Blood Rubber: The Effects of Labor Coercion on Institutions and Culture in the DRC*

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Abstract: We examine how historical exposure to extractive institutions affects long-run development in the case of the Congo Free State (CFS). The CFS granted concessions to private companies that used violent tactics to collect rubber. Local chiefs were co-opted into supporting the rubber regime, and individuals struggled to fulfill mandated quotas as natural rubber became increasingly scarce. We use a geographic regression discontinuity design along the former concession boundaries to show that greater exposure to extractive institutions causes significantly worse education, wealth and health outcomes. We then use survey and experimental data collected along a former concession boundary to examine how the effects of extractive institutions persist through local institutional quality and cultural norms. Consistent with their historical co-option by the concession companies, we find that chiefs within the former concessions are of lower quality and less accountable to their constituents. However, we find that individuals within the concessions are more trusting and have stronger norms of redistribution. The results demonstrate how historical events of short duration can have long-lasting effects on institutions and cultural norms.

Keywords: Culture, institutions, historical persistence, labor coercion.

JEL Classification: O15, N47, D72, O43, Z13.

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1. Introduction

African countries continue to address the legacy of exploitative colonial institutions. European colonizers often used labor coercion to extract natural resources in the colony for the benefit of the colonizer. We examine the case of the Congo Free State (CFS) to understand how historical exploitative institutions such as labor coercion affect current development, institutions and culture.[1] The CFS, what is today the Democratic Republic of Congo (DRC), was the personal colony of King Leopold II of Belgium between 1895 and 1908. In one of the world's first human rights movements, Leopold's regime became infamous for its use of coercive labor practices. During this period, Leopold designated parts of the CFS as concessions for private companies to extract rubber. The companies were given monopoly rights over natural resource extraction within the concession boundaries. Additionally, they were given state resources, primarily soldiers from the *Force Publique* (the CFS armed forces) and a state mandate to use coercive means to reach their rubber extraction goals. Local chiefs were co-opted into enforcing rubber collection quotas, and if quotas were not met, chiefs and villagers were subjected to violence. Historians Hochschild and Vansina estimate that 10 million people, approximately half of the population of Congo, died between 1880 and 1920 (Vansina, 2010; Hochschild, 1998). Today, the DRC remains one of Africa's poorest countries, ranked 186 (of 187) in the UNDP's 2015 Human Development Index.

We use the well-defined boundaries of the two largest historic rubber concessions, ABIR and Anversoise, to examine the long-run effects of labor coercion on economic development.[2] The concession boundaries were determined at a time when there was little knowledge of the geography of the interior of Congo. Thus, the CFS used the extent of river basins and a 25 kilometer buffer to define the boundaries of the concessions (Harms, 1975).[3] Consistent with the idiosyncratic manner in which the historical boundaries were determined, we demonstrate that those areas designated as concessions are geographically similar to the areas just outside of the concessions. We use Demographic and Health Survey (DHS) data from 2007 and 2014 to estimate the effects of historical labor coercion on present-day education, wealth, and health outcomes.

[1] Institutions are defined as external "rules" that shape individuals' expected payoffs for different actions. For evidence on the importance of institutions for development, see North (1990); Acemoglu et al. (2001); Acemoglu and Robinson (2012). Culture is defined as the collection of beliefs and internal views for individuals. For evidence on the importance of culture for development, see Greif (1994); Nunn and Wantchekon (2011).

[2] The two largest concessions that focused exclusively on rubber were ABIR and Anversoise. Section 2 provides detailed background on these concessions.

[3] River basins are defined as a river and its tributaries.

Using a geographic regression discontinuity design, we find that the former concessions areas have significantly worse education, wealth, and health outcomes than areas just outside the former concessions. We analyze the DHS data by age cohort to demonstrate that there is little evidence of convergence in outcomes over time. We also use archival data on when posts were established and the amount of rubber extracted from the post to examine heterogeneity by intensity of exposure. We find that greater exposure to rubber extraction is correlated with worse present day outcomes.

One possible concern with examining the effects of these historical rubber concessions is that the results reflect some inherent characteristic of residing within major river basins and not the effects of the rubber regime. To assess whether this is the case, we estimate our main specification across all major river basins in the DRC. We can then compare our estimated effects for the historical concession boundaries to the estimated effects for all other major river basins in DRC. We find that our estimates for the two rubber concessions are larger and more negative than the estimated effects for other river basins in DRC. This exercise suggests that our results are not a consequence of using major river basins to delineate the borders, but rather that the estimates reflect the negative long-run impacts of exposure to extractive institutions during the rubber period.

To better understand the channels underlying our findings, we compile historical data on important intermediate outcomes that could have been subsequently affected by the rubber extraction period. We use data on historical colonial investment and missionary presence to examine whether these factors can explain the persistent effects of exposure to labor coercion on development today. We find no evidence that there was differential investment in the region by the Belgian colonial administration nor that there was differential missionary presence. We argue that colonial investment and missionary presence are unlikely to explain the observed differences.

To further explore channels, we collected survey and experimental data in Gemena, DRC, a town on the border of the former Anversoise concession. These data allow us to test how local institutions and cultural norms may have changed as a result of exposure to extractive institutions. Our analysis compares individuals in Gemena with ancestors from inside the former concessions to individuals whose ancestors lived outside the former concessions.[4] Collecting

[4]Gemena was established in the 1920s by the Belgian Colonial government. Thus, nearly everyone who lives in Gemena today is a migrant from the surrounding area.

data from individuals that reside in Gemena, rather than in their villages of origin, has important advantages. By considering a population of migrants who currently live in the same institutional environment removed from the institutions of their origin villages, we are better able to isolate the impact of the rubber concession period on cultural norms.[5]

We first replicate the DHS results using the survey data collected in Gemena. We demonstrate that the villages within the former concessions are less developed than those just outside the former borders. We asked individuals about the public goods available in their villages of origin and their perception of the relative wealth of their village of origin. Consistent with the DHS results, we find that villages within the former concession are described as having fewer public goods and are rated as less developed.

We then test whether villages within the former concessions have lower quality local institutions. Historical accounts of the rubber concession period highlight how village chiefs were forced to support the rubber regime. Those who did not support the rubber regime were killed and replaced by outsiders willing to enforce the rubber quotas (Harms, 1975). Thus, we hypothesize that the historical co-option of village chiefs to support the rubber regime may have undermined local institutional quality. We measure institutional quality by the extent to which the chief provides various public goods for the village and the selection mechanism for the chief. We find that village chiefs within the former concessions are less likely to provide critical public goods, such as road maintenance and conflict arbitration. Additionally, they are less likely to be elected to their position and are more likely to be hereditary. These results provide important evidence that shocks to local institutional quality may persist and perpetuate the effects of historical exposure to labor coercion.

Finally, we examine how socials norms were affected as result of the rubber period. In particular, if those areas exposed to labor coercion are now less trusting, then this may help explain their relative underdevelopment (Algan and Cahuc, 2010; Nunn and Wantchekon, 2011). Using survey questions on trust, we find evidence that individuals from areas exposed to labor coercion are actually *more* trusting of others than those just outside the former concessions. This is the case for both "in-group" and "out-group" trust. This suggests that lower levels of trust cannot explain the underdevelopment of former concession areas.

[5]Additionally, logistically, it is considerably easier to work in a single city rather than multiple villages in this area of DRC, as the transportation infrastructure in the region is poor.

We relate this finding of higher trust to the literature on the effects of violence on social norms, which suggests that exposure to violence may actually increase pro-social norms (Bauer et al., 2016). We provide suggestive evidence that the former concession areas have more pro-social norms and more favorable views of informal redistribution. Individuals are 0.2 standard deviations more likely to agree with statements asking whether money earned by both luck and effort should be shared with others. Additionally, in an experimental task, individuals from concession areas are less likely to respect earned property rights, consistent with support for redistribution. The historical narrative on how communities responded to the labor coercion by increased reliance on social ties and informal insurance may provide some explanation for our observed results.

Our work contributes to the literatures on the long-run effects of labor coercion, the effects of indirect rule on governance, and to the relationship between violence and pro-social norms (Dell, 2010; van Waijenburg, 2015; Mamdani, 1996; Acemoglu et al., 2014; Bauer et al., 2016). Our paper is related to Dell (2010), who uses a geographic regression discontinuity design to examine the long-run impacts of the mining *mita* in Peru.[6] Her paper identifies the development in non-*mita* areas of *haciendas*, large plantation like estates, that provided public goods as the important mechanism for explaining the relative poverty of the *mita* areas. Without these estates, the *mita* areas were unable to develop public goods such as roads. However, this sheds little light on what happened to those directly exposed to the labor coercion, other than that they were not organized into *haciendas* by elites. By collecting survey and experimental data in the field, our paper is able to examine how labor coercion affected the local institutions and norms within the concession areas. This provides important evidence on the changes within areas affected by extractive institutions.

Second, we contribute to the literature on the effects of indirect rule on African development. For example, the work by Mamdani (1996) suggests that the implementation of indirect rule by colonial governments created less accountable leaders. Related work by Acemoglu et al. (2014) examines how the denomination of different numbers of ruling families by the colonial government has affected development in Sierra Leone. Districts with fewer ruling families, and therefore less political competition, experience worse development outcomes but higher levels

[6]Interestingly, our work finds negative estimates of similar magnitudes to Dell (2010) even though the length and form of labor coercion differ and the channels of persistence she highlights do not apply to the case of DRC.

of social capital, suggestive of higher social capture by local chiefs. We identify the effects of exposure to labor coercion, a form of colonial intervention that relied on co-opting local institutions, on the quality of local institutions today. We provide evidence that indirect rule led to the creation of less accountable leaders who provide fewer public goods.

Finally, we contribute to a growing literature on the long-run impacts of violence on social preferences. Bauer et al. (2016) provide an analysis of nearly 20 papers from over over 40 countries that examine the relationship between violence and social norms. The evidence they review suggests that violence can increase norms of local cooperation. However, this increase does not necessarily improve subsequent development. This is consistent with our finding that the exposure to violence in the rubber era may have increased pro-social norms and strengthened norms of redistribution, but that the former concession areas are still less developed.

More broadly, this paper is related to recent work on how colonial policies can have long-lasting effects on development.[7] An important set of studies found a large negative effect of colonialism on modern outcomes using cross-country evidence (La Porta et al., 1998; Acemoglu et al., 2001). Nunn (2008) finds a large negative effect of the slave trade on economic development in Africa. Michalopoulous and Papaioannou (2016) study how the arbitrarily drawn country borders under colonialism have led to more conflict and lower development by comparing partitioned to non-partitioned ethnic groups. We contribute to this literature by examining one of the most infamous cases of colonial extraction in Africa. We compare areas that are very similar geographically and culturally and that are presently under the same national institutions, but had differential exposure to colonial extraction. Thus, we isolate the long-run effects of the rubber period, rather than other possible confounding factors such as pre-existing ethnic institutions or present-day national institutions. We provide evidence that extractive colonial institutions during the rubber period drastically affected local institutions, social norms and long-run development.

The paper is organized as follows. Section 2 provides historical background on the Congo Free State and the rubber concessions. Section 3 describes the data and the empirical strategy and presents the main empirical results from the DHS data. Section 4 presents evidence that there has been no convergence in outcomes over time and explores several possible historical channels of persistence. Section 5 describes the data collection in Gemena, explains the hypotheses tested,

[7] A growing body of empirical evidence finds that historical events are important determinants of economic development today (Nunn, 2009).

and presents results on the persistent effect of the rubber period on local institutions and social norms. Section 6 concludes.

