis distance. Finally, we compute the average difference in outcomes across the matched samples for those parishes with monastic presence. In other words, we compute the average treatment effect on the treated (ATT), where treatment is defined by monastic presence.

Table 5 Column (2) reports results of our matching approach using presence of textile mills and occupational structure as dependent variables. Column (1) reports differences in means for these variables for the subsamples defined by the monastic presence dummy, and column (3) reports results from an OLS regression including the set of matching variables as covariates. As expected, the matching results are qualitatively similar to our previous regression results reported in Tables 3 and 5. The monastic presence dummy is positively correlated with the presence of a textile mill, the number of mills and mill employment, and all effects are significantly different from zero.

Columns (1) and (3) provide useful comparisons to our matching results. Comparing columns (1) and (2) is informative about selection into monastic presence. For a given outcome variable, if the raw dif-

²¹We match, with replacement, on the following set of variables: $\ln(1 + \text{non monastic income})$, area, slope, elevation, distance to the nearest river, distance to the nearest coalfield, distance to the nearest market town, and distance to London. For area, slope, elevation and distance to the nearest river, we include squared terms as well. Because we match on positive values of non-monastic property, we use a subsample of our data consisting of parishes with positive values for monastic property, non-monastic church property, or both.

ference in means is very different from the matching result, this means that there could be selection into monastic presence that is correlated with the outcome of interest. For instance, the raw difference for mill employment is close to zero and insignificant. Yet when we match we obtain a positive and significant result. For mill employment, therefore, there is potentially selection into treatment along one (or more) of our matching variables. Comparing columns (2) and (3) provides a check on the matching procedure. Angrist and Pischke (2009) show that the key difference between matching and OLS is weighting. Matching puts most weight on observations with the highest probability of receiving treatment whereas OLS puts most weight on observations with a probability of treatment closest to $1/2$. They argue that since both approaches are in essence weighted differences of means, OLS and matching estimates should not be too dissimilar. Comparing columns (2) and (3), this is what we find. Our OLS results are the matching results, both in size of estimated effects as well as in significance, though the OLS results are estimated with less precision.

Matching gains its legitimacy as a technique for causal inference from the idea that if there is no selection into treatment, conditional on covariates, differences in means across treatment and control groups have a causal interpretation (Imbens and Wooldridge, 2009). We now assess the extent to which our matching approach has been successful in moving towards conditional independence of monastic presence.

Table 6 reports covariate balance before and after matching, for our vector of matching covariates, as well as for two covariates we do not match on. Column (1) reports means for those parishes with monastic presence in the *Valor Ecclesiasticus* (i.e. those parishes for which the monastic presence dummy is equal to one). Column (2) reports the mean for parishes without monastic presence, but with church presence (i.e. those parishes for which the monastic presence dummy is equal to zero). Column (4) report means across the subset of control observations that has been matched at least once using our nearest neighbor matching procedure. The columns of interest in this table are (3) and (5) where we report p-values from a two sided t-test of the differences of the means in columns (1) and (2), and columns (1) and (4), respectively. Column (3), therefore, reports covariate balance before matching. Aside from distance to the nearest river and distance to the nearest market town none of the covariates balance. After matching, column (5), virtually all covariates balance within the set of matching variables. For illustration, we also report balance on two covariates not in our matching set: Our measure of pre-dissolution economic differences, taxation recorded in the Lay Subsidy revenues and soil suitability for growing wheat. Both covariates do not balance before matching, but do balance after.²²

²²Two covariates' post-matching means are closer to the treatment mean, but do not balance. First, the log of non-monastic income

The matching results in this section have focused on the distinction between monastic and non-monastic church property. Confirming our earlier results, we find that parishes where monasteries held income generating assets in 1535, display more industrial activity, employ fewer workers in agriculture and more in manufacturing and retail trade, relative to those parishes that are similar in terms of our set of observable covariates but which did not contain monastic assets. A weakness of the matching approach is that matching by definition relies only on observables. Section 3.3.3 discusses a sensitivity test of our results to the omission of unobservables.

4.3 Further Robustness Checks

We now conduct some more robustness tests to further probe our findings.

4.3.1 Alternative Ways of Coding the Valor

So far we have measured the impact of the Dissolution in a particular parish by the income which accrued to monastic properties in that parish according to the Valor or by a dummy variable equal to one when a parish had a monastic property, equal to zero when it had only non-monastic church property, and missing otherwise. These are of course imperfect proxies for what we would really like to measure since we can observe neither the proportion of the land area nor the fraction of property of a parish owned by the Church, nor how productive particular pieces of land were. We now investigate the robustness of our results using three alternative appealing ways of measuring the impact of the Dissolution in a parish. We first constructed total ecclesiastical income, adding monastic and non-monastic income in each parish. Second, we built a count variable which is equal to the number of monastic properties in a parish. Our final approach is to code a dummy variable which equals 1 if parish p contains at least one monastic property, and zero otherwise.

The results of using these other three measures of impact are recorded in the Appendix. Table A-1 shows results using the log of 1+Valor income for our main dependent variables from the 1838 Mill Census. All results show a positive and significant correlation. The interesting finding in this table is that we find that our basic results are very robust to these different ways of measuring the impact of the Dissolution.

does not balance. This is unsurprising since treatment status is defined by the relative absence of non-monastic property. Second, parishes generating monastic income are also 0.4 square kilometers larger, on average, than those that do not. Forcing balance on (a discretized measure of) parish area reduces balance across other covariates (results not reported). Note that we include parish area in all specifications in this paper.

4.3.2 Relaxing the fixed effects

In our results so far we included fixed effects at the county level ($n=43$) and at the hundred level ($n=965$). We believe that these fixed effects can account for unobservables at the county and hundred level that would confound our estimated relationships when not included. Restricting to within-county and within-hundred variation, however, precludes drawing conclusions about the pattern of industrialization across England. Although we believe that our estimation strategy is not particularly well suited to speak to these patterns, we nevertheless relax our fixed effects and report results from re-estimating equation 1 in table A-1 in the Appendix. Specifically, we report results for our main dependent variables from the 1838 Mill Census without any fixed effects and with a North-South fixed effect, which splits England in two parts, one formed by Cheshire, Cumberland, Derbyshire, Durham, Lancashire, Lincolnshire, Nottinghamshire, Northumberland, Staffordshire, Westmorland, Yorkshire: West Riding, Yorkshire: East Riding, Yorkshire: North Riding and one formed by all other counties. We find a positive and significant effect for the mill dummy, and no consistent positive effect for the number of mills and mill employment. Given that between the Dissolution in 1535 and 1838, when we measure the presence of mills, economic activity shifted from the South to the North (Darby, Glasscock, Sheail, Versey, 1979), it is no surprise that the number of mills and mill employment, measuring the intensive margin of economic activity are no longer significant when relaxing the fixed effects (although the estimated effects are still positive).

4.3.3 Selection on unobservables

This section assesses the sensitivity of our results to selection on unobservables, following Altonji et al. (2005) and Bellows and Miguel (2009). The idea is to use the reduction in an estimated coefficient resulting from including covariates (selection on observables) to get an estimate of the potential bias introduced by the omission of unobservables. To implement this idea, consider estimating equation (1) twice, using two sets of covariates. In the first regression, we include parish area and hundred fixed effects, and in the second we use an extended set of covariates.²³ Let the estimated coefficients on the the log of monastic income be $\hat{\alpha}_{baseline}$ and $\hat{\alpha}_{extended}$, respectively. Using these coefficients, we compute the ratio $b = \frac{\hat{\alpha}_{extended}}{\hat{\alpha}_{baseline} - \hat{\alpha}_{extended}}$. If $b = 1$ selection on unobservables will explain our result away if the bias introduced by omitting unobservables is at least as large as selection on observables, measured by the difference in estimated coefficients between the baseline and extended regressions. For $b > 1$, selection on unobservables would have to be stronger than selection on observables to explain away the result.

²³We include parish area, elevation, slope, soil suitability for wheat, distance to the nearest river, distance to the nearest market town, distance to the border and distance to London as covariates, as well as soil type dummies and hundred fixed effects.

Table A-2 in the Appendix reports estimates of b using our set of dependent variables. The lowest ratio is lowest for Mill Employment (10), and the median ratio is 12.4. What does this mean for our results? Taking Mill Employment as an example, $b = 10$ indicates that selection on unobservables would have to be ten times as strong as selection on observables to explain away our results. Since we have included the Lay Subsidy revenue to control for pre-existing income differences, several measures of potential agricultural yield, direct measures of competing explanations for the location of industrial activity (such as proximity to coal), as well as restrictive fixed effects, we believe it is unlikely that there are unobservables that, when included, would reduce our estimated coefficient to zero.

4.3.4 Dropping urban parishes

One might be concerned that our results are driven by the fact that monastic orders owned properties in urban areas and that these were also places where industrialization took place (obviously the Industrial Revolution was associated with very rapid urbanization). We tried to address this issue so far by using various types of covariates, but here we take a more direct strategy and check that our results are robust to dropping urban parishes. Table A-3 in the Appendix shows two sets of results, which differ in the way urban is defined. The first three columns consider parishes urban if they are coded as urban in the 1831 Census. The second set of results uses post-1832 reform parliamentary constituencies. Parliamentary constituencies were either county constituencies or borough constituencies. For these columns we treat all parishes falling in a borough constituency as urban. Using our main dependent variables from the 1838 mill census as dependent variable, and controlling for hundred fixed effects, this table shows that our main results are insensitive to dropping urban parishes.

4.3.5 North-West England

As a final robustness check, we restrict our sample to North-West England. We have argued that monastic presence increased local industrial activity. We would therefore expect our results to hold within any subdivision of the country, and especially in the industrial North. Table A-4 in the Appendix presents results for this exercise, using our main dependent variables from the 1838 Mill Census. In panel I, the sample is restricted to observations from the Northwestern counties Cumberland, Westmorland, Lancashire, Yorkshire West Riding, Cheshire, Derbyshire, Nottinghamshire and Staffordshire. In Panel II, the sample is further restricted to Lancashire, the heart of the Industrial Revolution. In both restricted samples, our

results are similar to our main results. Some of the estimated coefficients lose some precision, which is most plausibly driven by the smaller sample size. However, the size of the coefficients goes up as we restrict the sample. Using observations in Lancashire, the estimated coefficient for the mill dummy using hundred fixed effects is ten times larger than when we use the full country sample.

5 Examining the Channels

We now move to examine three of the channels via which the dissolution of the monasteries might have influenced the Industrial Revolution following our discussion in the introduction. Our econometric strategy is to re-estimate (1) by OLS letting y_p be one of our intermediate variables.

5.1 Occupational structure

We now re-work Tables 3 and 4 with different dependent variables taken from the 1831 Population Census. In Table 7 we reproduce Table 3 where there are again three sets of columns, the first uses the proportion of the labor force in agriculture, the second the proportion of the labor force in manufacturing and the final set uses the proportion of the labor force employed in retail. The columns differ within these sets by the different type of fixed effect as before. In column (1) we use county fixed effects and find that $\hat{\alpha}_M = -0.0139$ (robust s.e.=0.00174) and these results are unchanged when we use hundred fixed effects. In all cases there is a significant (at the 1% level) negative relationship between monastic income and relative employment in agriculture. In columns (3) and (4) we change the dependent variable to the share of the labor force employed in manufacturing. Here there is no significant relationship when we use county fixed effects, but with hundred fixed effects, a more attractive strategy for controlling for unobservables, we find a significant positive correlation at the 5% level. In the final set of columns we again find robust and highly significant correlations. For example, in column (6) when we use hundred fixed effects we find $\hat{\alpha}_M = 0.00879$ (s.e.=0.000918) so there is a positive and highly significant correlation between monastic income and the proportion of the labor force in retail.

We find smaller quantitative effects for the employment data in the 1831 census. For the share of males over 20 employed in agriculture we find that a one standard deviation increase in monastic income decreases this share by 0.02, compared to a mean of 0.62. For employment in manufacturing the effect is, expressed as a fraction of the mean of the dependent variable, twice as large. Increasing monastic income increases the share by 0.002, compared to a mean of 0.03. For employment in retail, increasing monastic income increases the share by 0.007, compared to a mean of 0.18.

Table 8 then probes the robustness of the results of Table 7 using exactly the same strategy and structure as Table 4. For the share of the labor force in agriculture and retail the addition of covariates has little effect on the magnitude of the estimated coefficients or the significance. However, for the manufacturing share, the results are now more significant and robust. There is also some evidence here that Lay Subsidy revenues is associated with less of the labor force in agriculture and more in retail, which is also true of non-monastic income. Neither variable is significantly correlated with the share of the labor force in manufacturing however. As before the geographical covariates have little impact of the estimated coefficient on monastic income or its standard error.

Taken together these last two tables suggest that in places which had more monastic lands in the 1530s and where the Dissolution of the monasteries had a bigger relative impact, there was subsequently more of a movement out of agriculture and into manufacturing and retail, a process which is clearly linked to structural change and the Industrial Revolution.

5.2 Agricultural yield and patents

In this section we focus on changes in agriculture, and how these are impacted by the Dissolution. Specifically, we look at agricultural productivity, measured by wheat yields and innovation in agriculture, measured by the number of agricultural patents filed by residents of parish p in the period 1700-1850. As in the previous section, we repeat the basic structure of tables 3 and 4.