2. The History of the Rubber Concessions

By the mid-1870s, European powers had made claims to most parts of Africa. However, the center of Africa remained largely unexplored. In a bid to make Belgium a colonial power, King Leopold II of Belgium convinced other European colonial powers of his philanthropic goals in Congo, including his mission to end the slave trade. The British, French, and German governments acquiesced to Leopold's interest in Congo to avoid conflict with each other over their own colonial aspirations. Thus, the CFS was created in 1885 as the personal colony of Leopold. According to the Berlin conference in which the borders of the CFS were outlined, Congo was to remain a free trade zone for individuals of all nationalities (Nzongola-Ntalaja, 2007).[8]

Leopold needed to demonstrate continued state presence in the Congo in order to retain his rights over it. This proved a costly endeavor. By 1890, Leopold had invested 19 million francs in the Congo, nearly the entirety of his father's fortune (Van Reybrouck, 2014, p. 70). In an attempt to increase revenues, he declared all lands and any raw materials found on these lands to be the property of the CFS. In 1890, the pneumatic tire was invented, leading to a dramatic increase in the demand for natural rubber. Congo had immense natural rubber resources, and Leopold finally saw an opportunity for profits.

The state had limited manpower and capacity, so Leopold set up concessions to be given to private companies to extract natural resources. Because most of the interior of DRC was uncharted at the time, the concession boundaries were defined using salient geographic characteristics such as major rivers and their basins (Harms, 1975). We focus on the two largest concessions granted in the Congo Basin: Anglo-Belgian India Rubber Company (ABIR) and Anversoise. The contracts establishing the agreements between the CFS and ABIR and Anversoise confirm that salient geographic characteristics determined the concession boundaries. ABIR was established in 1892 and given rights over the Maringa-Lopori basin. This concession area was defined by two rivers and their tributaries: the Maringa river and the Lopori river, plus a 25 km buffer

[8] In the free trade zones, individuals of all nationalities were to be able to conduct commerce. In practice, this was not always the case.

area around them.[9] In the same year Anversoise was created and given extraction rights in the Mongala river basin, defined by the Mongala river and its tributaries.[10] To see that the boundaries of the concessions do in fact conform to the definitions as stated in the founding contracts, Figure 2 illustrates the concession boundaries and the associated river basins. The concession borders appear to align almost exactly with the extent of the river basins.[11] Additionally, Figure 2 shows the locations of the posts established by the rubber concessions. They all fall within the boundaries of the concessions. In return for this land, the state would collect 2% of the concession companies' profits. Leopold himself was a majority stake holder in ABIR and Anversoise (Harms, 1975). Areas just outside of the concessions continued to be free trade zones, in which individuals of all nationalities could trade with locals, but these individuals did not have the same rights and resources granted to the concession companies.

2.1. Rubber Collection

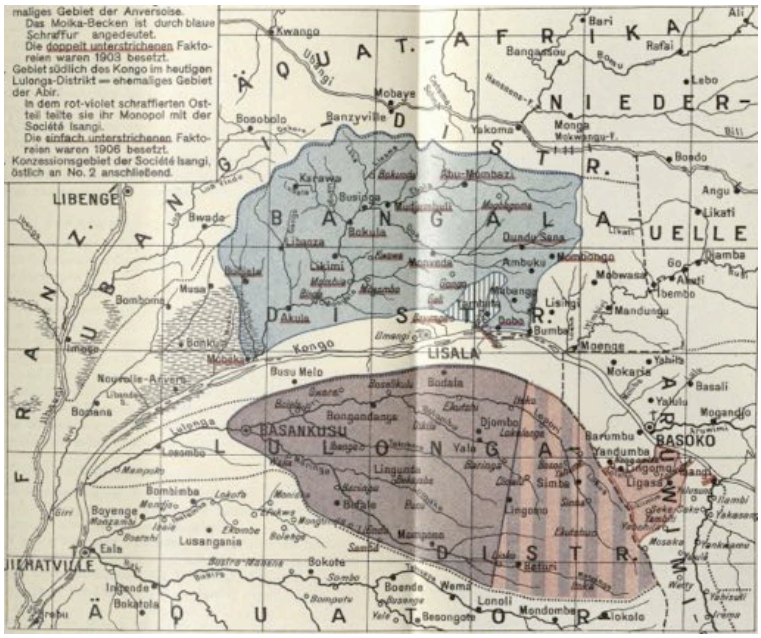
The concession companies forced individuals within their concessions to collect rubber as a form of paying taxes. Rubber was a unique commodity because collection of rubber required little capital investment, in contrast to the collection of other natural resources such as diamonds or minerals. The intensity of rubber extraction in concession areas was thus linked to the productivity and supply of labor. Once the rubber concessions were allocated, the companies set up posts within the concessions to collect rubber. One or two European agents would be assigned to each post within a concession. They would survey surrounding villages and make a census of the number of adult men in the village. Concession companies set quotas for the

[9]The initial contract between the Secretary of the Interior of the CFS, Mr. Eetvelde, and Mr. J.T. North and Alexis Mols, representatives of the Société Anonyme Anglo-Belgian-India-Rubber and Exploration Company defines the boundaries of ABIR as follows: "The State of Congo concedes to the undersigned on the other part under the conditions stated in this contract and for a period of 30 years starting today, the right to exploit rubber, gum copal and other products of the forest situated on state lands in the basin of the Lopori and the Maringa, from and including Basakusu and to include the forest situated in an area of 10 kilometers around this post. The state will provide all facilities for such exploitation that will be with the assistance of the District Commissioner and at the sole risk and peril of the concessionary" (Waltz, 1918, p. 372). Article 4 of the document specifies rights to an area of 25 km around each post.

[10]This concession was defined as the area north of part of the Congo River up to the former international border between the CFS and French Equatorial Africa. The initial contract between the Secretary of the Interior of CFS, Mr. Eetvelde, and Mr. Alexander de Browne de Tiège, representative of Anversoise defines the boundaries of the Anversoise concession as follows: "The Congo State accords to the undersigned on the other part, under the conditions indicated in the present contract and for a term of 50 years starting today...the concession of the forests in the state land situated in the basin of the Mongala, with the exclusive right to exploit the rubber, gum copal, and all the other products of the forest" (Waltz, 1918, p. 352).

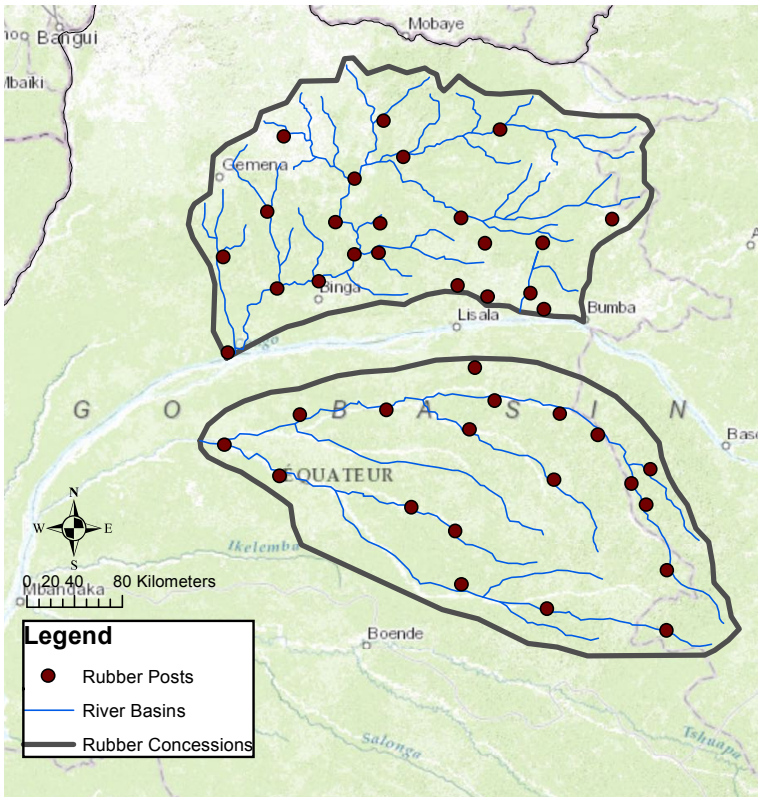
[11]In Appendix C Figure A26a we digitize all rivers in the area from a 1906 map to demonstrate that there are many rivers outside of the concession boundaries that aren't part of the relevant river basins.

Figure 1: ABIR and Anversoise Rubber Concession Areas



Notes: The Anversoise rubber concession is the northern concession and the ABIR concession is the southern concession in the figure above

Figure 2: Rubber Concessions, Posts, and the Mongala and Maringa-Lopori River Basins



collection of rubber based on these population censes. Male villagers were required to deliver a quota of about 4 kilos of dried rubber every 2 weeks. In addition, villages were required to provide food and supplies to maintain nearby posts.

Rubber collection was both time intensive and physically demanding. Individuals would travel deep into the jungle, find a rubber vine (*landolphia*), make incisions in the vine to let the sap trickle out, and then allow the sap to dry.[12] This process could take days, particularly as rubber supplies dwindled and untapped rubber vines became more difficult to find. Additionally, *landophilia* is a delicate vine that is easily destroyed in the tapping process. Over time it became increasingly difficult for people to meet the rubber quotas. For example, men in the Baringa area would spend around 10 days of every 14 in the forest collecting rubber (Harms, 1983). By the time individuals had met the rubber quota for the current two weeks, it would be time to collect for the following two weeks.

2.2. *Violence*

Individuals were severely punished if they failed to meet their rubber quota. Punishment could take many forms. For example, individuals could be imprisoned and forced to work. Their family members could be held for ransom until the quota was fulfilled. Individuals could also be subjected to various forms of physical violence, including whipping by the *chicotte* (a whip made of hippopotamus hide), burning with gum copal, or death. The chief of the village could also be imprisoned if his village did not meet the quota. In July 1902, records indicate that 44 chiefs were imprisoned in the villages around a single post (Harms, 1983).

The soldiers from the concession companies' private militias were primarily responsible for carrying out these violent tactics. However, the European agents also engaged in the imprisonment and torture of villagers. In 1903, one ABIR post received 17,600 cartridges for the Albini rifles used by the post sentries (Harms, 1983). To prevent waste, soldiers were required to provide a human hand for every bullet used. Testimony collected by Robert Casement, a British consul sent to Congo to investigate accusations of atrocities, documents the intensity of the labor coercion. First hand African accounts illustrate the extent of the violence:

[12] Rubber in the DRC came from either a vine or a tree. Most rubber collected during the CFS era was from the vine *landolphia*. There were also some rubber trees, *funtumia elastica*, but these were more prevalent in the French Congo and West Africa. In contrast, production in from plantations in South East Asia and Brazil was from the *hevea* tree (Harms, 1975).

> *"When I was still a child, the sentries shot at the people in my village because of the rubber. My father was murdered: they tied him to a tree and shot and killed him, and when the sentries untied him they gave him to their boys, who ate him. My mother and I were taken prisoner. The sentries cut off my mother's hands while she was still alive. Two days later, they cut off her head."* (Janssens, 1904)

If the ABIR sentries faced any resistance, they were able to call on soldiers from the *Force Publique* to provide support. In fact, the director of ABIR and the commander of the State police were stationed together in Basankusu, one of the first posts established by ABIR. The sentries were responsible for maintaining rubber production while the *Force Publique* soldiers were called upon to suppress revolts and to punish villages that did not comply with the rubber quotas. However, most of the violence was perpetrated by the private militias maintained by the concession companies. ABIR recruited free villagers and slaves to work as sentries.[13] Approximately 25 to 80 "post sentries" armed with rifles were assigned to each new post established. An additional 65 to 100 "village sentries," armed with muzzle-loading cap guns, were stationed in villages surrounding the posts. Between two to ten village sentries were placed in each of the villages in the vicinity of the rubber post. Generally, the sentries were outsiders; this strategy was purposefully selected to ensure that sentries were willing to use violence against villagers (Harms, 1974).