Table 9 reports the basic results where we just control for fixed effects at different levels. In columns (1)-(2) we use wheat yield as the dependent variable. We see that there is a robust and positive correlation between monastic income and wheat yield, when using county fixed effects. When including hundred fixed effects, we lose power due to the limited availability of the yield data, which is available for about one quarter of all parishes in England. The estimated effect using hundred fixed effects, although insignificant, is positive. The final two columns examine the impact of monastic income on agricultural innovation as measured by the total number of patents registered to inhabitants of a particular parish between 1700 and 1850. We find that there is a significant and positive relationship which changes little when we use fixed effects at different levels. For example, with the hundred fixed effects in column (6) we find an estimated coefficient of $\hat{\alpha}_M = 0.0183$ (s.e.=0.00377) which is significant at the 1% level.

We now turn to the magnitude of the effects for the various channels we consider in Table 9. We consider again the specifications with fixed effects at the hundred level. Relative to a mean of 21.86 bushels per acre, a one standard deviation increase in monastic income increases yield by about 2.1 bushels. Fi-

nally, the mean number of agricultural patents is 0.02, and increasing monastic income by one standard deviation increases this number by 0.02, or the size of its mean using column (6).

Table 10 then reproduces our basic robustness checks with very similar findings to those from before, again standardizing every coefficient. Lay Subsidy revenues is positively and significantly correlated with the dependent variable in all columns. The story with respect to non-monastic incomes in columns (2), (5) and (8) is similar. Nevertheless, monastic income remains highly significant. Our baseline results here are also robust to all of the geographic covariates which do little to change the magnitude of the coefficient or the standard error. Again, some of these are of independent interest. For example, the further away from a market town a parish is, the less patenting there is.

5.3 The rise of the Gentry and parliamentary enclosure

We now examine the impact of monastic income on the Rise of the Gentry and parliamentary enclosure between 1750 and 1840. We use the number of gentry present in parish p in 1700 (Adams, 1700) and a dummy = 1 if a parish is mentioned in a parliamentary enclosure act between 1750 and 1840 in the same empirical framework used in the previous section.

Table 11 reports results varying fixed effects across columns. For both the presence of the gentry and parliamentary enclosure, we find very robust and significant effects. Since in columns (3) and (4) the dependent variable is a dummy one can interpret this model as a linear probability model so what we find is that the greater was monastic income the higher was the probability that land within a parish would be enclosed by an act of parliament. This is consistent with the evidence we cited in the introduction that the gentry were very active in parliament and promoted legislation that furthered their economic interests.

Turning to quantitative effects, in 1700 there were on average 0.66 members of the gentry in a parish in our sample. Increasing monastic income by one standard deviation we see an increase of 0.12 members of the gentry, or around one fifth of the mean. Similarly, the mean probability of having land enclosed is 0.37. Increasing monastic income by a standard deviation increases the probability of being enclosed by 0.03, or about one twelfth of the mean, using column (4). Table 12 repeats the robustness exercises of table 10. The patterns of table 11 are robust and stable throughout all estimations.

The results of this section then give credence to all the channels we suggested. First, we find that places that were impacted more by the Dissolution are more productive and innovative in agriculture while employing more people outside agriculture. We also show that Tawney was indeed correct that there was an association between the Dissolution and the rise of the gentry. Since the empirical evidence for this has

been very controversial (see the essays in Stone, 1965b, and Cooper, 1983), this finding is interesting in itself. It also shows that places where it is likely that the Dissolution had more impact tended to have more enclosures, a policy which favored the construction of infrastructure and the rationalization of farming practices and the same places also tended to have more innovation in agriculture.

5.4 Results for different Monastic Orders

Recent work by Andersen et al. (2013) has argued that the Cistercian monastic order had a positive long-run effect on English economic growth, through the order's emphasis on thrift and hard work. We compare the Benedictines, who were established in England before the Danish conquest, to the Augustinians and the Cistercians, who arrived in England in the 12th century (Gasquet, 1899). We use the share of monastic properties in parish p (such as individual manors, or fields in villages) that were owned by a particular monastic order as independent variables and we use the non-monastic income as a covariate. By considering the share of properties belonging to different orders for a similar level of non-monastic income, we focus on the identity of the owner of a particular property rather than on the size of the properties or the size of the ecclesiastical sector in that particular parish.

Table 13 reports results for the location and scale of the textile industry. A greater share of properties owned by the Cistercians does not correlate significantly with presence of a textile mill, the number of textile mills, nor with total employment in textile mills. This finding supports the idea that the Cistercians were operating their lands efficiently before the Dissolution, consistent with Andersen et al. (2013). A greater share owned by the Benedictines or Augustinians, on the other hand, is positively correlated with industrial development. This finding suggests that these orders were farming inefficiently before the Dissolution.

6 Conclusions

In this paper we conducted what to our knowledge is the first empirical investigation of the long-run economic impact of the Dissolution of the monasteries in England between 1536 and 1540. Tawney (1941a,b) first proposed that the Dissolution and subsequent sell off of church land, representing around 25-30% of land in England, created a huge shock to the social structure. In particular, he argued that it precipitated the rise of the gentry, a new commercially oriented class of farmers who played a leading role in the political conflicts of 17th century England. Though historians now do not believe that the evidence which Tawney presented supports his original arguments about the connections between the gentry and

the Civil War or Glorious Revolution, we argued that nevertheless both theory and case study evidence leads one to hypothesize that there might be a reduced form relationship between the Dissolution, the rise of the gentry and the location of the Industrial Revolution.

The bulk of this paper investigates precisely this. To measure the impact of the Dissolution at the parish level we digitized the Valor Ecclesiasticus, the survey of church incomes that Henry VIII commissioned just prior to the Dissolution. We showed that the greater was monastic income according to the Valor, the more industrialization there was in 1838 in terms of the presence and number of textile mills and the number of mill employees. We also showed that greater levels of monastic income in 1535 were associated with a smaller proportion of the labor force employed in agriculture according to the 1831 Census, and a larger share of the labor force employed in manufacturing and retail. We further argued that there are grounds for believing that these correlations can be interpreted causally.

In addition to this reduced form evidence we explored some of the likely channels via which the Dissolution might have impacted industrialization. We showed that parishes which had higher levels of monastic income had more gentry in 1700, consistent with Tawney's original thesis. We also showed that they were more likely to have land enclosed, consistent with the notion that the gentry influenced policy via their large influence on Parliament. Finally, we also showed that higher levels of monastic income were associated with a greater number of agricultural patents, suggesting that the rise of the gentry was associated with greater agricultural innovation.

All in all, our findings support Tawney's hypothesis that the rise of the gentry was associated with the Dissolution of the monasteries and our evidence further suggests that it was also connected to perhaps an even more momentous event, the Industrial Revolution.

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Figure 1: Binned scatterplot for Monastic income and mill dummy. $\mathbf{X}$ includes parish area and hundred fixed effects.

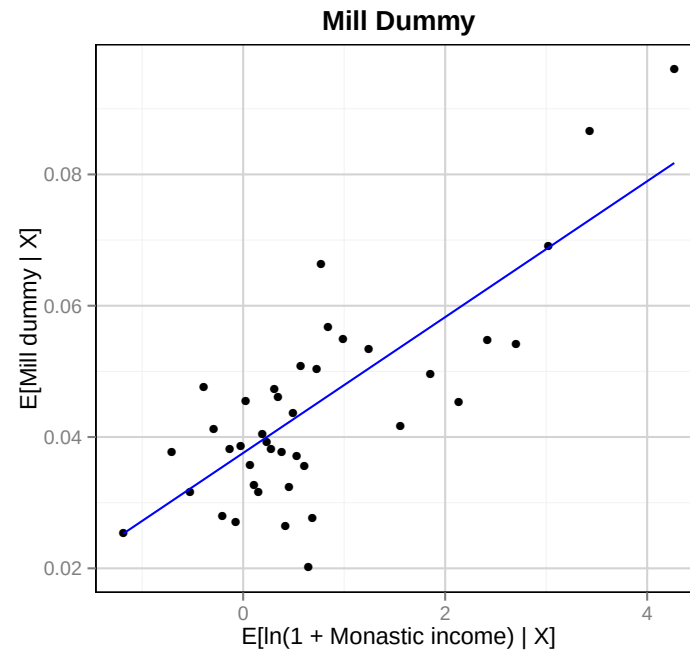
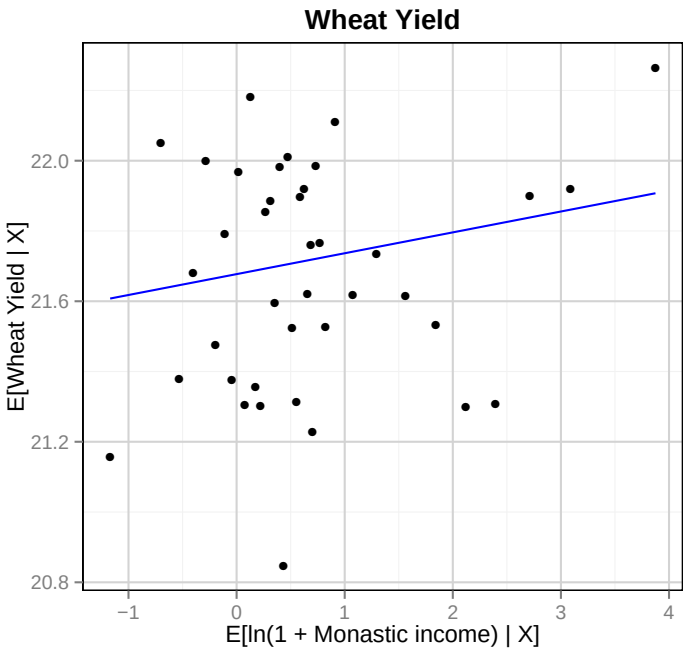


Figure 2: Binned scatterplot for Monastic income and Wheat Yield. X includes parish area and hundred fixed effects.



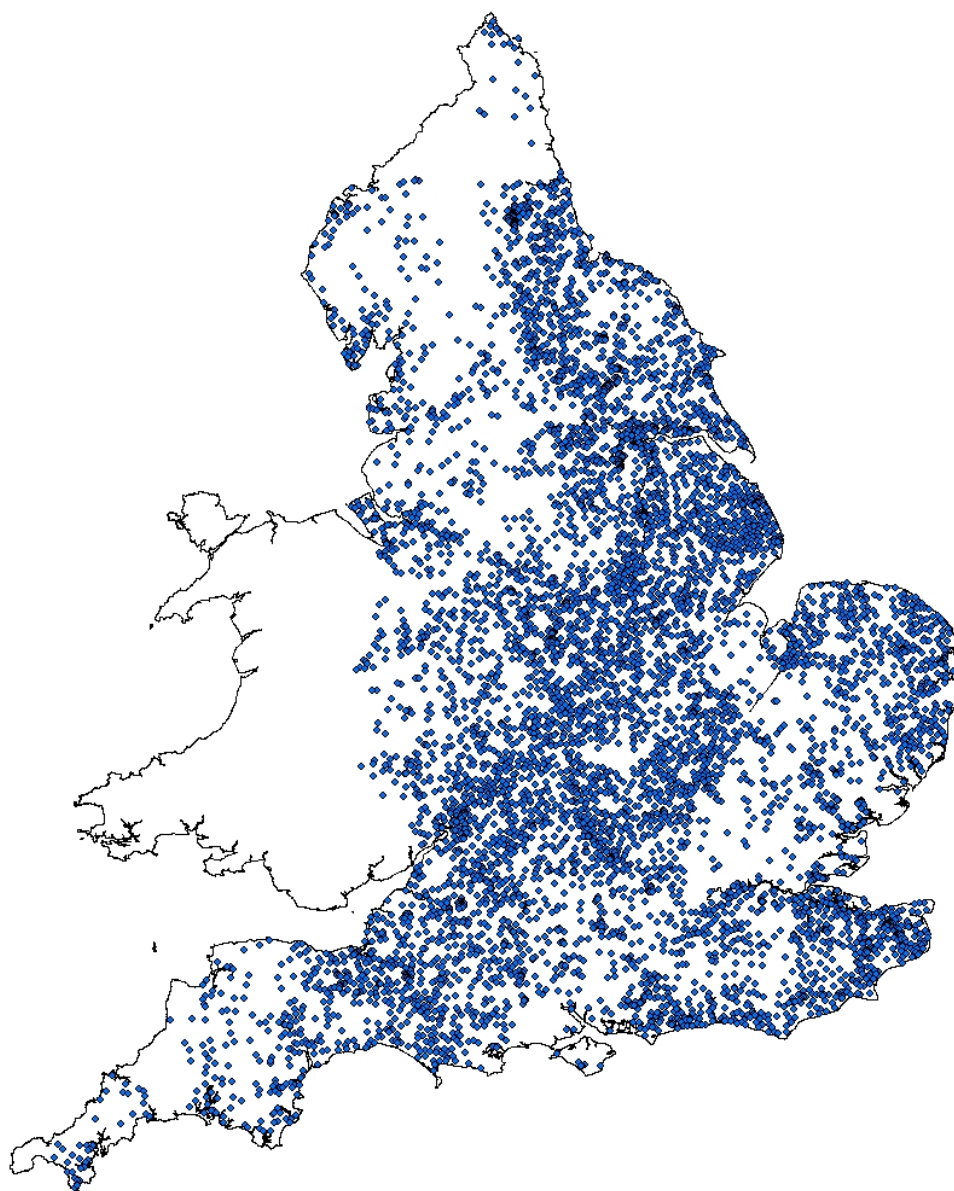


Figure 3: Spatial distribution of Monastic property. One dot indicates at least one monastic property in 1535.