2.3. Political Capture

The village sentries primary responsibility was to ensure rubber production. One tactic for ensuring compliance was to undermine local authority. One of the sentries in each village was assigned the position of *kapita*, or head sentry for that village. (Interestingly, *kapita* is a Lingala word used today to denote "village chief"). Once in the village, the *kapita* would recruit eight to ten people to serve as bodyguards. He then began the process of asserting his authority over the villagers. To do so he would attack men in positions of esteem or authority. For example, lineage headman were required to carry soil and rubbish alongside slaves. Anyone who challenged the *kapita* could be flogged or killed. Non-compliant chiefs were replaced, killed, or held captive. The sentry used his power to acquire food, women, and luxury items. Some sentries would leave their one year term in a village with five to six wives (Harms, 1974).

The *kapitas* severely undermined the prestige, authority and wealth of lineage headmen. The village headmen were "shamelessly degraded in the eyes of their people, made to fetch and

[13] Despite Leopold's pledge to end the slave trade, both the state and the concessions bought slaves for labor (Harms, 1974).

carry for soldiers, cast into chains and flung into prison" (Morel, 1904). Though they were still considered to have important connections to ancestors, the headmen no longer had the authority to make important decisions. They were unable to protect their lineage from the brutality and terror imposed by the sentries. Additionally, since most able-bodied men were required to collect rubber in the forest, there was a power vacuum in the village that was filled by the *kapita*. In fact, some sentries began to take on the responsibilities previously allocated to lineage headmen, such as settling disputes among lineage members. Finally, the sentries would take the wealth from lineage headmen, including marrying their daughters and wives (Harms, 1974).

2.4. Social Responses

During the rubber concession period, local villagers faced immense challenges and social stress. Aside from the violence, the rubber regime had other disastrous effects, such as the spread of disease and famine. Villagers had to develop alternative coping mechanisms as they faced a brutal rubber regime and local leaders who were unable to protect them. Historians have highlighted how the rubber period "demanded social adaptation and new forms of cooperation and mutual aid" (Nelson, 1994). According to oral histories collected by Nelson (1994), the rubber period was associated with an increased reliance on age sets, which encourage horizontal ties and cooperation among villagers of the same age grade. Age sets became particularly important as people were often forced to collect rubber in groups, far away from their village. These "pacts of friendship and mutual aid between age-mates facilitated the social mobility required in the search for rubber". These forms of mutual insurance were critical as they allowed individuals to "by-pass the corrupt or ineffective rule of their elders". In essence, these informal insurance systems grew in response to brutality of the rubber regime and the weakened formal institutions. They sought to provide stability at a time of great uncertainty. As one individual describes, "Before, we were weak. With age-sets, we were strong" (Nelson, 1994).

2.5. Aftermath

Though the CFS government objected in principle to the violence, in practice it allowed and encouraged it. The effectiveness of the labor coercion allowed the concession companies to make exorbitant profits. The price of rubber went from 6.20 francs per kilo in 1894 to over 10 francs per kilo in 1898. The cost incurred by the concession companies to "purchase" a kilo of rubber in CFS

and ship it to Antwerp was approximately 1.35 francs (Harms, 1983). The magnitude of profits earned by the concession companies led one contemporary observer to note "ABIR has in a single fiscal year made a net profit that represents more than twelve times the initial capital investment. Such a result is perhaps without precedent in the annals of our industrial companies" (Plas and Pourbaix, 1899).

By 1905, the natural rubber supplies were nearly exhausted in the Upper Congo Basin. Due to depleted rubber supplies and increasing condemnation of their labor practices in Europe, ABIR and Anversoise left CFS in 1906. In 1908, the CFS became a Belgian colony and after 1910, competitive production of rubber from *hevea* plantations in Southeast Asia and South America, along with the invention of synthetic rubber, lead to a large decrease in rubber prices (Harms, 1975).

The regime of labor coercion had disastrous effects on the local population. Villages subjected to labor coercion were unable to tend to their fields, leading to low yields and famine. Sentries raided local livestock. Malnourished individuals became particularly susceptible to disease, including the increasingly rampant sleeping sickness (Harms, 1983). The brutality of the rubber collection tactics resulted in the deaths of an estimated 10 million people and earned the policy the nickname *"Red Rubber"* (Vangroenweghe, 1985).

3. Long-Term Effects of the Rubber Concessions

3.1. Data

To examine the long run impact of rubber extraction by concession companies we first combine Demographic and Health Surveys (DHS) data from 2007 and 2014 with detailed maps of the two largest rubber concessions in the DRC. The DHS surveys from the DRC provide detailed information on education, assets, and health outcomes for individuals in many villages. This data source and the variables used in our analysis are described in detail in Appendix B.[14] The maps of the rubber concessions are from Waltz (1918). This resource describes all of the concessions given by King Leopold. This includes details on the physical boundaries and the year when each concession was granted. Figure 1 is a map of the concessions of interest: ABIR and Anversoise. These were the largest concessions in the Upper Congo Basin, and the largest concessions that

[14]We also attempted to use nightlight data as a measure of development. However, as Appendix Figure A3b shows, the area of interest in DRC has little nightlight.

focused exclusively on rubber (Vangroenweghe, 1985).[15] Figure 3 provides a map with the rubber concession borders and the DHS clusters from 2007 and 2014 that are within 200 kms and 100 kms of the borders of the rubber concessions.

3.2. Summary Statistics

Table 1 presents simple differences in means inside and outside the concession areas for variables from DHS. We restrict our analysis for these differences in means to observations that are within 200 kms of the rubber concession borders in order to compare relatively similar areas.[16] Simply comparing differences in means it appears that the concession areas are less educated, less wealthy, and have worse health outcomes than the areas just outside the concession borders.

3.3. Empirical Strategy

A concern with the simple differences-in-means presented in Table 1 is that the rubber concession areas might be different along a number of dimensions. Specifically, the rubber concessions might have been chosen strategically for certain characteristics that could also affect development today. For example, these areas might be more suitable for certain crops or have been populated by ethnic groups with different cultural norms. However, whether an area was exposed to rubber extraction is a deterministic and discontinuous function of whether or not a village fell inside the concession boundaries. As described in Section 2, these concession were granted at a time when much of the Congo had not been explored. The concession boundaries were defined by salient geographic characteristics - in this case, rivers and river basins. Thus, the concession boundaries are unlikely to have been selected based on local characteristics that also vary discontinuously at the concession border.

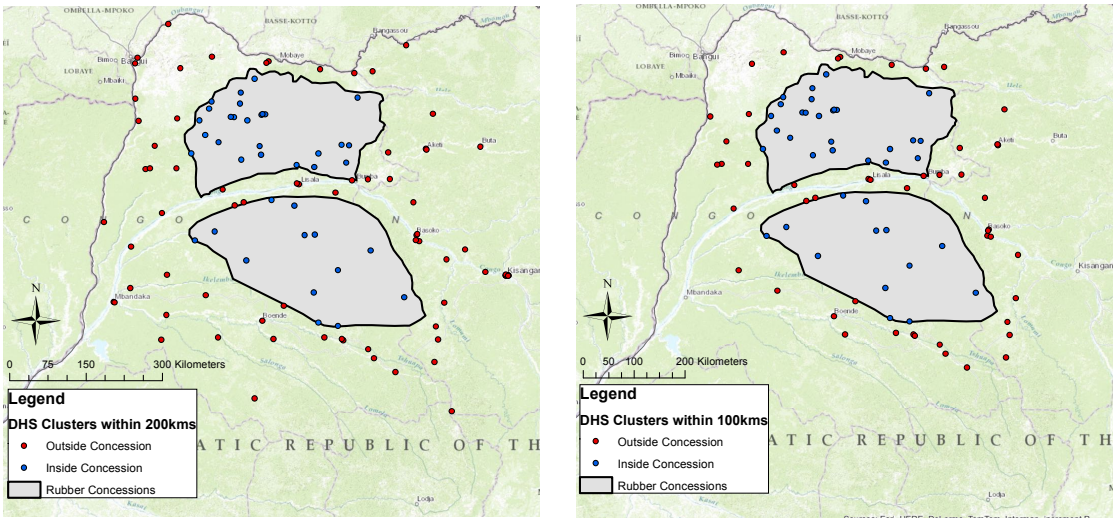
We can estimate the causal effect of exposure to the coercive institutions used to extract rubber on the outcomes of interest by estimating the following regression discontinuity (RD) specification:

$$y_{i,v} = \alpha + \gamma RubberConcession_{i,v} + f(location_v) + \mathbf{X}_i\beta + \phi_{j(v)} + \varepsilon_{i,v} \tag{1}$$

[15] King Leopold granted additional concessions that focused on mining or both ivory and rubber (Waltz, 1918). These were primarily in the southern provinces of Kasai and Katanga.

[16] We have also examined these differences in means – comparing areas inside the former concessions compared to areas outside the concessions – for (i) areas within 100 kms of the borders (ii) areas within 50 kms of the border and (iii) all DHS clusters in the DRC. The summary statistics are generally consistent with Table 1.

Figure 3: Maps of Clusters from the DHS 2007 and 2014 for DRC - Within 200 km and 100 km



(a) Within 200km

(b) Within 100km

Table 1: Summary Statistics

	Individuals Within 200 kms of Concession Borders			
	Mean Inside	Mean Outside	Clustered S.E.	(p-value)
Educational Attainment	1.013	1.409	(0.069)	0.0003
Obs	1,843	3,894	–	–
Years of Education	4.228	6.289	(0.368)	0.0006
Obs.	1,837	3,891	–	–
Literacy	0.884	1.283	(0.071)	0.0002
Obs.	1,836	3,870	–	–
Wealth Index	1.824	2.505	(0.156)	0.0009
Obs.	1,843	3,894	–	–
Wealth Score	-54,511	-18,419	(9,494)	0.0008
Obs.	1,843	3,894	–	–
Women Ht/Age Percentile	2,469	2,994	(204.8)	0.012
Obs.	545	1080	–	–
Child Ever Vaccinated	107.0	264.2	0.037	0.033
Obs.	599	1070	–	–
Child Ht/Age Percentile	2,314	2,633	182.1	0.082
Obs.	557	1055	–	–

Notes: The data are from the DHS 2007 and 2014 DRC surveys. Standard errors are clustered at the DHS cluster level. There are 109 clusters within 200 kms of the historical rubber borders. Educational Attainment is a 0 to 3 categorical variable where 0 is no education and 3 is higher education. Literacy is a 0 to 2 categorical variable where 0 is cannot read at all and 2 is able to read a whole sentence. Wealth Factor is an index generated by the DHS using principle component of asset ownership. Wealth Index is a 1 to 5 categorical variable where 1 is poorest quintile and 5 is richest quintile from the Wealth Factor Score. Ht/Age Percentile divides each respondent's height by their age and finds their percentile in the sample and normalizes this percentile to be within 0 and 1000. The DHS only records respondent's height and weight for a subsample of the female population. Child Ever Vaccinated is an indicator variable equal to one if the child has ever received a vaccination. Child Ht/Age Percentile divides each children's height by their age and finds their percentile in the sample and normalizes this percentile to be within 0 and 1000. See Data Appendix for more details.

where $y_{i,v}$ is our outcome of interest for individual i in village v; $RubberConcession_{i,v}$ is an indicator equal to 1 if v is inside a rubber concession area and equal to 0 otherwise; $\mathbf{X}_i$ is a vector of covariates for individual i; $\phi_{j(v)}$ represent district fixed effects;[17] $f(location_v)$ is the RD polynomial, which controls for smooth functions of geographic location for village v. We check robustness using various forms of the RD polynomial.[18] We limit our analysis to observations within 200 kms, 100 kms, and 50 kms of the concession boundaries as this restricts the range in which unobservable parameters can vary.[19] Our coefficient of interest is γ: the effect of being just inside the concession area on our outcome of interest. The intuition behind this specification is that concession borders arbitrarily allocated some villages to be in the concessions and others to be just outside the concessions. These villages should have similar geography, culture, history, and institutions prior to the concession era, allowing us to identify the effect of rubber extraction on contemporary outcomes.

The RD approach presented in equation (1) requires two identifying assumptions. The first assumption is that all relevant factors before the concessions were granted varied smoothly at the concession boundaries. This assumption is needed to ensure that individuals located just outside the concessions are an appropriate counterfactual for those located just inside them. For example, it would be a problem for identification if Leopold selected the borders strategically, capturing only rubber-suitable areas or areas that had greater population density. However, the historical evidence presented in Section 2 suggests that Leopold did not have much information about the interior of Congo in 1890.[20] The concession borders follow natural boundaries such as rivers and river basins. Reassuringly, the concession borders do not align with Murdock ethnic group borders.[21]

To assess the plausibility of this assumption, Panel A of Table 2 estimates specification (1)

[17]Specifically, for $\phi_{j(v)}$, $j(v)$ represents the function mapping each village v to district $j(v)$. In our area of interest, there are two provinces (Equateur and Orientale), eight districts and 34 territories. In 2015, DRC underwent a decentralization process that created 26 provinces out of the original 11. All of our analysis uses the territories and borders from before decentralization.

[18]For our baseline results we use a linear polynomial in latitude and longitude following recent work by Gelman and Imbens (2014) and Dell et al. (2015). Additionally, for our main results, we follow Dell (2010) and present results using cubic polynomials in distance to the concession borders and cubic polynomial in latitude and longitude.

[19]We calculated the Imbens-Kalyanaraman optimal bandwidth for several of our outcomes of interest with distance to the border as the running variable. The optimal bandwidth was generally between 75 and 125 kilometers depending on the outcome.

[20]This is also similar to the evidence presented by Michalopoulous and Papaioannou (2014, 2016), who point out that much of the interior of Africa was unexplored at this time and colonizers drew African borders at the time in an arbitrary manner with little respect to the local political geography.

[21]Appendix Figure A4b, shows the ethnic group boundaries from Murdock (1959) and the rubber concessions borders. The rubber concession borders do not align with ethnic group boundaries.

for important geographic characteristics such as altitude, precipitation and soil suitability and finds balance along these geographic characteristics.[22] Panel B of Table 2 presents results from estimating specification (1) for river characteristics such as navigable river density and access to rivers. Rivers are a particularly important geographic features for the area because they are one of the main forms of transportation. We find balance on these important geographic characteristics, especially for smaller bandwidths, suggesting that the areas inside and outside the concession are comparable along the border. These results are presented both with standard errors clustered at the territory level and Conley standard errors. The Conley standard errors account for spatial auto-correlation (Conley, 1999).[23]

The second important assumption for this regression discontinuity approach is that there was no selective sorting across the RD threshold once the concession borders were established. Selective sorting would require certain villages to be able to select out of being in a concession. This is unlikely to have happened given how the borders were drawn. A related concern is selective migration during the rubber era. It is likely that some migration took place, as individuals tried to avoid the rubber demands and the associated violence. However, evidence from Harms (1975) suggests that the rubber companies greatly controlled migration (using village censuses they collected themselves) and forced people to remain in their villages. Additionally, Harms (1975) notes that local chiefs were held accountable when individuals that migrated did not meet their quotas, incentivizing chiefs to prevent migration. However, this assumption of no migration is unlikely to hold perfectly. We analyze migration in Section 4.3 as a potential source of persistence and present results on what selective migration would have to look like to explain our results.

[22]We use 20km by 20km grid cells to match the analysis in Dell (2010). See Appendix B for detailed information on data sources and variables used. Ideally we would also present balance on pre-colonial demographic characteristics. However, we have not been able to find pre-colonial demographic data for the DRC. The Ethnographic Atlas has interesting variables, but we are hesitant to use this as a pre-colonial demographic measure since the data was collected during the colonial era. Additionally, it does not have many data points for our area of interest.

[23]For the Conley standard errors, we use a cut-off window of 50 kms. The results are robust to the use of different cut-offs. For the clustered standard errors, we cluster at the territory level, the lowest administrative level in the area. For some bandwidths, the number of clusters is slightly below thirty, potentially leading to overly optimistic standard errors (Cameron et al., 2008); however, the cluster standard errors tend to be quite consistent with the Conley standard errors.

Table 2: Balance on Geographic and River Characteristics

	Panel A: Geographic Characteristics								
	Elevation			*Precipitation*			*Soil Suitability*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inside Concession	-14.84*	-3.942	0.219	0.268	-1.266	-1.18	0.016	-0.001	-0.003
	(7.418)	(5.959)	(5.259)	(2.323)	(1.974)	(1.571)	(0.013)	(0.017)	(0.020)
	[5.415]	[5.333]	[5.214]	[1.230]	[1.100]	[1.041]	[0.012]	[0.013]	[0.015]
Observations	1,350	853	504	1,350	853	504	158	106	60
Clusters	34	29	25	34	29	25	34	29	25
Mean Dep. Var.	435	433	436	80	75	73	0.060	0.068	0.064
	Panel B: River Characteristics								
	Navigable River Density			*Access to Navigable Rivers*			*Access to Any River*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inside Concession	-1.647	-0.238	3.269	-0.005	-0.005	0.052	-0.112**	-0.087	-0.091
	(2.111)	(2.428)	(3.150)	(0.039)	(0.047)	(0.065)	(0.052)	(0.058)	(0.071)
	[2.362]	[2.403]	[2.802]	[0.040]	[0.044]	[0.053]	[0.045]	[0.049]	[0.057]
Observations	1,353	853	504	1,353	853	504	1,353	853	504
Clusters	34	29	25	34	29	25	34	29	25
Mean Dep. Var.	12.559	10.329	10.577	0.225	0.215	0.216	0.516	0.478	0.425

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. We include district fixed effects. Elevation and precipitation come from the Global Climate Database created by Hijmans et al. (2005). This data provides monthly average rainfall in millimeters and elevation measures in meters. *Precipitation* is a measure of the average yearly precipitation (in millimeters of rainfall per year) for each 20km by 20km grid cell. *Elevation* calculates the average elevation in meters for each 20km by 20km grid cell. *Soil Suitability* is from Ramankutty et al. (2002) and Michalopoulos (2012). It is an index from 0-1, with higher values indicating higher soil suitability for agriculture. *Navigable River Density* is defined as total length in meters of navigable river in each grid divided by the grid's surface area in kilometers squared. *Access to Navigable Rivers* and *Access to Any River* is an indicator variable equal to one if a grid cell contains a navigable river or any river. Data on navigable rivers and rivers in the DRC is from the *Referentiel Geographique Commun* (2010). We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

3.4. Regression Discontinuity Results

To examine the long-run effects of exposure to extractive institutions, we analyze 2007 and 2014 DHS data.[24] We first focus on education and present results for observations within 200 kms, 100 kms, and 50 kms of the concession borders. We display results using a linear polynomial in latitude and longitude, third-order polynomials in distance to the concession border, and third-order polynomials in latitude and longitude. Section 3.5 discusses additional polynomials and other robustness checks, including doing the analysis separately for each concession. Table 3 reports estimates for specification (1) for different education outcomes. The results are consistent with the summary statistics from Table 1: areas inside the concession have significantly lower

[24]The Data Appendix in Appendix B contains detailed information on the source of the data, the variables used and their definitions. Note that even though the DHS data has geographic coordinates for each village, the DHS randomly displaces the exact coordinates by up to 5 km (and up to 10 km for 1% of rural clusters). Importantly, since the displacement is random, this simply induces classical measurement error.

levels of education. Individuals just inside the former rubber concessions are estimated to have approximately 1.5 fewer years of education than individuals just outside the concessions.

The results for years of education can be seen graphically in Figure 4. The figure presents a geographic scatterplot of the DHS clusters shaded with the average years of education in each cluster. The background shows predicted values for a finely spaced grid of longitude-latitude coordinates from a regression using a cubic polynomial in latitude and longitude and the $RubberConcession$ indicator variable. The plot can thus be used to assess how well the RD fit is approximating the data across space.[25] The 3D plot suggests that the RD polynomial is capturing some of the heterogeneity in outcomes across space, and that there is indeed a discontinuity at the concession borders.

Table 4 reports estimates for specification (1) for the wealth measures available in the DHS survey. Individuals in villages inside the former rubber concessions are approximately 15% less wealthy than similar individuals outside the rubber concessions. In standard deviation terms, areas inside the former concessions are about 0.3 standard deviations less wealthy. Finally, Table 5 reports estimates for specification (1) for different health outcomes and finds evidence that individuals from inside the former concessions have worse health outcomes. Children inside the former concessions have approximately 5 percentage points lower height-to-age percentile and have about 6.5 percentage points lower vaccination rates; similarly, women are approximately 7 percentage points lower in the height-to-age percentile measure. Overall, we find evidence that individuals residing in villages inside the former rubber concessions are less educated, less wealthy, and have worse health outcomes today than individuals in villages outside the former rubber concessions.

3.5. *Robustness of DHS Results*

There are three main empirical concerns for the DHS results presented in Tables 3-5: robustness to alternative RD specifications, random displacement of DHS clusters, and the use of basins to define borders. The first concern is whether the results are robust to alternative specifications of the RD-polynomial. We find that our wealth and education results are robust to parsimonious polynomials in latitude and longitude (linear, quadratic, cubic polynomials) but our results

[25]The spatial RD plots for other outcome variables are presented in Appendix A as are the more standard 2D-RD plots.