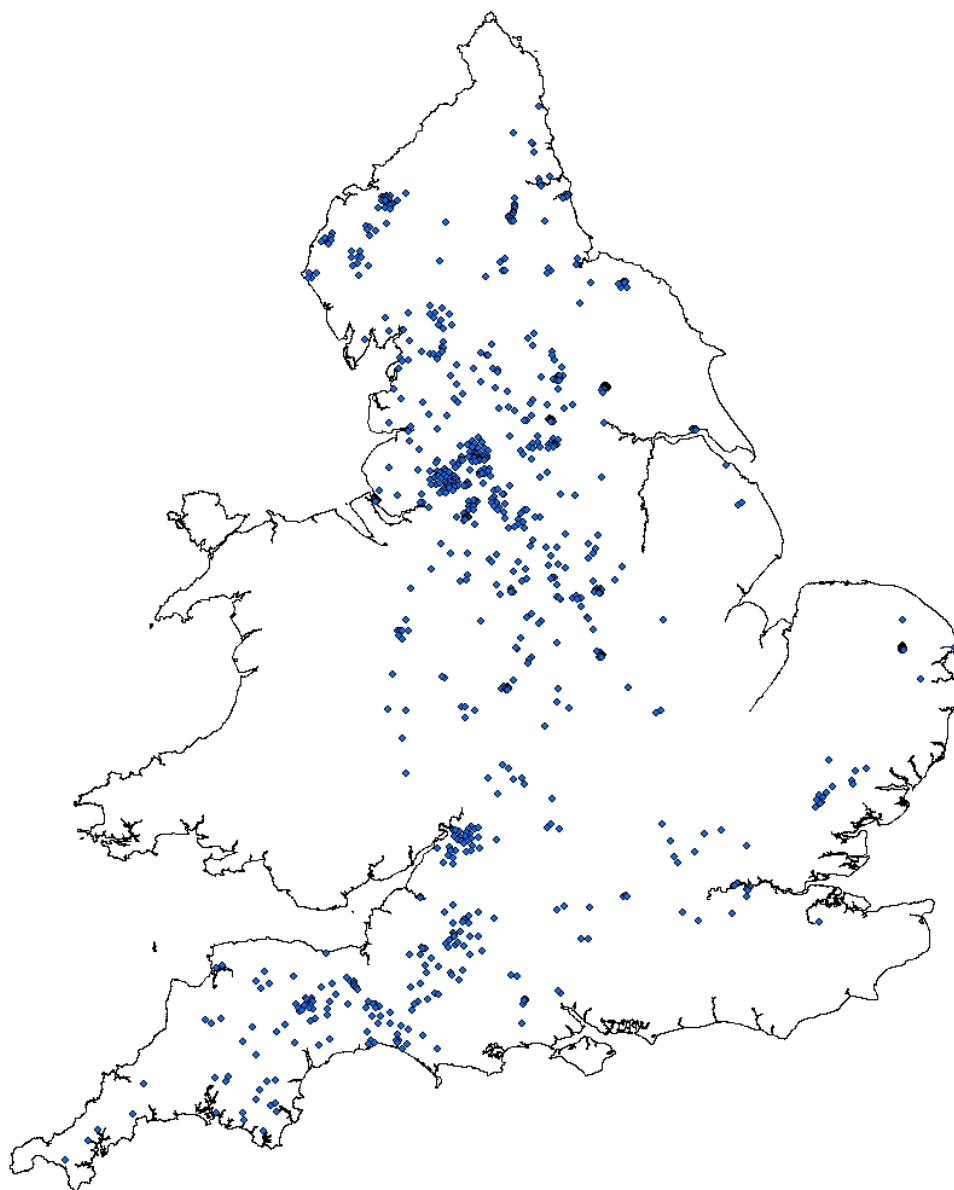


Figure 4: Spatial distribution of mills in England. One dot indicates at least one mill in 1838.

Table 1: Distribution of Landownership in England in 1436 and 1688: Percentages of cultivated land owned

	1436	1688
Aristocracy and greater gentry	15-20	15-20
Middling and lesser gentry	25	45-50
Yeomen, family farmers and other small owners	20	25-33
Church & Crown	25-35	5-10

Notes: Adapted from Clay (1986, p. 143)

Table 2: Summary statistics for selected variables

	Full sample		Monastic dummy = 1		Monastic dummy = 0		Difference of means	
	mean	sd	mean	sd	mean	sd	difference	t-stat
ln(1 + Monastic Income)	0.71	1.28	2.18	1.34	0.00	0.00	2.184***	(170.78)
ln(1 + Non Monastic Income)	1.05	1.36	1.57	1.44	0.79	1.24	0.778***	(35.55)
ln(1 + Valor Income)	1.46	1.56	2.84	1.23	0.79	1.24	2.043***	(98.75)
ln(1 + Lay Subsidy Income)	3.16	3.34	4.08	3.34	2.72	3.24	1.363***	(24.86)
Mill dummy	0.04	0.20	0.05	0.21	0.04	0.20	0.00769*	(2.26)
Nr. of Mills	0.17	4.05	0.27	6.68	0.13	1.70	0.136*	(2.01)
Mill Employment	15.68	279.71	18.70	328.64	14.23	252.91	4.471	(0.95)
Wheat Yield	21.68	4.49	21.83	4.45	21.61	4.51	0.218	(1.47)
Share of males in Agriculture 1831	0.62	0.25	0.62	0.24	0.62	0.25	-0.00831	(-1.82)
Share of males in Manufacturing 1831	0.03	0.11	0.03	0.09	0.04	0.11	-0.00867***	(-4.46)
Share of males in Retail 1831	0.18	0.13	0.19	0.13	0.17	0.13	0.0183***	(7.86)
Nr. of Gentry in 1700	0.67	1.00	0.87	1.11	0.58	0.92	0.291***	(17.61)
Parliamentary Enclosure 1750-1840	0.37	0.48	0.48	0.50	0.32	0.46	0.161***	(20.25)
Nr. of Agricultural Patents 1700-1850	0.02	0.28	0.04	0.37	0.02	0.23	0.0253***	(5.33)
Terrain elevation	88.41	75.54	78.37	63.62	93.23	80.19	-14.86***	(-11.80)
Terrain slope	2.63	1.96	2.36	1.65	2.76	2.08	-0.395***	(-12.11)
Wheat suitability	37.68	15.45	40.32	14.33	36.41	15.81	3.917***	(15.24)
Distance to nearest river	2.47	2.12	2.58	2.16	2.42	2.10	0.158***	(4.45)
Distance to nearest market town	6.12	3.41	5.88	3.16	6.24	3.51	-0.354***	(-6.21)
Distance to the border	26.26	21.44	27.00	22.02	25.90	21.15r	1.107**	(3.09)
Distance to London	199.18	107.16	178.81	90.02	208.95	113.18	-30.14***	(-16.95)
Distance to nearest coalfield	42.51	41.06	43.53	40.13	42.02	41.49	1.513*	(2.20)
Observations	16291		5281		11010		16291	

Notes: Monastic dummy is an indicator variable that is equal to one if parish p contains at least one property in the Valor Ecclesiasticus that belonged to a monastery. If parish p contains no monastic properties, the monastic dummy is zero. The difference of means columns report the difference between the means of the subsamples defined by the monastic dummy and the significance of this difference, obtained from a two-sided t-test. * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 3: Monastic Income and the Location and Scale of the Textile Industry

	Mill dummy		Number of Mills		Mill Employment	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(1 + Monastic Income)	0.00876*** (0.00160) [0.00159]	0.0106*** (0.00155) [0.00149]	0.0492** (0.0210) [0.0209]	0.0671*** (0.0249) [0.0241]	5.095** (2.291) [2.288]	6.519** (2.538) [2.4612]
Control for Parish area	Y	Y	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred	County	Hundred
Mean dep. var.	0.04	0.04	0.17	0.17	15.68	15.68
Observations	16243	16243	16243	16243	16243	16243
R^2	0.053	0.334	0.011	0.743	0.022	0.128

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Conley (1999) standard errors adjusted for arbitrary two-dimensional spatial correlation are reported in square brackets. These errors are constructed assuming weights equal to one for observations less than four decimal degrees apart, and weights equal to zero for observations further apart. Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). ln(1 + Monastic Income) is the natural log of monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 4: Textile mills and controls

	Mill dummy			Number of Mills			Mill Employment		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(1 + Monastic Income)	0.0631*** (0.00967)	0.0521*** (0.00957)	0.0642*** (0.00959)	0.0189** (0.00758)	0.0131** (0.00655)	0.0196*** (0.00729)	0.0252** (0.0109)	0.0146 (0.0112)	0.0270** (0.0110)
ln(1 + Lay Subsidy Income)	0.0391*** (0.0108)			0.0253*** (0.00802)			0.0517*** (0.0182)		
ln(1 + Non Monastic Income)		0.0837*** (0.0107)			0.0465*** (0.0137)			0.0876*** (0.0272)	
Terrain elevation			-0.0558*** (0.0198)			-0.0149 (0.0198)			-0.000167 (0.0246)
Terrain slope			0.0727*** (0.0173)			0.00718 (0.00844)			0.00355 (0.0120)
Wheat suitability			-0.00207 (0.0128)			0.0160* (0.00876)			0.00565 (0.0183)
Distance to nearest river			-0.0507*** (0.00809)			-0.00597 (0.00390)			-0.0117* (0.00599)
Distance to nearest market town			-0.0458*** (0.0117)			-0.0178** (0.00809)			-0.0479*** (0.0173)
Distance to the border			-0.0320 (0.0371)			0.0374* (0.0205)			0.0320 (0.0333)
Distance to London			0.339** (0.159)			-0.0158 (0.102)			-0.0516 (0.209)
Distance to nearest coalfield			-0.0964* (0.0586)			-0.0644** (0.0268)			-0.121* (0.0626)
Control for Parish area	Y	Y	Y	Y	Y	Y	Y	Y	Y
Soiltype dummies	N	N	Y	N	N	Y	N	N	Y
Observations	16243	16243	16228	16243	16243	16228	16243	16243	16228
R ²	0.334	0.338	0.341	0.743	0.744	0.744	0.129	0.133	0.131

Notes: All regressions are estimated using OLS and include fixed effects at the hundred level. The unit of observation is a parish. All coefficients are standardized. Heteroskedasticity robust standard errors are reported in parentheses. Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). ln(1 + Monastic Income) is the natural log of monastic income generated in parish p in 1535. ln(1 + Non Monastic Income) is the natural log of non monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). ln(1 + Lay Subsidy Income) is the natural log of taxable income from the 1524/5 lay subsidy returns (Sheail, 1968). Elevation is the average elevation of the terrain measured in meters. Slope is the average slope of the terrain measured in degrees. Wheat suitability is the average value of an index of soil suitability for growing wheat ranging from 0 to 100. Distance to the nearest river, the nearest market town, the sea and London are based on our own calculations in GIS and are measured in kilometers. The database of market towns comes from Adams (1700). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 5: Matching estimates

	Difference in means (1)	Nearest Neighbor match (ATT) (2)	OLS (3)
<i>Mill dummy</i>			
1 vs. 0 Monastic presence dummy	0.0088* (0.0483)	0.0246*** (0.0061)	0.0171*** (0.0049)
<i>Number of Mills</i>			
1 vs. 0 Monastic presence dummy	0.1229 (0.2892)	0.2114** (0.1038)	0.293* (0.176)
<i>Mill Employment</i>			
1 vs. 0 Monastic presence dummy	-0.9569 (0.8995)	14.62** (5.043)	10.45 (8.171)
Observations	7961	7961	7961

Notes: Monastic presence dummy is an indicator variable that is equal to one if there is at least one monastic property in parish p , equal to zero if there is at least one non-monastic church property in parish p but no monastic property, and missing otherwise. In our matching sample, the monastic dummy equals one for 4713 parishes and zero for 3248 parishes. Column (1) reports the difference in means across treatment status. Stars indicate the significance of the difference in a two-sided t-test. Column (2) reports the average treatment effect on the treated using a one-nearest neighbor match, where the nearest neighbor is found using the Mahalanobis distance described in the text. Standard errors are Abadie-Imbens robust standard errors for nearest neighbor matching (Abadie and Imbens, 2006). Column (3) reports coefficients and robust standard errors from an OLS regression of the relevant dependent variable on the set of matching variables. The set of matching variables includes $\ln(1 + \text{Non Monastic income})$, area, area squared, slope, slope squared, elevation, elevation squared, distance to the nearest river, distance to the nearest river squared, distance to the nearest coal field, distance to the nearest market town, and distance to London. Mill dummy is an indicator variable equal to one if there was a mill in in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 6: Covariate balance

		Before Matching		After Matching	
	Treatment group Mean (1)	Control Group Mean (2)	p-value difference in means (3)	Control Group Mean (4)	p-value difference in means (5)
<i>Treatment variable: Monastic presence dummy</i>					
Matching covariates					
Area	9.7587	8.9921	0.000	9.3544	0.000
ln(1 + Non Monastic income)	1.6372	2.4981	0.000	1.8905	0.000
Slope	2.3639	2.6086	0.000	2.3132	0.121
Elevation	78.329	83.178	0.001	76.832	0.234
Distance to nearest river	2.5878	2.5804	0.877	2.5303	0.179
Distance to nearest coalfield	44.577	58.154	0.000	44.171	0.626
Distance to nearest market town	5.8787	5.9881	0.126	5.88	0.134
Distance to London	175.57	168.75	0.001	174.39	0.515
Other observables					
ln(1 + Lay Subsidy tax)	4.3175	4.6175	0.000	4.3559	0.568
Wheat suitability	40.653	41.811	0.001	40.863	0.482
Observations	4713	3248		1833	

Notes: Column (1) reports the mean of the relevant variable for those observations that have at least one monastic property as well as no missing observations in any of the matching variables. Column (2) reports the mean of the relevant variable for those observations that have no monastic property, but do have at least one church property. Columns (3) reports the p-value of a two-sided t-test of the difference between the means reported in columns (1) and (2). Column (4) reports the mean of the relevant variable for those observations that have been matched at least once using the procedure described in the text. Columns (5) reports the p-value of a two-sided t-test of the difference between the means reported in columns (1) and (4).