Table 3: Rubber Concessions and Education RD Analysis

	Years of Education			*Literacy*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
	Panel A: Linear Polynomial in Latitude and Longitude					
Inside Concession	-1.100***	-1.385***	-1.648***	-0.226***	-0.284***	-0.345***
	(0.339)	(0.338)	(0.387)	(0.069)	(0.070)	(0.080)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.174***	-1.373***	-1.696***	-0.230***	-0.277***	-0.367***
	(0.338)	(0.336)	(0.375)	(0.070)	(0.070)	(0.076)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.540***	-1.594***	-1.532***	-0.299***	-0.333***	-0.365***
	(0.376)	(0.371)	(0.415)	(0.078)	(0.082)	(0.083)
Observations	5,670	4,274	2,623	5,648	4,266	2,619
Clusters	110	85	52	110	85	52
Mean Dep. Var.	5.628	5.109	5.209	1.170	1.065	1.077

Notes: Standard errors are clustered at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *Literacy* is a 0 to 2 categorical variable where 0 is cannot read at all and 2 is able to read a whole sentence. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure 4: RD Plot for Years of Education

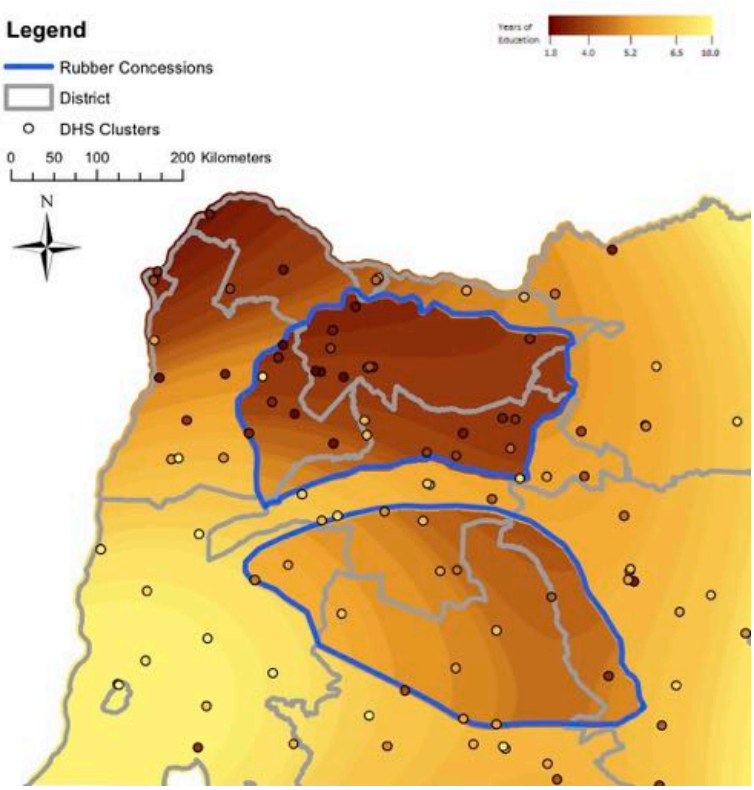


Table 4: Rubber Concessions and Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Linear Polynomial in Latitude and Longitude					
Inside Concession	-0.503***	-0.582***	-0.682***	-11,235*	-17,540***	-22,610***
	(0.142)	(0.143)	(0.200)	(5,720)	(5,152)	(7,115)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.475***	-0.541***	-0.530**	-11,583**	-16,430***	-17,221**
	(0.146)	(0.153)	(0.203)	(5,643)	(5,396)	(7,147)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.697***	-0.771***	-0.582***	-18,574***	-22,374***	-17,182**
	(0.171)	(0.194)	(0.196)	(6,734)	(6,551)	(6,756)
Observations	5,679	4,281	2,627	5,679	4,281	2,627
Clusters	110	85	52	110	85	52
Mean Dep. Var.	2.287	2.034	2.101	-30014	-46330	-43799

Notes: Standard errors are clustered at the DHS cluster level. We include district fixed effects and control for age, age squared, and gender. *Wealth Factor* is an index generated by the DHS using principle component of asset ownership. *Wealth Index* is a 1 to 5 categorical variable where 1 is poorest quintile and 5 is richest quintile from the Wealth Factor Score. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 5: Rubber Concessions and Health RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.077**	-0.075**	-0.069	-338.4**	-401.5**	-551.4**	-682.9***	-790.7***	-868.1***
	(0.035)	(0.035)	(0.043)	(162.7)	(167.6)	(231.8)	(214.3)	(211.9)	(277.8)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.081**	-0.081**	-0.093**	-477.6***	-517.5***	-675.6***	-720.6***	-794.2***	-855.3***
	(0.035)	(0.036)	(0.044)	(181.5)	(176.1)	(185.6)	(209.1)	(216.6)	(268.7)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.051	-0.037	-0.072	-501.2***	-623.9***	-483.3**	-770.5***	-867.4***	-808.9***
	(0.042)	(0.051)	(0.052)	(189.4)	(188.5)	(187.2)	(231.9)	(250.6)	(301.2)
Observations	3,184	2,556	1,605	1,314	822	822	1,589	1,218	758
Clusters	110	85	52	110	85	52	110	85	52
Mean Dep. Var.	0.814	0.797	0.793	2523	2468	2472	2689	2602	2628

Notes: Standard errors clustered at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. We examine the DHS health questions asked to a subset of female respondents. Respondent *Ht/Age Percentile* divides each respondent's height by her age and finds her percentile in the entire sample and normalizes this percentile to be within 0 and 10000. Similarly, Child *Ht/Age Percentile* divides each child's height by his or her age and finds his or her percentile in the entire sample and normalizes this percentile to be within 0 and 10000. *Child Ever Vaccinated* is an indicator variable equal to one if the respondent's child has ever been vaccinated. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

begin to lose significance with higher-order polynomials in distance to the concession border (fourth order polynomials and above).[26] Nevertheless, the coefficient magnitudes and signs all remain similar across most specifications, suggesting that we lose significance with higher-order polynomials due to over-fitting rather than to more precise estimation. The health results are slightly less robust to higher-order RD polynomials compared to the education and wealth results. However, as detailed in the data appendix, these questions are only asked to a subsample of the population (about a third of all women and children) so we lose power in the analysis.

Additionally, we use alternative euclidian distance specifications where we modify $f(.)$ in equation (1) to be a function of distance to the former concession border. Once again, we find that our results are robust to parsimonious polynomials in distance to the former borders (linear, quadratic, cubic, interacted-linear, interacted-quadratic) but begin to lose significance with higher-order polynomials in distance (interacted third-order, interacted-quartic).[27] However, the estimated coefficients from the distance to border specifications generally have the same sign and are of similar magnitudes as the latitude-longitude specifications from Tables 3-5. Overall, we find that our results are robust to alternative RD polynomials.

A second potential issue is that the DHS randomly displaces the coordinates of the clusters in order to maintain the confidentiality of the respondents. The GPS coordinates for the DHS clusters are displaced by up to 5 km for all urban clusters and 99% of rural clusters, and up to 10 km for 1% of rural clusters. Importantly, this displacement is random and simply induces classical measurement error. This would bias our coefficient towards zero. However, with the regression discontinuity approach, one might be concerned that the results are being driven by clusters right near the border (that might be incorrectly assigned to inside or outside the concession because of the random displacement). Thus, we estimate our regression discontinuity results with a "donut-hole" of 5 kms in Appendix D.2 and find that the results are robust to excluding observations very close to the border.[28] This provides evidence that the results are not being driven by these potentially mis-classified clusters.

[26] We present the results for these specifications in the Appendix D.1.2.

[27] These results are presented in the Appendix D.1.1. By "interacted" polynomial we mean that we interact the "Inside Concession" indicator with all terms in the polynomial.

[28] The results also hold with alternative donut holes, for example, with a 10 km exclusion criterion.

3.6. *Falsification Exercise: Major River Basins in DRC*

An additional possible concern with the results presented in Section 3.4 is that, since the concession borders were drawn using major river basins as the salient geographic feature for the borders, the results are reflecting some inherent characteristic of river basins, rather than exposure to labor coercion. To assess this claim, we conduct a falsification exercise where we run our main specification across all major river basins in DRC using the HydroBASINS data from Lehner and Grill (2013) to examine how our estimated effects for the former concessions correspond to the estimated effects for all other major river basins in DRC.[29] Figure 5 presents the empirical cumulative distribution of the RD estimates for education for all major river basins in DRC, excluding the basins corresponding to the Anversoise and ABIR concession boundaries. To highlight where the corresponding RD estimates for ABIR and Anversoise would fall relative to these estimated basin effects, we include in solid-red the RD estimate corresponding to the Anversoise concession border and in dashed-blue the RD estimate corresponding to the ABIR concession border. The Anversoise estimate falls on the far-left of the distribution and there is no river basin that has as negative an estimate, while the ABIR estimate is also on the far-left of the distribution and is more negative than the effect of all but one other river basin. The ABIR estimate falls in the bottom 3.44% of this river basin RD estimate distribution while Anversoise falls in the 0.0% of this distribution.[30] This falsification exercise presents important evidence that the results presented in Section 3.4 are not a consequence of the concessions being drawn using river basins, but instead suggests that our estimates do represent the impacts of exposure to extractive institutions during the rubber period.

3.7. *Analysis Using Historical Post Level Data*

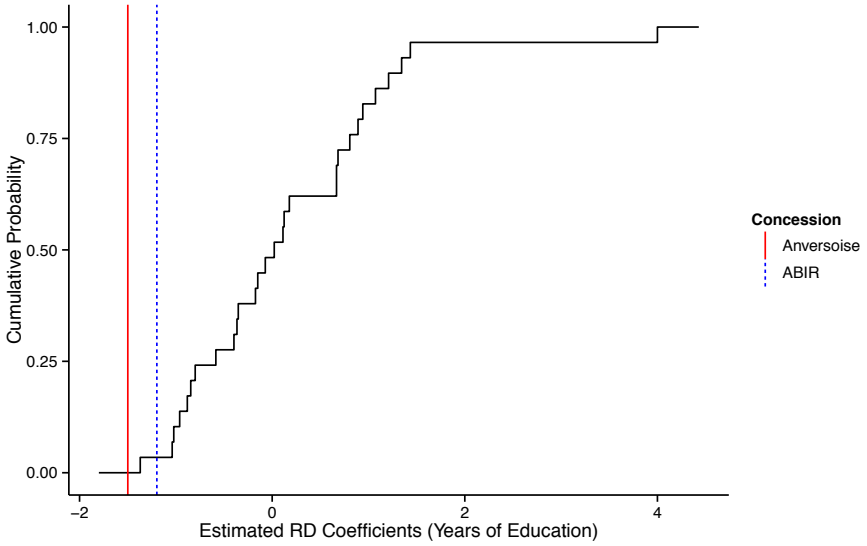
As a complement to the RD analysis, we analyze post-level rubber production data from 1904 for ABIR.[31] We visited the Belgian Foreign Public Service Foreign Affairs archives to gather CFS-era colonial documents on the concessions. We combined data on rubber production from the foreign

[29]See Appendix E for detailed explanations on the HydroBASINS data, the algorithm used in the construction of the river basin layers, and the implementation of the falsification exercise.

[30]Appendix E presents results using alternative specifications. Additionally, it presents the results using the river basin borders from HydroBASINS used to define the ABIR and Anversoise concessions rather than the actual concession borders. The results are very similar.

[31]We have been unable to find similar data for Anversoise concession. Most data on the concessions were destroyed at Leopold's request prior to the CFS becoming the Begian Congo in an effort to cover up the human rights abuses that occurred.

Figure 5: Empirical Cumulative Distribution of RD Estimates for Major River Basins in DRC



Cumulative Distribution and Concession Estimates

Notes: The estimates use our baseline RD specification – linear latitude-longitude – within a bandwidth of 100 km from the river basin borders. The solid-red line presents the RD estimate corresponding to the Anversoise concession border and the dashed-blue line presents the RD estimate corresponding to the ABIR concession border. See Appendix E for details on the implementation of this falsification exercise.

affairs archives with data from the De Ryck Collection, a collection of Congo colonial manuscripts. Altogther, we compiled data on rubber production for 19 posts within the ABIR concession between July and December 1904 (see Figure 2 for map of post locations) (de Ryck, 1885-1954).[32] We use these measures of production as a proxy for intensity of exposure to extractive institutions. We match DHS clusters to rubber posts within 50 kilometers (Figure 2 shows the locations of the posts established by the rubber concessions). Even though we are limited by the small number of DHS clusters near former rubber posts, we find that individuals within DHS clusters close to posts that produced more rubber during these 6 months of 1904 are less wealthy today. To the extent that rubber production captures the intensive margin of exposure to coercive institutions, these results suggest that greater exposure indeed leads to worse development outcomes.[33] As an alternative measure of intensity of exposure, we use year of post establishment. Posts within ABIR were established between 1892 and 1903. We find that individuals close to posts that were operating for more years are also worse off. These results are presented in Table 6 and

[32]Some data exists on rubber production for 1905 and part of 1906. However, this data is much more incomplete and coincides with the end of the ABIR's presence in the region.

[33]The results are not statistically significant when we include individual and geographic controls as demonstrated in Column (2) of Table 6; however, the magnitude of the effect remains remarkably consistent with this inclusion, suggesting that the results lose statistical significance due to the small sample size.

in Figure 6, and they suggest that some of the heterogeneity in development outcomes near the former concessions can be explained by the intensity of extraction during the Congo Free State period.

Table 6: Post Level Rubber Production in 1904, Year of Post Establishment, and Wealth

	Wealth Index		*Wealth Index*	
	(1)	(2)	(3)	(4)
Rubber Production in 1904	-0.0252***	-0.0220	–	–
	(0.008)	(0.016)	–	–
Year Post was Established	–	–	0.0383*	0.0382**
	–	–	(0.021)	(0.018)
Observations	704	704	704	704
Clusters	16	16	16	16
Controls	N	Y	N	Y
Mean Ind. Var.	7.969	7.969	1898	1898

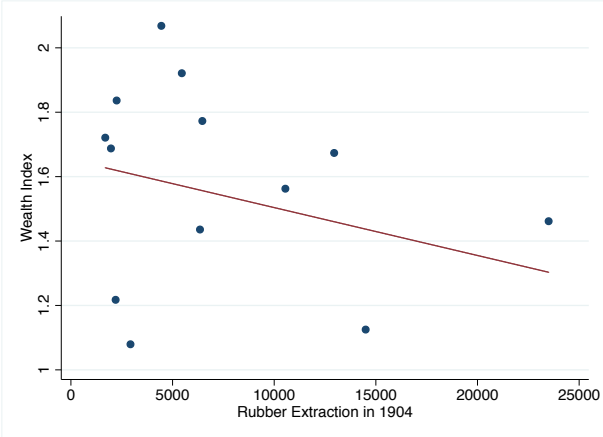
Notes: *Rubber Production in 1904* measures production in tons for the last six months of 1904 for ABIR posts. We match DHS clusters to the closest ABIR post and limit the sample to clusters within 50 kms of the former ABIR posts. We cluster standard errors at the DHS cluster level. In columns (2) and (4) we include district fixed effects and control for age, age squared, gender, survey year as well as latitude and longitude. *Wealth Index* is a 1 to 5 categorical variable where 1 is poorest quintile and 5 is richest quintile from the Wealth Factor Score. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

4. Channels of Persistence

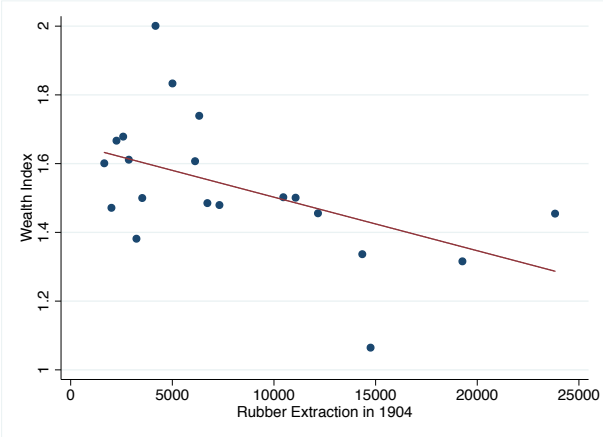
The results presented in Section 3.4 suggest that being in a former rubber concession has large long-term consequences for present day development. However, it is not clear why this effect persists. This persistence is particularly puzzling for a few reasons. The rubber extraction period was relatively short (1892 to 1906) and the concession companies left these areas over 100 years ago. As Table 2 shows, the areas inside and outside former concessions are similar on key geographic characteristics. Thus, in a region that relies primarily on agriculture as a source of income, we would expect these areas to converge over time.[34] Additionally, local populations do not rely on rubber vines for production or consumption today. Thus, differences in rubber resource endowments after the concession companies left are unlikely to be relevant for present day development.

[34]The population density results in Appendix G.1 that show that the former concession areas have lower population density. A Maluthusian model would predict higher income per capita inside the concession areas and a simple Solow model would predict convergence. Empirical evidence from other settings that experienced intense violence – such as Rwanda in the 1990s (Rogall and Yanagizawa-Drott, 2013) and the 1609 Spanish expulsion of the Moriscos (Chaney and Hornbeck, 2013) – suggest that the concessions would have converged to a similar level of development by now.

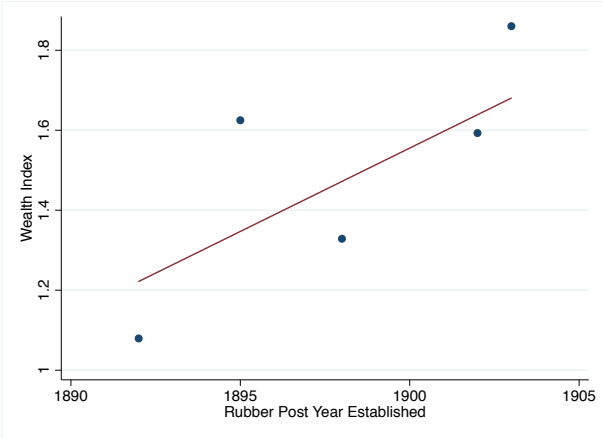
Figure 6: Analysis Using Historical Post Level Data



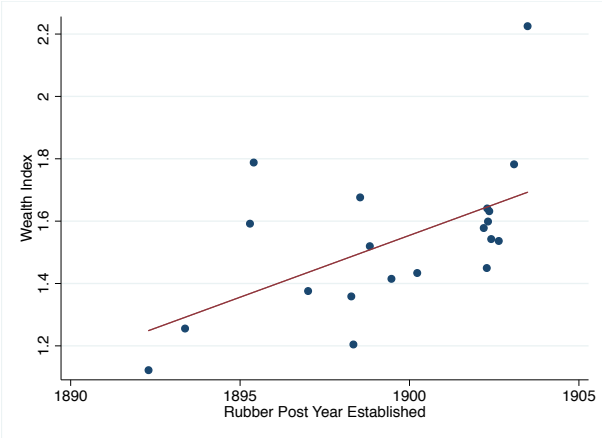
(a) Wealth and rubber production in 1904



(b) Wealth and rubber production in 1904 (controls)



(c) Wealth and year of post establishment



(d) Wealth and year of post establishment (controls)

Notes: We use data on the amount of rubber produced in 19 posts within the ABIR concession between July and December 1904 and match posts to DHS clusters within 50 km of the former posts. Figures (b) and (d) include controls for age, age squared, gender, survey year, latitude and longitude. Rubber Production in 1904 is measured in tons.

In this section, we explore several important intermediate outcomes that might help us better understand the channels underlying our findings. In particular, guided by the historical literature on the DRC, we explore whether the rubber extraction period (i) affected subsequent Belgian colonial policies and colonial infrastructure investments and (ii) altered migration patterns and induced selective migration. We examine these channels using both archival data and existing data.

4.1. On a Convergence Path?

Before examining channels for persistence and their implications, it is important to understand whether areas inside the former rubber concessions are actually on a path to convergence with

areas outside the former concessions but have simply not caught up yet. We test for convergence in our setting by examining whether younger cohorts inside the former concessions are "catching up" to similar cohorts outside the former concessions in terms of the development outcomes examined in Tables 3-5.[35] To do this, we compare cohorts inside and outside the concessions born within five years of each other by estimating a regression that includes fixed effects for each 5-year cohort along with the interactions between the $InsideConcession$ indicator and cohort fixed effects.[36] Formally, we estimate the following specification:

$$y_{i,v} = \gamma InsideConcession_{i,v} + \alpha_y C_y + \gamma_y C_y \times InsideConcession_{i,v} + \mathbf{X}_i\beta + \phi_{j(v)} + \varepsilon_{i,v} \quad (2)$$

where C_y are 5-year cohort fixed effects and the other variables are defined as in equation (1).[37] Figure 7 plots the estimated cohort coefficients for years of education, literacy, height-to-age and wealth. We see no evidence for convergence across cohorts: the estimated coefficients for each cohort are similar, stable and do not get closer to zero for younger cohorts. The one exception are the estimates for the health outcome, where older cohorts appear to have slightly higher height-to-age percentiles inside the former concessions. This could potentially be explained by selective survival - of the older individuals, we only observe those healthy enough to survive inside the former concessions.

4.2. Differences in Subsequent Colonial Policies

One potential explanation for the differences in development today is that the subsequent Belgian colonial policies were different inside and outside the former concessions. We gathered archival data from the Académie Royale des Sciences d'Outre-Mer (1954) and Rouck (1945) to assess whether colonial policies and investments were different in the former concessions relative to areas just outside the border. In particular, we examine missionary presence and colonial infrastructure investments.

4.2.1. Missionary Presence

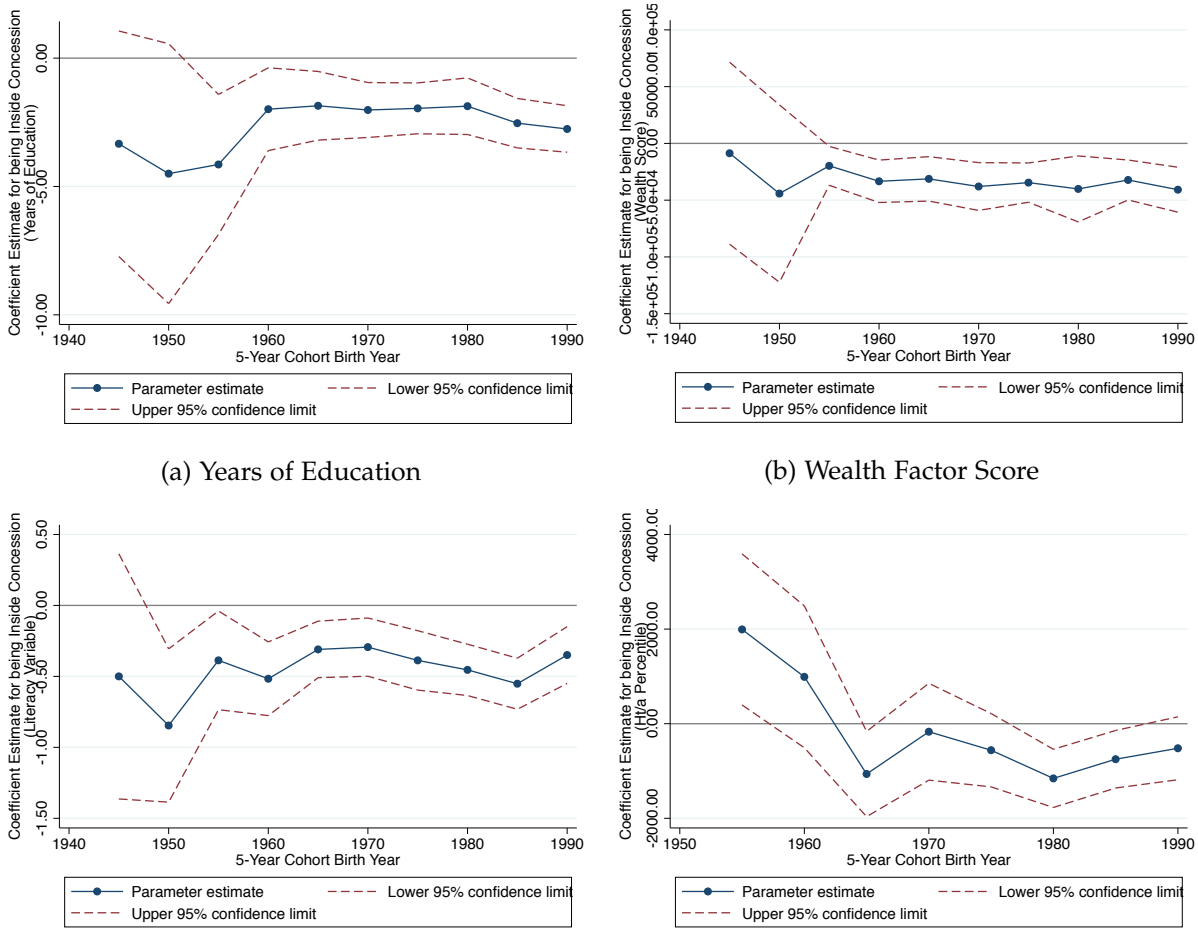
During the colonial period, Catholic and Protestant missions were the primary providers of education (Hochschild, 1998). Given the differences in education found in Table 3, differences

[35] As well, this allows us to test whether our results are not driven by older cohorts.