Table 7: Monastic Income and Occupational Structure

	Share in agriculture		Share in manufacturing		Share in retail	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(1 + Monastic Income)	-0.0139*** (0.00174)	-0.0152*** (0.00156)	-0.000849 (0.000571)	0.00127** (0.000530)	0.00935*** (0.000968)	0.00879*** (0.000918)
Control for Parish area	Y	Y	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred	County	Hundred
Mean dep. var.	0.62	0.62	0.03	0.03	0.18	0.18
Observations	12831	12831	12831	12831	12831	12831
R ²	0.104	0.428	0.236	0.528	0.029	0.279

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Share in agriculture is the share of males aged 20 and above employed in agriculture in the 1831 census. Share in manufacturing is the share of males aged 20 and above employed in manufacturing in the 1831 census. Share in retail is the share of males aged 20 and above employed in retail in the 1831 census. ln(1 + Monastic Income) is the natural log of monastic income generated in parish *p* in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 8: Occupational structure and controls

	Share in agriculture			Share in manufacturing			Share in retail		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(1 + Monastic Income)	-0.0724*** (0.00792)	-0.0656*** (0.00793)	-0.0678*** (0.00762)	0.0148** (0.00635)	0.0151** (0.00632)	0.0151** (0.00628)	0.0796*** (0.00910)	0.0715*** (0.00917)	0.0755*** (0.00891)
ln(1 + Lay Subsidy Income)	-0.0825*** (0.0112)			0.00740 (0.00959)			0.124*** (0.0125)		
ln(1 + Non Monastic Income)		-0.0842*** (0.00841)			0.00125 (0.00657)			0.112*** (0.00971)	
Terrain elevation			0.142*** (0.0202)			0.0195 (0.0198)			-0.193*** (0.0212)
Terrain slope			-0.131*** (0.0157)			0.0497*** (0.0153)			0.0567*** (0.0175)
Wheat suitability			0.0209 (0.0155)			-0.0341** (0.0136)			0.0307* (0.0166)
Distance to nearest river			0.0446*** (0.00954)			-0.0254*** (0.00766)			-0.0303*** (0.0101)
Distance to nearest market town			0.168*** (0.0113)			-0.0330*** (0.00928)			-0.145*** (0.0128)
Distance to the border			0.0361 (0.0365)			0.0653* (0.0390)			-0.00448 (0.0390)
Distance to London			-0.0177 (0.148)			-0.151 (0.154)			0.0172 (0.155)
Distance to nearest coalfield			0.236*** (0.0665)			-0.402*** (0.0538)			-0.00432 (0.0692)
Control for Parish area	Y	Y	Y	Y	Y	Y	Y	Y	Y
Soiltype dummies	N	N	Y	N	N	Y	N	N	Y
Observations	12831	12831	12819	12831	12831	12819	12831	12831	12819
R ²	0.431	0.433	0.459	0.528	0.528	0.536	0.286	0.289	0.306

Notes: All regressions are estimated using OLS and include fixed effects at the hundred level. The unit of observation is a parish. All coefficients are standardized. Heteroskedasticity robust standard errors are reported in parentheses. Share in agriculture is the share of males aged 20 and above employed in agriculture in the 1831 census. Share in manufacturing is the share of males aged 20 and above employed in retail in the 1831 census. Share in retail is the share of males aged 20 and above employed in retail in the 1831 census. ln(1 + Monastic Income) is the natural log of monastic income generated in parish p in 1535. ln(1 + Non Monastic Income) is the natural log of non monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). ln(1 + Lay Subsidy Income) is the natural log of taxable income from the 1524/5 lay subsidy returns (Sheail, 1968). Elevation is the average elevation of the terrain measured in meters. Slope is the average slope of the terrain measured in degrees. Wheat suitability is the average value of an index of soil suitability for growing wheat ranging from 0 to 100. Distance to the nearest river, the nearest market town, the sea and London are based on our own calculations in GIS and are measured in kilometers. The database of market towns comes from Adams (1700). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 9: Monastic Income and Agriculture

	Wheat Yield (bushels/acre)		Nr. of Agricultural Patents 1700-1850	
	(1)	(2)	(3)	(4)
$\ln(1 + \text{Monastic Income})$	0.159*** (0.0495)	0.0677 (0.0515)	0.0159*** (0.00374)	0.0183*** (0.00377)
Control for Parish area	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred
Mean dep. var.	21.68	21.68	0.02	0.02
Observations	4148	4148	16243	16243
R^2	0.306	0.542	0.008	0.103

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Wheat Yield is the agricultural yield in bushels per acre of a plot growing wheat in parish p (Kain, 1986). Number of Agricultural Patents is the total number of agricultural patents that were registered to people living in parish p between 1700 and 1850 (Woodcroft, 1854, 1862). $\ln(1 + \text{Monastic Income})$ is the natural log of monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 10: Agriculture and controls

	Wheat Yield (bushels/acre)			Nr. of Agricultural Patents 1700-1850		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(1 + Monastic Income)	0.0452*** (0.0141)	0.0427*** (0.0141)	0.0254* (0.0133)	0.0792*** (0.0169)	0.0785*** (0.0168)	0.0800*** (0.0171)
ln(1 + Lay Subsidy Income)	0.0571*** (0.0183)			0.0360** (0.0170)		
ln(1 + Non Monastic Income)		0.0452*** (0.0146)			0.0226* (0.0124)	
Terrain elevation			-0.331*** (0.0273)			-0.0290*** (0.0106)
Terrain slope			-0.0230 (0.0240)			0.0379** (0.0148)
Wheat suitability			-0.00586 (0.0193)			-0.0224 (0.0138)
Distance to nearest river			0.0231* (0.0132)			-0.0152** (0.00669)
Distance to nearest market town			-0.0852*** (0.0152)			-0.0373*** (0.00893)
Distance to the border			0.118*** (0.0287)			0.0176 (0.0321)
Distance to London			0.173** (0.0751)			-0.0286 (0.0921)
Distance to nearest coalfield			0.0708** (0.0355)			-0.0632 (0.0419)
Control for Parish area	Y	Y	Y	Y	Y	Y
Soiltype dummies	N	N	Y	N	N	Y
Observations	4153	4153	4148	16243	16243	16228
R^2	0.306	0.306	0.392	0.104	0.104	0.107

Notes: All regressions are estimated using OLS and include fixed effects at the county level in columns (1)-(3) and at the hundred level in columns (4)-(6). The unit of observation is a parish. All coefficients are standardized. Heteroskedasticity robust standard errors are reported in parentheses. Wheat Yield is the agricultural yield in bushels per acre of a plot growing wheat in parish p (Kain, 1986). Number of Agricultural Patents is the total number of agricultural patents that were registered to people living in parish p between 1700 and 1850 (Woodcroft, 1854, 1862). ln(1 + Monastic Income) is the natural log of monastic income generated in parish p in 1535. ln(1 + Non Monastic Income) is the natural log of non monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). ln(1 + Lay Subsidy Income) is the natural log of taxable income from the 1524/5 lay subsidy returns (Sheail, 1968). Elevation is the average elevation of the terrain measured in meters. Slope is the average slope of the terrain measured in degrees. Wheat suitability is the average value of an index of soil suitability for growing wheat ranging from 0 to 100. Distance to the nearest river, the nearest market town, the sea and London are based on our own calculations in GIS and are measured in kilometers. The database of market towns comes from Adams (1700). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 11: Monastic Income, Gentry and Enclosure

	Nr. of Gentry in 1700		Parliamentary Enclosure	
	(1)	(2)	(3)	(4)
$\ln(1 + \text{Monastic Income})$	0.0905*** (0.00742)	0.0942*** (0.00746)	0.0243*** (0.00305)	0.0240*** (0.00310)
Control for Parish area	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred
Mean dep. var.	0.66	0.66	0.37	0.37
Observations	16228	16228	16243	16243
R^2	0.111	0.228	0.177	0.287

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Nr. of Gentry in 1700 is the number of gentry in 1700 in parish p , recorded in Adams (1700). Parliamentary Enclosure is an indicator variable equal to one if an act of parliamentary enclosure between 1750 and 1840 included part of parish p (Tate and Turner, 1978). $\ln(1 + \text{Monastic Income})$ is the natural log of monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 12: Gentry, Enclosure and controls

	Nr. of Gentry in 1700			Parliamentary Enclosure		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(1 + Monastic Income)	0.107*** (0.00951)	0.0958*** (0.00938)	0.110*** (0.00943)	0.0506*** (0.00809)	0.0434*** (0.00818)	0.0584*** (0.00823)
ln(1 + Lay Subsidy Income)	0.157*** (0.0119)			0.147*** (0.0109)		
ln(1 + Non Monastic Income)		0.145*** (0.0101)			0.117*** (0.00894)	
Terrain elevation			-0.112*** (0.0158)			-0.0653*** (0.0165)
Terrain slope			0.0160 (0.0134)			-0.0499*** (0.0133)
Wheat suitability			0.0239 (0.0162)			0.0212 (0.0160)
Distance to nearest river			-0.00554 (0.00924)			0.00844 (0.00937)
Distance to nearest market town			-0.113*** (0.0106)			-0.0302*** (0.0102)
Distance to the border			-0.0451 (0.0350)			0.123*** (0.0374)
Distance to London			-0.0999 (0.140)			0.595*** (0.147)
Distance to nearest coalfield			-0.134** (0.0639)			0.193*** (0.0676)
Control for Parish area	Y	Y	Y	Y	Y	Y
Soiltype dummies	No	No	Yes	No	No	Yes
Observations	16243	16243	16228	16243	16243	16228
R^2	0.239	0.242	0.244	0.297	0.296	0.294

Notes: All regressions are estimated using OLS and include fixed effects at the hundred level. The unit of observation is a parish. All coefficients are standardized. Heteroskedasticity robust standard errors are reported in parentheses. Nr. of Gentry in 1700 is the number of gentry in 1700 in parish p , recorded in Adams (1700). Parliamentary Enclosure is an indicator variable equal to one if an act of parliamentary enclosure between 1750 and 1840 included part of parish p (Tate and Turner, 1978). ln(1 + Monastic Income) is the natural log of monastic income generated in parish p in 1535. ln(1 + Non Monastic Income) is the natural log of non monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). ln(1 + Lay Subsidy Income) is the natural log of taxable income from the 1524/5 lay subsidy returns (Sheail, 1968). Elevation is the average elevation of the terrain measured in meters. Slope is the average slope of the terrain measured in degrees. Wheat suitability is the average value of an index of soil suitability for growing wheat ranging from 0 to 100. Distance to the nearest river, the nearest market town, the sea and London are based on our own calculations in GIS and are measured in kilometers. The database of market towns comes from Adams (1700). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table 13: Different Monastic orders and textile mills

	Mill dummy		Number of Mills		Mill Employment	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of number of Monastic properties						
Benedictine	0.0160*	0.0174*	0.192	0.207**	7.862	25.35*
	(0.00895)	(0.00954)	(0.125)	(0.0970)	(7.905)	(13.34)
Augustinian	0.0282***	0.0344***	0.308**	0.294***	16.83**	31.03***
	(0.0102)	(0.0102)	(0.140)	(0.0944)	(8.239)	(11.19)
Cistercian	0.00635	-0.00401	-0.148	-0.189	-18.84	-39.64
	(0.0137)	(0.0145)	(0.309)	(0.304)	(28.45)	(44.29)
Control for ln(1 + Non Monastic Income)	Y	Y	Y	Y	Y	Y
Control for Parish area	Y	Y	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred	County	Hundred
Observations	8808	8807	8808	8807	8808	8807
R ²	0.069	0.346	0.030	0.806	0.057	0.212

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). Each variable for a monastic order is the share of properties in parish p in the Valor owned by a monastery of that order. ln(1 + Non Monastic Income) is the natural log of non monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Appendix to:
The Long-Run Impact of the Dissolution
of the English Monasteries