[36] We do this for observations within 200 kms of the concession borders.

[37] Note that we are not estimating a distinct RD polynomial for each cohort as that would be too demanding of the data given our sample size.

Figure 7: Estimated Cohort Coefficients for Individuals within 200 kms of the Rubber Concessions



(a) Years of Education

(b) Wealth Factor Score

(c) Literacy

(d) Height/Age Percentile

Notes: These figures plot the estimated coefficient for each 5 year cohort indicator interacted with the indicator for being inside a former concession area for observations within 200 kms of the concession borders. The regression also includes cohort fixed effects. Standard errors are clustered at the DHS cluster level. The figures also plot 95% confidence intervals for the coefficients. All outcome variables are from the DHS 2007 and 2014 surveys. The regressions all have 1496 observations. Wealth Factor Score is an index generated by the DHS using principle component on asset ownership. Literacy is a 0 to 2 categorical variable where 0 is cannot read at all and 2 is able to read a whole sentence. Ht/Age Percentile divides each respondent's height by her age and finds her percentile in the entire sample and normalizes this percentile to be within 0 and 10000.

in missionary presence might be responsible for the results if missionaries or colonial officials decided not to engage as much with the former concession areas. We use data from Nunn (2010) on missionary posts in 1924 and colonial maps from 1897 and 1953 to test whether areas inside the concessions had fewer missionary posts.[38] Panel A of Table 7 presents results from estimating equation (1) on missionary presence in 1897, 1924 and 1953. We find no evidence that areas inside and outside the concessions had significantly different missionary presence during the colonial period. Additionally, we find no differential Protestant or Catholic presence, nor do we find any

[38]Data from 1897 are from Rouck (1945) and data from 1953 are from the Académie Royale des Sciences d'Outre-Mer (1954).

differences in type of mission station (e.g. with health center, school or neither).[39] This suggests that differences in outcomes are not driven by subsequent missionary interventions in the areas, nor by the different policies pursued by Protestants and Catholic missions during the colonial era.

Table 7: Rubber Concessions, Missionary Stations, and Colonial Investment

	Panel A: Number of Missionary Stations in:								
	1897			*1924*			*1953*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inside Concession	0.001	0.003	0.005	0.011	0.011	0.027	0.088	0.030	0.035
	(0.003)	(0.002)	(0.005)	(0.012)	(0.013)	(0.019)	(0.074)	(0.074)	(0.064)
	[0.003]	[0.003]	[0.005]	[0.014]	[0.014]	[0.018]	[0.045]	[0.049]	[0.060]
Observations	1,353	853	504	1,353	853	504	1,353	853	504
Clusters	34	29	25	34	29	25	34	29	25
Mean Dep. Var.	0.002	0.001	0.002	0.025	0.026	0.026	0.181	0.254	0.254
	Panel B: Colonial Infrastructure Investment								
	Number of Telecomm Stations in 1953			*Number of Health Centers in 1953*			*Road Network Density in 1968*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inside Concession	-0.008	-0.013	-0.003	0.033	-0.044	-0.060	-1.924	-6.030*	-3.832
	(0.009)	(0.011)	(0.017)	(0.036)	(0.041)	(0.037)	(3.522)	(3.538)	(4.049)
	[0.012]	[0.014]	[0.017]	[0.036]	[0.040]	[0.047]	[3.328]	[3.340]	[3.742]
Observations	1,353	853	504	1,353	853	504	1,353	853	504
Clusters	34	29	25	34	29	25	34	29	25
Mean Dep. Var.	0.030	0.034	0.030	0.199	0.246	0.246	30.99	35.39	35.21
	Panel C: Market Access								
	Number of Bridges in 2010			*Road Density in 2010*			*Road Density in 2010*		
Sample Within:	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms	200 kms	100 kms	50 kms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inside Concession	-0.061**	-0.047*	-0.063*	-10.37*	-17.52***	-10.58*	-7.81**	-11.27***	-5.39
	(0.026)	(0.026)	(0.031)	(5.38)	(5.75)	(5.30)	(3.71)	(3.99)	(3.59)
	[0.021]	[0.020]	[0.025]	[4.75]	[4.83]	[4.96]	[3.31]	[3.41]	[3.65]
Observations	1,353	853	504	1,353	853	504	1,353	853	504
Clusters	34	29	25	34	29	25	34	29	25
Mean Dep. Var.	0.067	0.055	0.060	55.9	57.5	54.4	5.83	4.52	4.06

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial and include district fixed effects. The 1924 data are from Nunn (2010). Data from 1897 are from Rouck (1945) and data from 1953 is from the Académie Royale des Sciences d'Outre-Mer (1954). Number of Missionary Stations in each year is a measure of the number of missions in each 20 km by 20 km grid cell for each year that we have a map with the exact locations of missions. In Panels B and C Columns 1-3 control for density of navigable rivers and columns 4-9 control for the percentage of each grid cell that is a river. Data is from 2010 available from the Referentiel Geographique Commun for DRC. *Number of Telecomm Stations in 1953* is defined as the total number of colonial telecommunications stations located in each 20 km by 20 km grid cell in 1953. *Number of Health Centers in 1953* is defined as the total number of colonial health centers stations located in each 20 km by 20 km grid cell in 1953. Data are from Académie Royale des Sciences d'Outre-Mer (1954). *Road Network Density in 1968* is defined as total length in meters of roads in each 20 km by 20 km grid divided by the grid's total surface area in kilometers squared for roads in 1968. Data is from 2010 available from the Referentiel Geographique Commun for DRC. *Number of Bridges* variable is defined as the total number of bridges located in each 20 km by 20 km grid cell. *Road Density* is defined as total length in meters of roads in each 20 km by 20 km grid divided by the grid's total surface area in kilometers squared. Columns 7-9 control for population levels by including the *Mean Population Density* measure from Landscan 2007 used in Table A23. We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

[39] Results not presented but available upon request.

4.2.2. *Colonial Infrastructure Investments*

Even though the Belgian colonial government was not primarily responsible for the provision of schooling, the government did provide infrastructure investment and other public goods (Van Reybrouck, 2014). If the colonial government chose to invest less in former concessions areas - perhaps due to lower population density as a result of the rubber period - then differences in colonial investments during this period could be a channel through which the rubber areas remain less developed today.

Using colonial data from the Académie Royale des Sciences d'Outre-Mer (1954), we test whether areas inside the former concessions had fewer telecommunication stations and health centers in 1953 and lower road network density in 1968.[40] The estimates are presented in Panel B of Table 7. We find little evidence that colonial investments in these goods were different inside and outside the concessions: areas inside the concessions had similar numbers of telecommunication stations and health centers in 1953, and similar (though sightly lower) road network density in 1968.

4.3. *Selective Migration*

As mentioned in Section 3.3, a potential channel of interest is selective migration. Selective migration would be a plausible channel of persistence if all of the most capable individuals are leaving the former concession areas and moving to places outside of the former concession, and the relevant determinants of income are highly heritable.[41] Unfortunately, detailed micro-level information on migration rates does not exist for our area of interest. However, in this section we conduct three exercises to examine how likely it is that selective migration could explain our results.

First, we conduct a trimming exercise with the DHS data to examine whether differential rates of migration might be responsible for differences in development outcomes between former concessions and areas just outside the former concessions. Since we do not have migration data for our area of interest, we assume a large migration rate of 15% and omit the top 15% of the most

[40]The DRC achieved independence in 1960, but dealt with political instability in the subsequent years (Van Reybrouck, 2014); thus, even though the road density data is from after independence, it serves as a reasonable proxy for colonial road investments.

[41]Examining the plausibility of this last assumption about the heritability of the relevant determinants of income, especially in a rural setting, is interesting but outside the scope of the paper.

well-off individuals who reside outside of the concessions to address the situation in which all of the most well-off people just outside of the former concessions actually came from inside of the concessions. For reference, Dell (2010) omits the top 4.8% using information on migration rates in Peru, so our assumed level of selective migration is much higher. It is also a much higher estimate than the differences in population flows we observe using Landscan data from 2007 compared to 2013, or using our measure for population density in 1954 and modern Landscan data. In both cases, population growth differences between inside and outside the concessions are a maximum of 4%. After trimming the top 15% of the sample outside the concessions but within 200 km, the estimates of the effect of the former rubber concessions remain of similar magnitude and statistical significance. These estimates are reported in Appendix F.1.1 and demonstrate that even under a strong assumption of high levels of selective migration our results remain consistent.

Second, we can also consider how much of the sample we would have to trim in order for our results to lose significance. Specifically, we can omit the most well-off x% of individuals who reside outside of the concessions and examine how large x would have to be so that we no longer observe statistically significant differences between former concession and non-concession areas, under the strong assumption that x% of the most well-off from outside the concession are actually from inside the concession. When we examine our education and income results, we find that x would have to be between 16% and 26% to explain the differences we observe.[42] This would imply that for selective migration to fully explain the results, only the "best" people from inside are leaving and that one-fifth of the individuals we observe outside the concession who are the most well-off all came from inside the concession.

Finally, we can examine whether our estimated results differ between places inside the former concessions where it would be easier to migrate compared to places where it would be more difficult to migrate. In particular, we can compare villages close to a segment of the concession border that has a traversing road relative to those villages that are not close to a border segment with a traversing road.[43] The idea is that in a village near to a segment of the concession border that has a traversing road, it is easier to migrate out of the former concession. If selective migration is very large such that all of the "good" people are leaving, we would expect that the RD estimates for villages with access to traversing roads to be larger and more negative than

[42]The exact x depend on the bandwidth used, the RD specification, and the dependent variable.

[43]Note, almost all villages happen to next to some road, so this exercise is not simply comparing villages with roads to those without roads.

the estimate for villages for which migration is more difficult. The results for this analysis are presented in Appendix F.2. Figure A25 of Appendix F.2 also includes a map illustrating the border segments with and without traversing roads. We find that areas with easier access to roads leaving the concession are not significantly worse off than villages without easy access to traversing roads, offering some additional suggestive evidence that selective migration is not enough to explain the differences in development presented in Section 3.4.

The results from these exercises suggest that migration today is likely not the main channel behind the differences between former concessions and neighboring areas. This finding is consistent with a growing literature that highlights a lack of selective migration in developing country settings. For instance, Bazzi et al. (2015) examine the Transmigration Program in Indonesia that relocated two million migrants from rural Java and Bali to new rural settlements in the Outer Islands and find there has been little selective migration away from the settlements.[44] They are also consistent with qualitative evidence from our visits to the area: migration to other rural areas is challenging due to (i) poor infrastructure and (ii) difficulties in gaining access to land and resources in a different village if one does not originate from that community.[45]

4.4. Market Access and Public Good Provision Since Independence

An additional potential channel of interest is differences in investment in market access and public goods post-independence.[46] After independence, the central government suffered from political instability (Van Reybrouck, 2014); thus, much of the subsequent maintenance of roads and the provision of public goods was not provided by the central government. If investment levels in roads are significantly lower within the former concessions, this would suggest local failure of collective action as a potential mechanism for persistence. This lack of local maintenance could arise for many reasons. For example, local governments may not have the capacity to invest in public goods or in infrastructure maintenance in former concession areas, or individuals in the former concessions are less trusting of outsiders and therefore choose not to invest in public goods and infrastructure.