1: Extra Results

Table A-1: Robustness of Mill results

<i>Dependent variable:</i>	Mill dummy		Number of Mills		Mill Employment	
	(1)	(2)	(3)	(4)	(5)	(6)
Different measures of Valor impact						
	<i>Panel I-A: $\ln(1 + \text{Valor Income})$</i>					
$\ln(1 + \text{Valor Income})$	0.0106*** (0.00143)	0.0134*** (0.00138)	0.158** (0.0631)	0.127*** (0.0335)	14.06*** (3.661)	16.11*** (4.343)
R^2	0.055	0.337	0.014	0.744	0.027	0.133
	<i>Panel I-B: Nr. Monastic obs. in Valor</i>					
Nr. Monastic obs. in Valor	0.00767*** (0.00182)	0.00857*** (0.00191)	0.0407*** (0.0144)	0.0448*** (0.0143)	3.631** (1.626)	4.696** (1.950)
R^2	0.053	0.334	0.011	0.743	0.022	0.128
	<i>Panel I-C: Monastic dummy</i>					
Monastic Dummy	0.0129*** (0.00381)	0.0246*** (0.00360)	0.230* (0.126)	0.174*** (0.0640)	13.42** (6.377)	17.63** (6.967)
R^2	0.051	0.333	0.012	0.743	0.022	0.128
Observations	16243	16243	16243	16243	16243	16243
Fixed Effects	County	Hundred	County	Hundred	County	Hundred
Different fixed effects						
$\ln(1 + \text{Monastic Income})$	0.00612*** (0.00154)	0.00726*** (0.00154)	0.0226 (0.0192)	0.0333* (0.0192)	2.250 (1.962)	3.300 (2.021)
Observations	16246	16246	16246	16246	16246	16246
Fixed Effects	None	North-South	None	North-South	None	North-South
Control for Parish area	Y	Y	Y	Y	Y	Y

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). $\ln(1 + \text{Monastic Income})$ is the log of total monastic income in parish p , measured in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). Parish area is measured in square kilometers. The North-South dummy is equal to one if parish p is in one of the following counties: Cheshire, Cumberland, Derbyshire, Durham, Lancashire, Lincolnshire, Nottinghamshire, Northumberland, Staffordshire, Westmorland, Yorkshire: West Riding, Yorkshire: East Riding, Yorkshire: North Riding or . * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table A-2: The potential effect of unobservables

	$\frac{\hat{\alpha}_{extended}}{\hat{\alpha}_{baseline} - \hat{\alpha}_{extended}}$
Mill dummy	26.6
Nr. of Mills	12.4
Mill employment	10.0

Notes: Every line presents two regressions for the dependent variable listed in that row, summarized by the ratio $\frac{\hat{\alpha}_{extended}}{\hat{\alpha}_{baseline} - \hat{\alpha}_{extended}}$ where $\hat{\alpha}_{baseline}$ is the coefficient on $\ln(1 + \text{Monastic Income})$ in a regression that includes Parish area as a control as well as a set of hundred fixed effects (and robust standard errors). $\hat{\alpha}_{extended}$ is the coefficient on the same variable of interest in a regression that includes Parish area, elevation, slope, soil suitability for wheat, distance to the nearest river, distance to the nearest market town, distance to the border, distance to London as controls, as well as soil type dummies and hundred fixed effects (and robust standard errors). Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839).

Table A-3: Dropping urban parishes

	Drop urban parishes from 1831 census			Drop borough constituencies		
	(1) Mill Dummy	(2) Nr. of Mills	(3) Mill employment	(4) Mill Dummy	(5) Nr. of Mills	(6) Mill employment
$\ln(1 + \text{Monastic Income})$	0.0429** (0.0215)	0.00761*** (0.00143)	3.985** (2.025)	0.0591** (0.0259)	0.00983*** (0.00156)	5.653** (2.589)
Control for Parish area	Y	Y	Y	Y	Y	Y
Mean dep. var.	0.04	0.17	15.68	0.04	0.17	15.68
Observations	15817	15817	15817	13254	13254	13254
R^2	0.088	0.348	0.124	0.077	0.236	0.102

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. In columns (1) to (3) parishes that were classified as urban in the 1831 census were removed from the sample. In columns (4) to (6) parishes that were located in a borough constituency were removed from the sample (Cannon, 1973). Mill dummy is an indicator variable equal to one if there was a mill in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). $\ln(1 + \text{Monastic Income})$ is the natural log of monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

Table A-4: Monastic Income and the Textile Industry in North West England

	Mill dummy		Number of Mills		Mill Employment	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel I sample: North West England</i>						
<i>ln(1 + Monastic Income)</i>	0.0273*** (0.00613)	0.0304*** (0.00606)	0.258* (0.132)	0.347** (0.146)	29.76** (14.43)	36.72** (14.85)
Observations	3661	3661	3661	3661	3661	3661
R^2	0.036	0.288	0.008	0.746	0.017	0.123
<i>Panel II sample: Lancashire</i>						
<i>ln(1 + Monastic Income)</i>	0.0810*** (0.0210)	0.102*** (0.0203)	1.659* (0.907)	1.864* (0.989)	224.5** (104.0)	226.7** (107.6)
Observations	683	683	683	683	683	683
R^2	0.044	0.315	0.006	0.825	0.029	0.160
Mean dep. var.	0.04	0.04	0.17	0.17	15.68	15.68
Control for Parish area	Y	Y	Y	Y	Y	Y
Fixed Effects	County	Hundred	County	Hundred	County	Hundred

Notes: All regressions are estimated using OLS and include fixed effects at the level indicated in the table. The unit of observation is a parish. Heteroskedasticity robust standard errors are reported in parentheses. In panel I, the sample is restricted to observations from the northwestern counties Cumberland, Westmorland, Lancashire, Yorkshire West Riding, Cheshire, Derbyshire, Nottinghamshire and Staffordshire. In Panel II, the sample is further restricted to Lancashire. Mill dummy is an indicator variable equal to one if there was a mill in in parish p in 1838. Number of Mills is the total number of cotton, wool, flax and worsted mills in parish p in 1838, and Mill Employment is the total number of people employed in mills in parish p in 1838 (Parliament, 1839). $\ln(1 + \text{Monastic Income})$ is the natural log of monastic income generated in parish p in 1535 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). * indicates statistical significance at the 10 percent level, ** at the 5 percent level, *** at the 1 percent level.

2: Scatter plots of main variables

This section contains scatter plots of the main estimated relationships in this paper. After partialing out parish area and fixed effects at the level of the hundred, we use a linear fit to summarize the relationship between the log of monastic income and the presence of a textile mill in 1838. We then divide the sample into 40 equal sized bins, average the residualized log of monastic income and every outcome variable within these bins, and plot the resulting reduced sample. The size of each scatter point is proportional to the average number of gentry within the relevant bin. All outcome variables are described in section 2 of the paper.

Figure A-1: Binned scatterplot for Monastic income and mill dummy

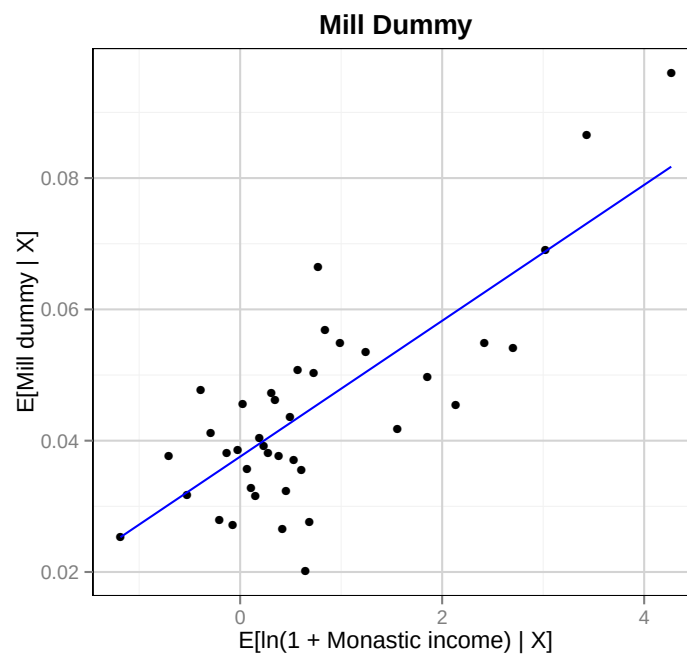


Figure A-2: Binned scatterplot for Monastic income and number of mills

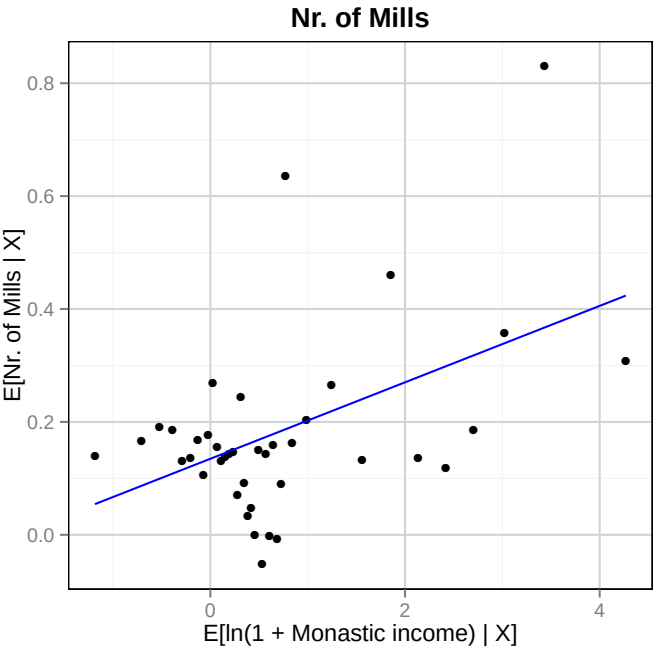


Figure A-3: Binned scatterplot for Monastic income and mill employment

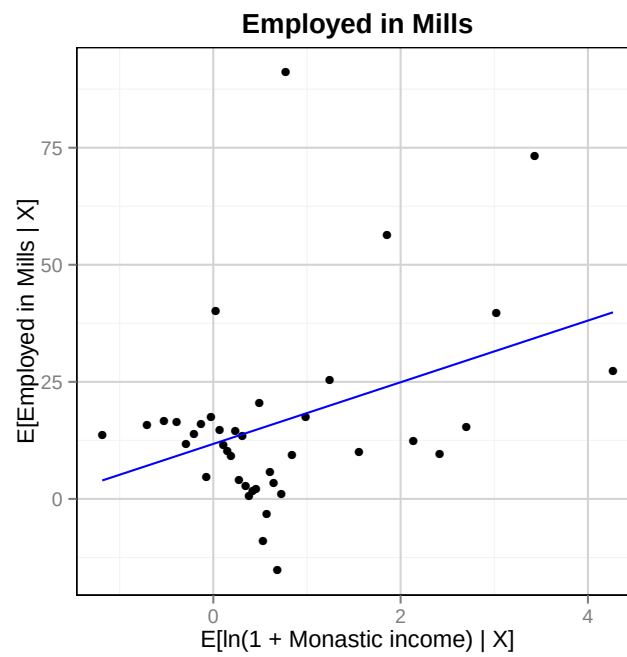


Figure A-4: Binned scatterplot for Monastic income and share in agriculture

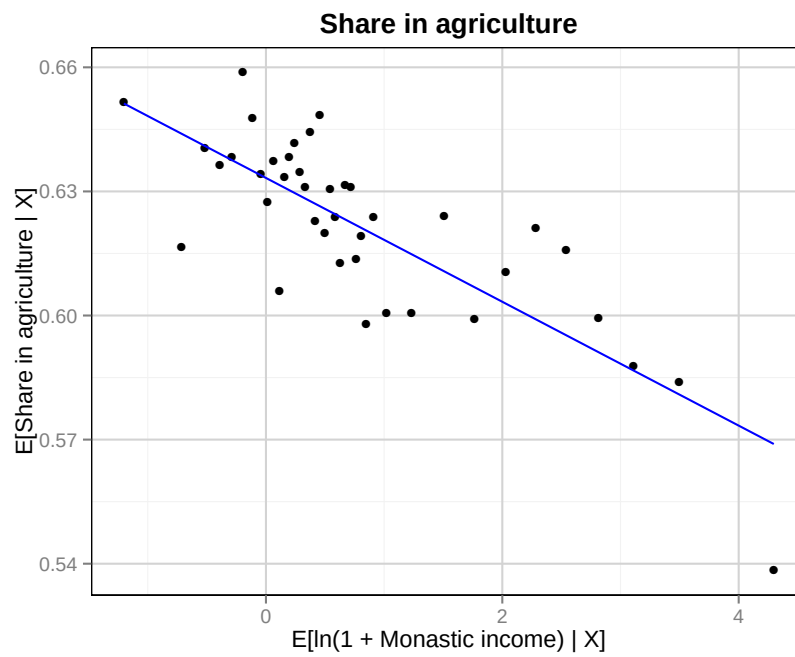


Figure A-5: Binned scatterplot for Monastic income and share in manufacturing

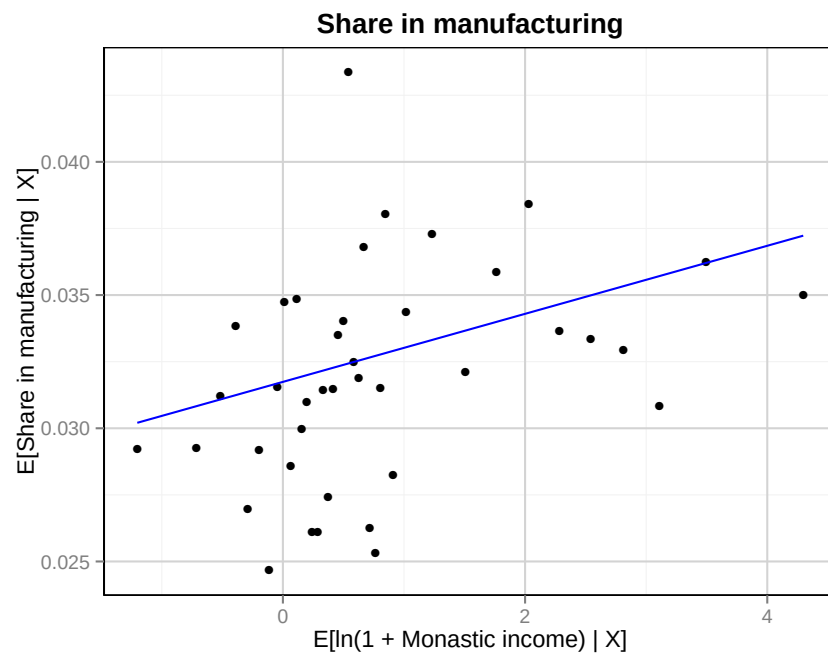


Figure A-6: Binned scatterplot for Monastic income and share in retail

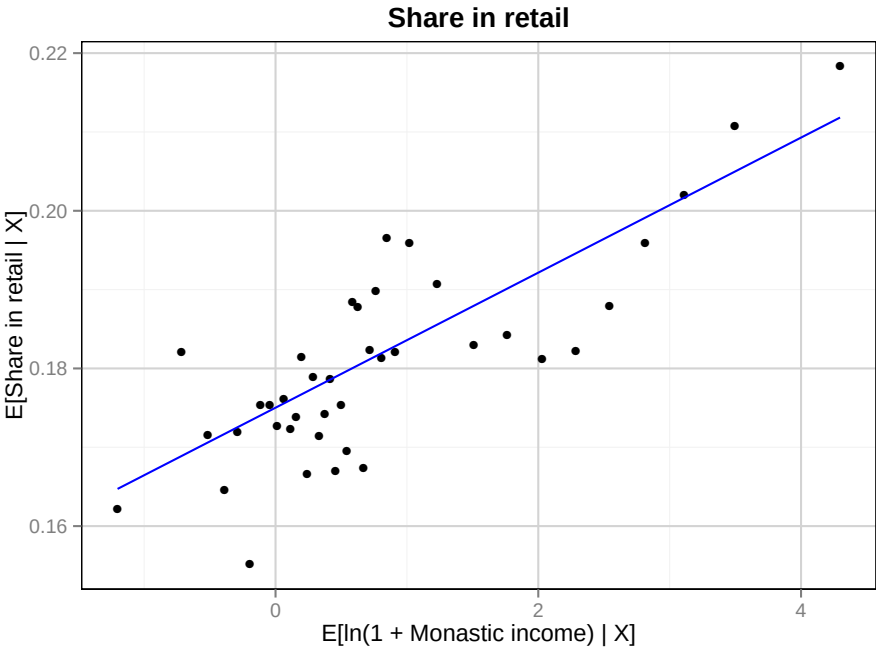


Figure A-7: Binned scatterplot for Monastic income and wheat yield

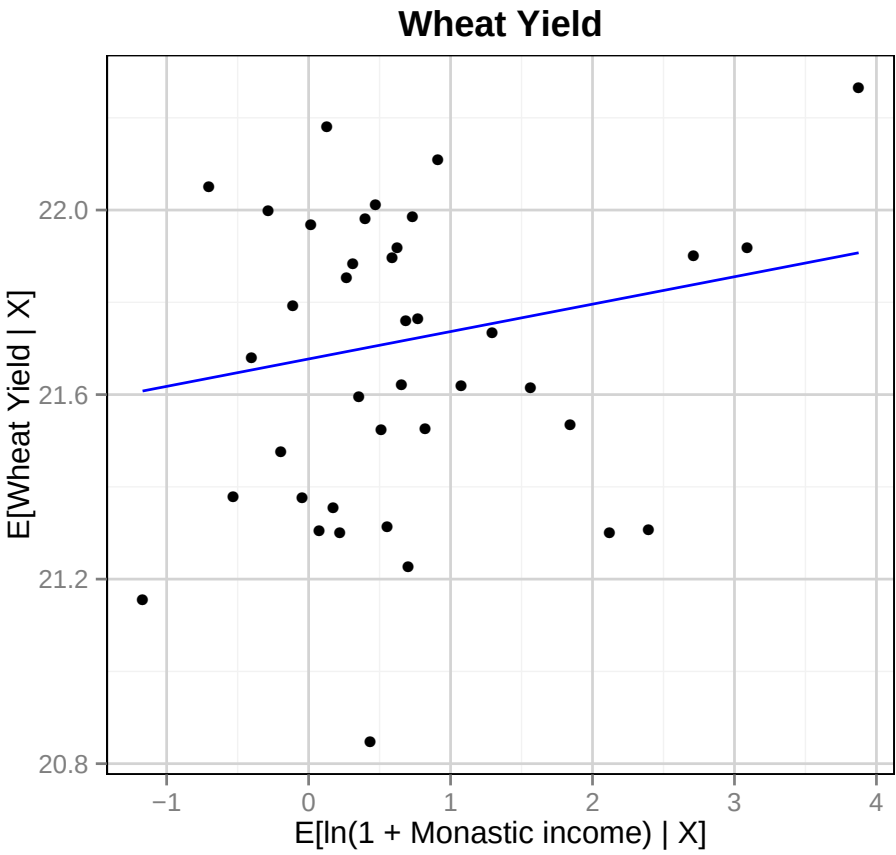


Figure A-8: Binned scatterplot for Monastic income and Number of Patents

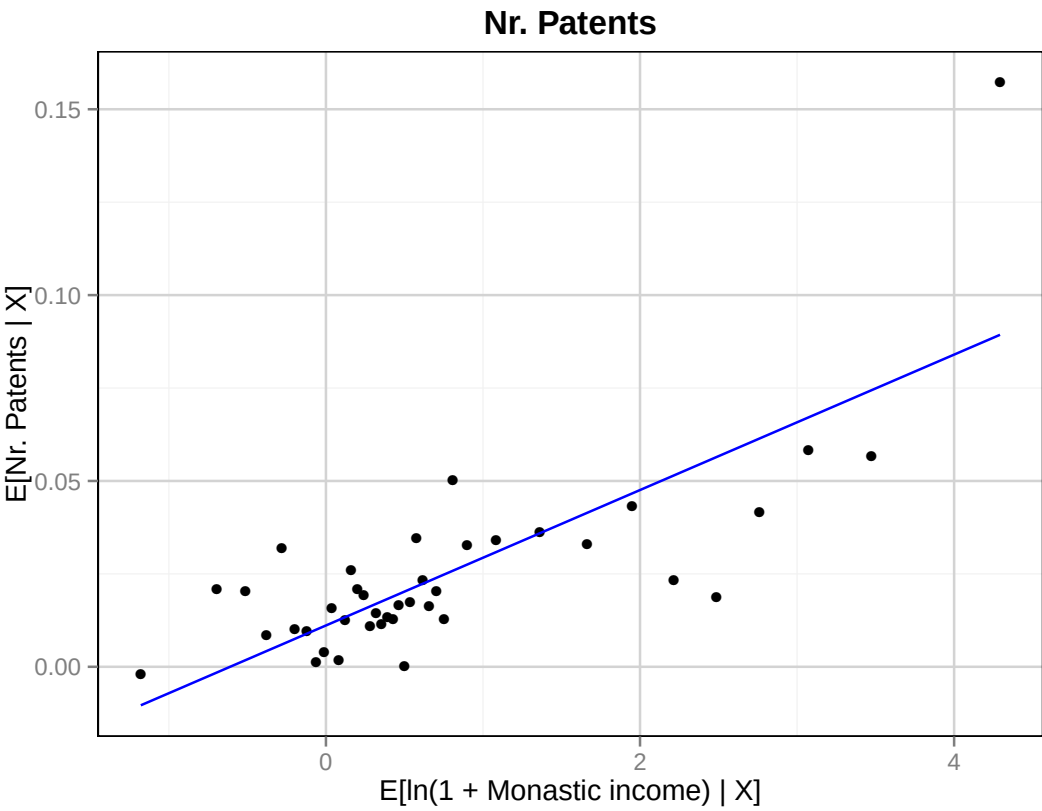


Figure A-9: Binned scatterplot for Monastic income and Number of Gentry

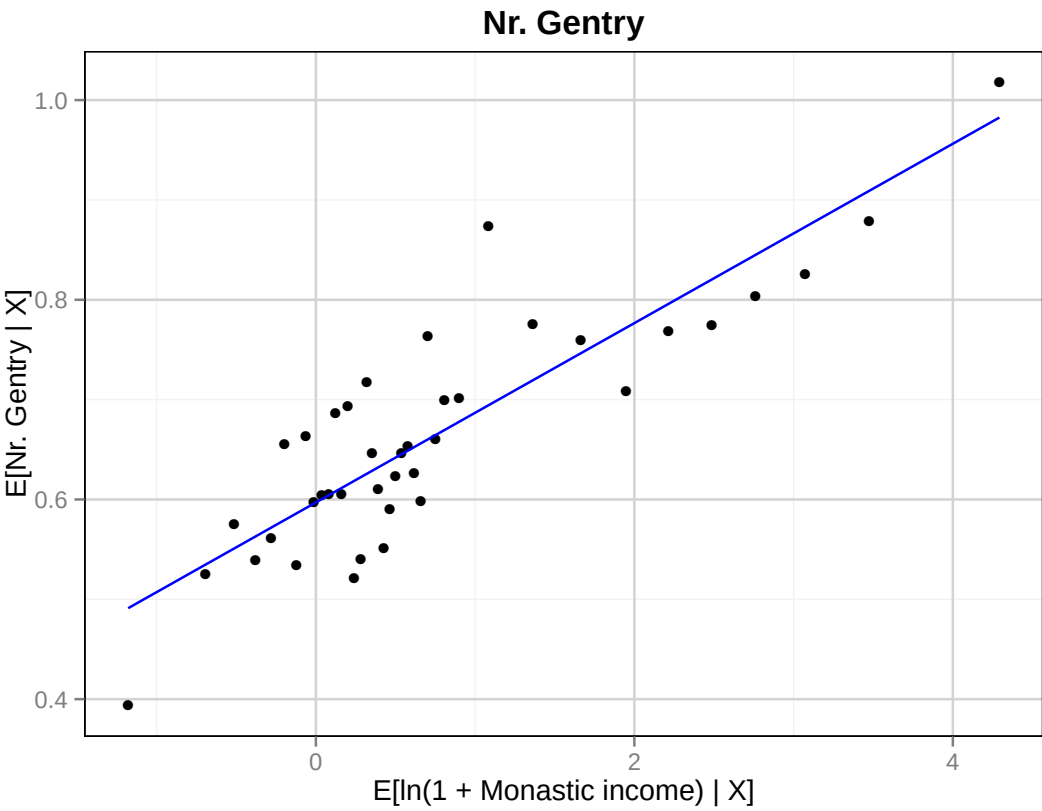
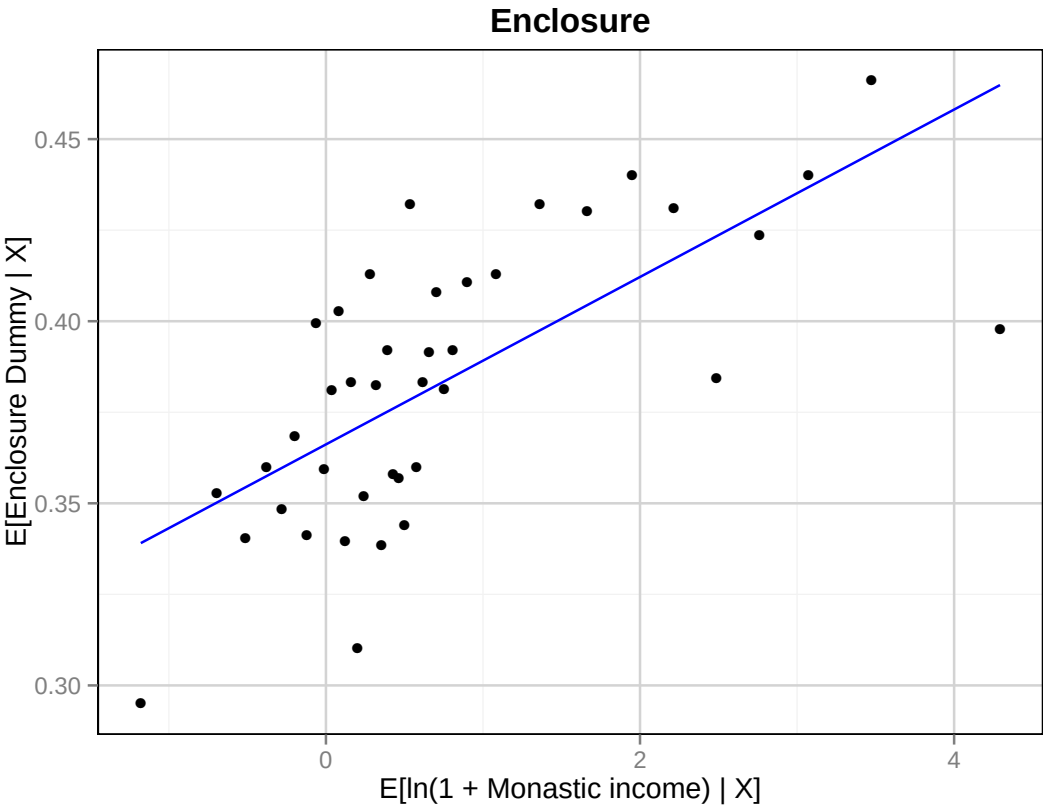


Figure A-10: Binned scatterplot for Monastic income and Enclosure



3: Historical background to the Dissolution of the Monasteries

This section reviews the historical background to the Dissolution of the monasteries and the Valor Ecclesiasticus, the relationship between the expropriation of the monastic lands and the rise of the gentry and provides case study evidence linking the gentry to the Industrial Revolution.

Acts of parliament leading up to the Dissolution of Monasteries

In 1532 Parliament passed 'An Acte concernynge restraynt of payment of Annates to the See of Rome'.¹ This act diverted the Annates paid by anybody with the rank of bishop or higher from the Pope to the Crown. Hunter (1834) argues that this act was meant to strengthen the king's bargaining position with the Pope. A second act was passed in the parliament that sat from January 15th 1534. This act made it 'unlawful to make any payment on any pretence to the See of Rome, and severing the connection which had existed between the two states' (Hunter, 1834, p.13).

Parliament next decided that all payments to the Pope were now to be paid to the king instead. This was passed in the parliament that sat from November 3rd 1534 in the act titled 'An Acte Concerninge the payment of Firste Fruites of all dignities benefices and promocyons spirituall, and also concerning one annuall pencyon of the tenth parte of all the possessions of the Church, spirituall and temporall, graunted to the Kinges Highnes and his heires'. This act also named the king as the head of the Church of England for the first time. In order to assess how much revenue Henry VIII could expect he sent out surveyors, called commissioners, to record the value of incomes generated by ecclesiastical property in England. The Valor Ecclesiasticus is the summary report of these commissioners.

How the survey underlying the Valor Ecclesiasticus was carried out

Every diocese received commissioners, at least three, that were to assess the value of all ecclesiastical possessions in that diocese. The survey started on January 30th 1535 and was to be finished by the Octaves of Holy Trinity (usually the 8th Sunday after Easter; Knowles (1979) cites the 1st of May). All commissioners were to be local notables, below the rank of Baron (Hunter, 1834, p. 19). These notables were usually the justices of the peace, mayors, sheriffs and the local gentry (Savine, 1909, p. 17). The oath of the commissioners can be found in the second volume of the Valor. The commissioners then split up into parties of at least three, divided the diocese among them and administered the survey. The subsequent collection

¹This section builds mostly on Hunter (1834). See also Youings (1971) and Knowles (1979). Annates are synonymous with first fruits or first year's profits of every benefice, to be collected when the benefice changed occupier. A benefice is an ecclesiastical position, such as a parish priest.

of the incomes was left to the bishops who were expected to collect the amount due by Christmas and deliver it to the Exchequer by April of the following year (Savine, 1909, p. 3).

After the survey, Henry decided to expropriate the English monasteries, rather than simply re-directing their income streams. He started with the monasteries that were valued under 200 pounds. In 1536, parliament passed an act popularly known as the Dissolution of the Lesser Monasteries Act, which expropriated 453 monasteries (Jack, 1970, p.1). In 1539, The Second Act of Dissolution followed, expropriating all remaining monasteries.²

The local Gentry and the disposal of the monastic lands

There were three broad ways in which the Crown obtained ownership of a monastery. The first was outright expropriation. This method was most commonly used when dealing with smaller monasteries. The abbot would sign a 'deed of gift' transferring ownership to the Crown. A second way was surrender. After the initial wave of dissolution, larger monasteries were charged with some crime and were given the choice to surrender and receive pensions or to be tried in court. The third way was dissolution by negotiation. Some of the larger abbeys managed to secure favorable arrangements for themselves before signing the deed of gift. The full procedure of dissolution is given in Youings (1971, p. 73).

Some of the expropriated lands were given away as gifts by the King. Even before the first commission for the sale of lands was established in 1539 a total of 234 grants had been made (Youings, 1971, p. 117). Not coincidentally, one of the first grantees was the Chancellor of the Court of Augmentations (the government body in charge of the dissolution), Richard Rich.³ Other grantees included Henry's Chief Minister Thomas Cromwell and several members of the aristocracy. The total amount of land granted appears to have been small. For Devon, it was about 25% of the expropriated monastic land and for Leicestershire around 15% (Youings, 1967, p. 343).

The remaining land was initially leased out by the Crown. Although selling of the lands started as early as 1539, it was not until 1543, when war with France broke out, that the Crown started selling large swathes of monastic lands. Between 1543 and 1547 the Court of Augmentations oversaw the sale of two thirds of all expropriated land. By 1558 virtually land had been sold (Habakkuk, 1958). The sale of the monastic land was in hands of the Court of Augmentations.⁴ Most sales of monastic land were concluded

²For an exact chronology of the dissolution of the lesser monasteries see Jack (1970) and Hoyle (1995). Gasquet (1899) includes in appendix I a list of monasteries that paid the Crown to not be dissolved.

³Richard Rich was originally a lawyer with no noteworthy background. He would be knighted and be styled Baron Rich during his lifetime. For three centuries his descendants would be part of the English peerage (Carter, 2004).

⁴The process of obtaining land was as follows: Prospective buyers would need to obtain an updated assessment of the income of the lands they desired from the local augmentations officer. The request and the updated *valor* would then be submitted to the Court in London. If approved, the sale would be concluded. The prices were initially set at twenty years' rent. Around 1560 the

at the fixed price of 20 years income, with the rent being a tenth of annual income. A pervasive pattern is that:

“Most purchasers came from landed stock, even if at the time of making their purchase they happened to be engaged in trade or following a profession.” (Woodward, 1966, p. 131).

In other words, the ecclesiastical land was disproportionately sold to members of the gentry.⁵ Families such as the Knatchbulls from Kent and the Cholwichs from Devon were yeomen at the beginning of the sixteenth century but rose to be among the gentry over the course of the century, rising to the peerage later. The Levesons of Staffordshire invested profits from wool trading to buy the former Augustinian priory at Trentham. Other members of the gentry used their positions of power in London to obtain lands in their home parishes. Samuel Whitbread used proceeds from the brewing business to set up an estate in Bedfordshire, where his family lived. The three sons of Ronald Barkley, a clothier’s apprentice in London, established themselves as members of the minor gentry in the country side (examples from Mingay (1976, pp. 8, 9, 41, 59)). Famously, Sir Nicholas Bacon rose from being a lawyer to Lord Keeper of the Great Seal and was granted a substantial estate by Henry (Simpson, 1961). Overall, as noted in Table 1 in the paper, the proportion of land owned by the gentry increased from 25% in 1436 to 45-50% by 1688. The Church and Crown’s share went from 25-35% in 1436 to 5-10% in 1688.⁶ The shares of land owned by great landowners and the yeomanry were relatively stable. The numbers in this table square with a great deal of other evidence. For example, the 1524 Lay Subsidy suggests that there were 200 knightly families and 4,000 to 5,000 esquires and gentlemen in England at that time. Thomas Wilson, in his book *The State of England Anno. Dom, 1600*, estimated that these numbers had increased to 500 and 16,000 respectively (Wilson, 1936). Gregory King’s calculations of the social structure of England in 1688 (King, 1810) suggest there were 620 knights, 3,000-3,500 esquires and between 12,000 and 20,000 gentlemen (see Thirsk and Cooper, 1972, pp. 755, 766-8, Cooper, 1983, pp. 20-42). Even though the population of England approximately doubled over this period this suggests that the gentry were indeed relatively rising. Micro estimates for different counties tell a similar story, for instance in Yorkshire heraldic evidence suggests that there were 557 gentry families in 1558, 641 in 1603 and 679 in 1642 (Cliffe, 1969, pp. 5f). For Warwickshire a similar measure increases from 155 families in 1500 to 288 in 1642 (Carpenter, 1992, p. 90, and see Heal

price had gone up to the equivalent of 30 year’s rent and by 1600 it was 40 (Habakkuk, 1958).

⁵For instance, in Devon, well over 50% of monastic lands were bought by local gentry (Kew, 1970). In Norfolk, the gentry possessed 70% of 1527 manors by 1545; by 1565 this was 76% (Swales, 1969). Not all these gentry were established before and merely expanded their possessions. Of the leading gentry families in Hertfordshire in 1642 less than 10% had been settled there before 1485. In Essex this figure stood at 18%, in Norfolk 42% and in Suffolk 13% (Mingay, 1976, p. 9). For Monmouthshire, see Gray (1987). For evidence that monastic land sales around 1600 were still mainly local and that the gentry was still heavily involved in these, see Outhwaite (1971).

⁶For a detailed study of these patterns in Huntingdonshire, see Bedells (1990).

and Holmes, 1994, pp. 11-12, for more discussion).

Why was the gentry so disproportionately represented among those buying the monastic land? First, the local gentry were intimately associated with monastic life. Almost all religious houses had a steward, who would officially represent the monastery, acting as an ambassador, and one or more receivers, who would collect rents and other dues. Most houses also employed bailiffs, associated with the manor courts.⁷ Often, these positions were filled by local gentlemen.⁸ Second, the gentry were granted many new leases on monastic land before the dissolution when the monasteries anticipated expropriation and sought to entrench their positions. After the Dissolution, the gentry renewed these leases with the Court of Augmentations (Woodward, 1966, p. 328; Jack, 1965). Third, the gentry were part of almost every commission involved in the dissolution procedure. The Valor commissioners were by and large members of the local gentry and the higher clergy (Woodward, 1966, p. 59). When dissolution was decided, the surrender documents were signed in the presence of the local knights and gentry (Youings, 1971, pp. 67, 70). After the dissolution, the same gentlemen would be employed as auditors for the Court of Augmentations. As the gentry had previous claims on monastic property as either employee or lessee, were well informed about what to ask for, had often been employed by the Court, and often actively campaigned for dissolution, it is not a surprise that the Court of Augmentations favoured the local gentry when selling the land.

After the dissolution of the monasteries there were three remaining categories of church landholders: bishops, cathedrals, and colleges (both ecclesiastical and Oxford/Cambridge). Yet as Heal (2008) documents, by 1650 the lands of the bishops and cathedrals were sold off as a consequence of them siding with Charles I in the Civil War. Though after the Restoration the bishops got their land back it was generally leased out to the new occupant in very long leases (typically 99 years). At the end of this process, the only remaining lands in the hands of the Church were held by Oxford and Cambridge colleges and some cathedrals, and parish churches which owned the plot of land they were on.

Connecting the Dissolution and the Industrial Revolution

In the introduction to the paper we suggested that even though this connection has not been explored much before, there is a great deal of case study evidence that suggests that the gentry played important roles in the Industrial Revolution. For example, in his seminal study of the history of the British coal industry Nef pointed out the intensity with which gentry were involved not just in mining the coal un-

⁷For a description of the various offices associated with a early modern manor, see Levett (1927).

⁸In the Valor, the gentry are referred to as *miles*, *armiger* or *magister*. The office of Bailiff is *Ballius* and the office of steward is called *Seneschallus*. Savine (1909, p. 358) provides lists of gentry mentioned in the Valor.

der their own lands but also renting other lands with coalfields. In Lancashire and the West Riding of Yorkshire there were

“the Andersons of Lostock, who had pits in Leeds and the surrounding manors, the Ashtons, a well-known Lancashire family with many branches who had pits in the lands around Oldham, the Hultons of Preston, who had pits near Bolton, the Listers, a West Riding family with colliery interest about Halifax and also at Colne, the Gascoignes of Gawthorpe, with colliery interests at Kippax and Barwick-in-Elmet, the Mallets of Normanton, who worked coal in the adjoining manor of Rothwell, and many others. Among the Lancashire families, the Listers alone appear to have been on yeoman extraction. In Durham and Northumberland many of the prominent local gentry became interested during the sixteenth and seventeenth century in the coal industry” (Nef, 1966, p. 9).

The central role of the gentry in the Lancashire coal mining industry is amply documented by Langton (1979a,b). He notes for the period 1590 to 1689 that in the coal industry “the landed gentry provided most of the investment and ability” (1979a, p. 74). Though the gentry suffered financial problems after this, his data indicates that for the period between 1690 and 1739 almost 50% of the collieries in central Lancashire were both owned and operated by landed gentry while more were leased and operated by gentry (1979a, Figure 28, p. 124).⁹

A fascinating case which brings together many of our arguments is that of the Hesketh family. The Hesketh family had lived in Rufford in Lancashire from around 1250. On the eve of the Dissolution, the family owned several manors around Rufford and leased lands from Chester Abbey. After the Dissolution, these lands were leased from the king. One member of the Hesketh family, Thomas, was knighted in 1553 and in 1561 he purchased the manor of Hesketh-with-Becconsall (around five miles from Rufford) that had until recently been part of the Priory of St. John of Jerusalem in England. His son, called Sir Robert Hesketh, was elected a member of parliament for Lancashire. His will indicates that he had the right to ‘dig and delve for coal and other materials’. Indeed, by the middle of the seventeenth century we find the Heskeths partnering with four local gentlemen and a yeoman to open a mine in Wrightington, some six miles from Rufford. Many years later, in 1761, a Thomas Hesketh acquired the title of baronet. The baronetcy is called ‘the Hesketh baronetcy, of Rufford in the county palatine of Lancaster’. By this time, the Heskeths were not only regular members of parliament but they were financing the Industrial

⁹Swain (1986, p. 197) concludes his study of Lancashire by noting “Thus we find that the gentry predominated amongst colliery entrepreneurs.” See Jenkin (1983) for a similar conclusion in the case of South Wales.

Revolution, being involved in several mines in Shevington, a mere eight miles from Rufford (Farrer, 1908; Langton, 1979a, pp. 76, 126; Hasler, 2006).

This hypothesis is of course rather inconsistent with the notion that economic revolutions are always initiated by ‘new people’, an idea going back at least to Pirenne (1914) and Schumpeter (1954). Crouzet (1985) in his detailed study of the social background of the industrialists of the British Industrial Revolution argued that it was the ‘middling sort’ that led the way. For example, in his sample of the fathers of 226 founders of large industrial undertakings between 1750 and 1850 only 16 were gentry (see also Rabb, 1999). Yet Crouzet used a very narrow definition of ‘founder’ which ruled out partners if they were not directly involved in the running of businesses and people who financed such enterprises. The importance of the gentry was not simply that they themselves were involved in industry, but that they also played an important role in forming partnerships and financing the main entrepreneurs - for example the relationship between the gentleman Thomas Bentley and Josiah Wedgewood (McKendrick, 1964) (see Hudson, 2002, for more examples).

4: Construction of our dataset

This section describes the sources and the method of coding for the variables used in the main body of the paper, focusing on the Valor Ecclesiasticus (Valor). We include a short introduction to the Valor, a description of its structure, an outline of our method of coding the data and an example of applying this method. We conclude by discussing the quality of the data. Since all our variables of interest, including monastic and non-monastic income in the Valor, vary at a geographical level, we choose our unit of observation to be the lowest unit of geographical aggregation for which we have a reliable database.

Unit of observation

Our unit of observation is an area from the *GIS of the Ancient Parishes of England and Wales*, which is based on the work of Roger Kain and Richard Oliver (Southall and Burton, 2004; Kain and Oliver, 2001). The GIS consists of an ArcGIS shapefile with an underlying database.¹⁰ Since areas may consist of several disjoint shapes¹¹, we collapse the shapefile to collect these into one shape. The resulting database has

¹⁰Each area in the underlying database has a type, which corresponds to an administrative unit that was used in the nineteenth century. The most common type is the ecclesiastical parish. Other types of units are townships, hamlets, boroughs, chapelries or divisions. Around fifty percent of areas are parishes, out of a total of 22729 areas. Townships and parishes together make up eighty percent of the areas. For sub parish units, there is a parish identifier as well.

¹¹For instance, a parish can consist of a main portion where the parish church is and a smaller detached portion.

17898 unique shapes. Having created our unit of observation this way, we then merge each data source to this database using either one of two methods:

1. We directly match an observation in a data source based on its name to a corresponding area in the database underlying the shapefile of the GIS of Ancient Parishes.
2. We record Ordnance Survey grid references¹² for each unit we want to match, map these units in ArcMAP and spatially join them to the shapefile in the GIS of Ancient Parishes database. Grid references are found using third sources such as Vision of Britain through time project at <http://www.visionofbritain.org.uk/>, the gazetteer of British places names maintained by the association of British Counties at <http://www.gazetteer.org.uk/map.php> and the gazetteer of British placenames maintained by the Genuki project at <http://www.genuki.org.uk/big/Gazetteer/>. We only use this method if method 1 is unavailable.

Using either method, we assign an area number to the observations in each data source. We then proceed to match each data source to the collapsed database. For our main variables the exact assignment method is described below. If it was impossible to assign an area number to an observations using either of the above methods, we have not used it in our analysis.

The GIS of Ancient Parishes database uses the administrative structure of England around 1850 whereas we use data that is from before 1850. This creates a problem since in 1844 parliament passed the *Counties (Detached Parts) Act* that reassigned several detached parts of counties (exclaves) to formally be under their 'mother' county instead of the county they were physically in. Since we matched names within counties to minimize confusion resulting from repetition of names, this could create a problem. However, the GIS of ancient parishes database records in the commentary category whether a part was transferred. Using this information we matched within county/parish composition as it was before 1844.

The Valor Ecclesiasticus

This section describes the state of the Valor Ecclesiasticus archival records, our method for coding the data and an example from the manor of Helton, Lolbroke and Bell.

¹²The Ordnance Survey, a government mapping agency, has divided England, Wales and Scotland up into hundred by hundred kilometer squares (the 'grid') and assigned a two letter identifier to each grid square. A grid reference then records a place within each square by adding an even number of digits, measuring east and north distance within the grid square, measured from the bottom left corner. For instance, the Tower of London is located at TQ3350080599 which means that it is in square TQ and then 33 kilometers and 500 meters to the North and 80 kilometers and 599 meters to the East, measured from the bottom left corner of the square.

The state of the Valor Ecclesiasticus records

The original returns of the Valor are held in the National Archives at Kew Gardens in London and consist of 22 volumes and 3 portfolios.¹³ The Record Commission published a transcription of the records titled *Valor ecclesiasticus temp. Henr. VIII. : Auctoritate regia institutus*, consisting of six volumes that were published, respectively, in 1810, 1814, 1817, 1821, 1825 and somewhere between 1831 and 1834 (Caley and Hunter, 1810, 1814, 1817, 1821, 1825, 1831). One of the editors, Joseph Hunter, wrote a historical introduction to the survey (Hunter, 1834). He reports that some parts of the survey are lost. The most important ones are:

- The diocese of Ely.
- A substantial part the diocese of London.
- The counties Berkshire, Rutland, Northumberland.
- A substantial part of the diocese of York, including the whole of the deaneries of Rydal and Craven.¹⁴

Smaller parts that were lost (such as an individual rectory, or some manors) were taken from third sources and printed in the Record Commission edition. The most important third source is the Liber Valorum (Ecton, 1711) which is a compilation of abstracts of the original records that were made for Henry VIII. These abstracts are usually referred to as the King's Book (or Liber Regis). These compilations, however, record the total (net) taxable income for an ecclesiastical unit and don't specify the geographical source where the components of the income was generated which precludes us from getting a clean measure of the income of a unit, see below. When recording the data, we have tagged the observations that are taken from third sources. Excluding them from the analysis does not change the results (not reported).

The organization of the Valor

The Valor is recorded in a very systematic way. The main geographical unit by which the survey can be broken down is the diocese. Within every diocese there is a clear order in which the lower level units are coded, with the monasteries featuring most prominently. The exact order is given below. Next to this ordering of units, there is an ordering of the income data within each unit. All income is first of all divided into temporalities and spiritualities. Temporalities are all incomes that the monks/benefice

¹³The dedicated website is at <http://www.nationalarchives.gov.uk/records/research-guides/dissolution-of-the-monasteries.htm>.

¹⁴A deanery is an ecclesiastical administrative division, comparable to the hundred.

holders receive from activities, like farming, that are not theirs by virtue of holding the specific benefice. The most important parts of the temporal income are the incomes from demesnes in manu (farmed by the benefice holder) and from payments of tenants on Church lands (Savine, 1909, p. 85). Spiritualities are those incomes to which benefice holders are entitled by virtue of holding the benefice. It also includes income from glebe lands (lands designated to support the benefice holders) and from oblations (another church tax). The second distinction in the returns for individual ecclesiastical units is between gross and net income. Gross income represent total income, and net income represents income (*valet clare* or *Et remanclare* (clear value remaining) in the returns) over which incomes (*Xa inde* in the Valor) payable to the king would be determined. The following deductions from gross income were allowed (Hunter, 1834):

1. Rents resolute to the Chief Lords, and all other annual and perpetual rents and charges.
2. The alms which were due to the poor, according to any foundation or ordinance.
3. Fees to stewards, receivers, bailiffs and auditors.
4. Synodals and procurations,¹⁵ with which most abbeys and benefices were charged.

Monetary values in the Valor are recorded in *l.s.d.* or *£.s.d* notation. This refers to pounds (*librae*), shillings (*solidi*) and pennies (*denarii*). There are 12 pennies in a shilling and 20 shillings in a pound. Particular details regarding the notation of income are in Lindley (1957).

Within the Valor, there is a fixed order in which ecclesiastical units appear (taken directly from Hunter, 1834): per diocese we have

1. The See of the bishop or archbishop.
2. The endowments on the various offices in the cathedral church.
3. Archdeaconries/Deaneries with their claims, and per entry the following:
 - (a) Monasteries and colleges.
 - (b) Parsonage, vicarages, chantries and free chapels.

If a deanery is home to a monastery, this monastery is listed before the other benefices in the deanery and has a specific ordering, namely:

1. Income of the precincts (i.e. any land immediately surrounding the monastery).

¹⁵Synodals and procurations are ecclesiastical fees.

2. Income from lands in the county in which the house stood.
3. Income from lands in other counties
4. Income from impropriate rectories (rectories for which the proceeds went to a layman).

Our main explanatory variable: Monastic income

The entries for individual ecclesiastical properties generating income, such as manors, have their income broken down into temporal/spiritual income and gross/net income, as outlined above. Both spiritual income and the deductions, being mainly customary church taxes, do not reflect the economic value of the assets of the surveyed property. Therefore, we use as our main measure of monastic income the gross income accruing from temporal possessions, for those assets that are classified as monastic. We similarly obtain our measures for non-monastic income, and total income.

An example: the manor of Helton, Lolbroke and Bell

The manor of Helton, Lolbroke and Bell was a possession of Abbotsbury abbey and was located in Bridport deanery (in the Valor it is called *Byrport*) in Dorset. Figure A-11 is a photograph of the entry as it appears in the Record Commission edition of the Valor. Note that we omitted any deductions from this picture, it just lists temporal and spiritual income.¹⁶

The first entry is an assize rent (*reddit assis'*, a fixed rent) in Helton, which gives an annual income of £: xl s: xvii d: vii. The next entry is a part of the demesne (*tr'daicaliu*) that is not farmed by the rector (*firma dimiss'*) for which he receives a rent. The next entry is another assize rent in Lolbroke & Bell. Then we have an entry that records proceeds from the manor court (*pficuis cur'*) and several other incomes (*al' pquisit'*) taken for an average year (*coibs annis*).

The next two entries are two rents resolute (*reddit' resolut*) that are owed to an abbot and payable to his manor (*abbti & conventui de Miltonad maniu suu*). The second figure is payable to the vicar of archdeaconry of Dorset (*vic'Dors'*). The third entry is payable to the master of the hundred Richard de Whitway (*hundr dni R de Whitway*). The last entry is payable due to the local bailiff of the manor Gilbert Kaynell (*Gilbti Kaynell balli*).

We are interested in the income from assets, or temporal income. For this manor, these are the assize rents from lands held by the manor, or the first three entries in figure A-11. We therefore coded three

¹⁶In order to distinguish these sources of income in the text a knowledge of the scribal Latin in which the Valor is recorded is required. A valuable introduction to this as well as a glossary of terms and scribal abbreviations can be found in Martin (1949).

5: Data sources

Variable	Source	Comment
Main Variables		
The Valor Ecclesiasticus	Caley and Hunter (1810, 1814, 1817, 1821, 1825, 1831)	For coding method, see above.
Textile mill variables	Parliament (1839)	
Channels and the Lay Subsidies		
Occupational structure variables – 1831 census	Gatley (2005)	
Agricultural yield	Kain (1986)	The data were transcribed and made available to use by James Dowey, see Dowey (2013)
The number of agricultural patent holders	Woodcroft (1854)	
Number of Gentry in 1700	Adams (1700)	
Enclosure dummy	Tate and Turner (1978)	
The Tudor Lay Subsidies	Sheail (1968)	
Covariates		
Coal deposits	Strahan (1912)	Digital copy available through www.davidrumsey.com
Elevation	CGIAR consortium at http://srtm.csi.cgiar.org/	
Slope	Earth Resources Observation and Science Center of the USGS at http://eros.usgs.gov	
Inland rivers and water bodies	Digital Chart of the World available through www.diva-gis.org	Distances computed in ArcGIS
Distance to London		Computed in ArcGIS
Distance to national border		Computed in ArcGIS
Distance to market town	List of Market towns from Adams (1700). Distances computed in ArcGIS	
Suitability for wheat and barley	FAO at http://webarchive.iiasa.ac.at/Research/LUC/GAEZv3.0/	We used the rain-fed, low intensity, base-line period settings
Soil type	FAO at http://webarchive.iiasa.ac.at/Research/LUC/GAEZv3.0/	

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