[44]The results are also in line with the evidence from Peru described in Dell (2010).

[45]Thus, rural to rural migration in this setting is most likely quite low. Large cities are the primary destination for migrants.

[46]This outcome is particularly interesting given the results in Dell (2010), who finds large negative differences in market access and public good provision in former *mita* areas.

Using data from the *Referentiel Geographique Commun* on current road networks and bridges in DRC today, Panel C of Table 7 examines whether areas inside the former concession have lower market access today.[47] We find that areas inside the former rubber concessions have fewer roads and bridges today relative to areas outside of the former concessions. The results in Panel C of Table 7 combined with the results in Panel B – in which we find no evidence of differences in road network investments by the Belgian colonial government – suggest that differences in public good and infrastructure provision *since independence* are a plausible channel of persistence in this setting. Because the Belgians did not invest differentially in road infrastructure inside and outside the concessions, road network density was similar at independence. Yet, today we find that road networks are less dense inside the former concessions. Given that there have not been any substantial investments in new roads in the area since independence, these results suggest that the observed differences in road network density today are driven by a failure by local chiefs and their constituents to maintain roads that existed at the time of independence.

5. Testing for Differences in Institutions and Culture

The historical accounts presented in Section 2 suggest that differences in local institutions or cultural norms may have arisen as a result of the rubber regime. We test whether exposure to the rubber regime affected a series of important outcomes related to local institutions, including: the quality of local institutions, the accountability of chiefs, and respect for authority. We also test for differences in cultural norms. We focus on pro-social norms, including trust, sharing norms, and respect for property rights. The hypotheses are explained in detail below.[48]

The first hypothesis we test is whether the rubber concession period caused a long-term deterioration in the quality and accountability of local institutions. This hypothesis is motivated by Mamdani (1996), who argues that the creation of unaccountable chiefs during the colonial period has had long-run negative consequences for development in Africa. This hypothesis is particularly salient in both the historical accounts of the rubber period and in the oral histories from individuals in Gemena. Individuals from our interviews described how the rubber regime

[47] Figures A1 and A4 in Appendix A are maps of road networks and bridges.

[48] Before conducting the data collection in Gemena during the summer of 2015, we traveled to Gemena in January 2015 to conduct focus groups. We interviewed elders in the community to learn how the rubber history is understood and remembered by locals and to identify potentially important channels. The set of hypotheses below follow from the history presented in Section 2 and our interviews with elders.

co-opted local chiefs, incarcerated non-compliant chiefs and replaced chiefs with individuals that supported the rubber agents. For example, one of our interviewees noted:

> "Chiefs were sometimes given a percentage for organizing [people to collect rubber]. He would be punished otherwise, with beating, and they would choose another chief eventually if the chief did not obey them. They would replace the chiefs with other chiefs who would welcome them." - Interview, Gemena, January 2015

Today, local chiefs are tasked with organizing public good maintenance and construction, resolving conflict and welcoming outsiders. If the rubber regime altered the quality and accountability of local chiefs, this could explain the worse development outcomes we observe inside the former concessions. We examine differences in the quality of chiefs inside and outside the concession, as measured by provision of public goods. We also look at differences in chief accountability, as measured by the selection mechanism for chiefs. An important consideration when examining differences in local institutions is to account for differences in respect for authority. If respect for chief authority is lower inside the concessions due to the rubber concession period, then local chiefs may be less able to organize productive activities, resolve conflicts, and provide order, even if the chiefs themselves and the formal local institutions are of the same quality. Thus, we also test for differences in respect for authority using survey data and a chief implicit association test (IAT).

Finally, we test for differences in pro-social norms, including trust, altruism, and sharing norms. The rubber period may have eroded norms of trust in others. This is particularly important for trust in outsiders, as both the rubber agents and the village sentries were outsiders. Lower trust in others could potentially explain lower development today, as trust is particularly important for trade in the region.[49] We test for differences in trust using survey questions. We also examine other pro-social norms including altruism and norms of redistribution. Individuals coped with the violence of the rubber regime and political capture by relying on mutual insurance and horizontal ties. As local chiefs were unable to safeguard citizens from exploitation, individuals may have had to increase reliance on forms of informal insurance. Norms of redistribution tend are prevalent in Africa and have been cited as an important explanation for African com-

[49] In this area of the DRC, small villages must trust local merchants to sell their agricultural output and to return with the earnings. If trust levels are low, individuals might decide not to trade and forgo potential income opportunities.

parative development (Platteau, 2000).[50] We examine both self-reported norms of sharing and experimental measures of respect for earned property rights.

5.1. Data Collection

Existing data from DRC does not allow us to measure differences in local institutions or cultural norms. To better examine these channels, we conducted surveys and collected experimental data in Gemena, DRC. Gemena is the capital of Sud-Ubangi province and is situated near the border of the former Anversoise concession (Gemena is less than 10 km away from the former concession border). In the previous analyses, Gemena is consistently an outlier, representing one of the more developed places within the former concessions. The town was created by colonial administrators in the mid-1920s, after the CFS period, and therefore consists primarily of migrants from surrounding areas. Nearly all individuals in our sample identify their "village of origin" as a village outside the town of Gemena.[51]

The data were collected between July and August 2015. As there is no census available for the DRC, we created a sampling frame for Gemena using Google satellite imagery from June 2015. We divided Gemena into 89 polygons and estimated the number of households in each polygon (see Figure 8). We selected polygons to visit using stratified random sampling. The probability of selecting a particular polygon was proportionate to its estimated population. We divided our survey into two visits per household to avoid survey fatigue. The first visit consisted of the main survey module and second visit consisted of lab experiments and a short survey. We selected 40 polygons and visited households within each polygon, for a total sample size of 520 individuals for the first visit and 484 for the second visit.[52] Of those sampled, 49.71% percent identified their village of origin as being from inside the boundaries of one of the former concessions and a total of 511 originate from villages within 200 kms of the former concession boundaries. Figure 9 presents a map of the location of villages of origin within our sample, the location of Gemena,

[50]Strong redistributive norms may hinder development by weakening incentives for investment. As Platteau (2000) notes, profits from investments in these settings are expected to be shared but the downsides from unsuccessful investments are often not shared. Jakiela and Ozier (2016) note that redistribution in sub-Saharan Africa often acts as a "kinship" tax on productive investments.

[51]"Village of origin" is the village where an individual's family or ancestors are from. This is a commonly understood concept in this area and all respondents knew their village of origin.

[52]For the second visit, we limited re-visits to individuals from the area of interest. Additionally, since data collection occurred during harvest, our enumerators sometimes had difficulty tracking down the same respondent for the second visit; thus, we replaced 25 individuals with other individuals using the same skip pattern within the same polygon. In the analysis that follows, we include all observations for which we have data but our results remain the same if we limit the sample to only individuals that participated in both visits.

and the former rubber concessions borders. For more details on sampling and survey methods, see Appendix C.1.

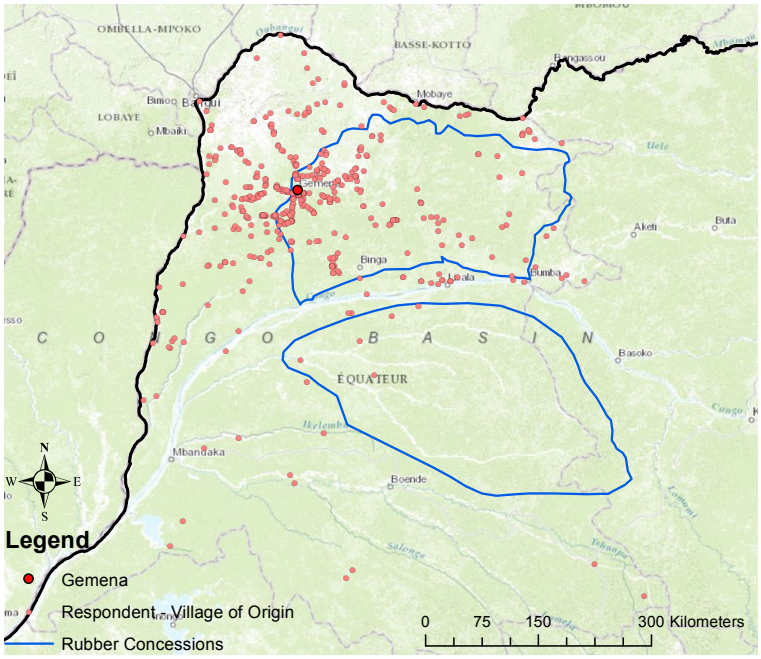
Figure 8: Gemena Polygons for Sampling

We collect data from a Gemena-based sample and compare individuals with ancestors from inside the former concessions to those with ancestors from outside the former concessions. This approach has two main advantages. First, logistically, it is considerably easier to work in one main town rather than numerous villages in the area as transportation infrastructure is of very poor quality. Second, it allows us to more precisely identify cultural differences: by examining individuals removed from their original institutional environments and who now share the same institutional environment, any differences in behavior in experimental measures are capturing differences in internalized cultural norms.[53] The behavioral games we conducted are explained in detail below. Individuals also answered a series of questions on demographics, migration history, income, trust and political attitudes.

In addition to collecting individual level data, we ask individuals detailed questions about the institutions in their villages of origin. Individuals who were familiar with their village of origin were asked questions on the public goods available in their villages of origin, the responsibilities of the local chief, and the selection mechanism for the village chief. By comparing villages on

[53]This follows the approach in Lowes et al. (2015a), and is similar to the strategy employed in Alesina et al. (2013) where they compare migrants in Europe to try to understand cultural differences arising from differences in historical plough use in origin countries.

Figure 9: Gemena, the Rubber Concessions, and Location of Origin Villages within the Sample



either side of the concession border, these questions allow us to understand whether villages inside the former concession have worse local institutional quality.

5.2. *Empirical Approach*

To formally test the hypotheses described above, we estimate analogous versions of equation (1) as in Section 3.3. The survey data has multiple questions that could be used to test the hypotheses of interest. We present all of our survey-based results using thematic indices that group related questions to address concerns of data mining and multiple hypothesis testing. For example, to examine levels of development in origin villages, we group all questions on the existence of various public goods in origin villages. By grouping multiple questions into an index, we both reduce the chance of finding statistical significance on any individual component of an index (type I error) and also reduce the risk of low statistical power (type II error). We follow Kling et al. (2004) and Clingingsmith et al. (2009) and compute the average effect size (AES) across outcomes within an index.[54]

[54]Specifically, for a set of K grouped outcomes Y^k in an index, with $RubberConcession$ local average treatment effect α_k, the AES is $\gamma = \frac{1}{K}\sum_{k=1}^{K}\frac{\alpha_k}{\sigma_k}$, where σ_k is the standard deviation of outcome k in the comparison group, i.e. individuals from outside the former concessions. To test γ against a null hypothesis of no average effect, we jointly estimate the α_k's in a seemingly unrelated regression framework to account for the covariance between effects α_k. See Kling et al. (2004) for more details.

By using the information on individuals' villages of origin, we can estimate a spatial RD. Specifically, we estimate the causal effect of exposure to the extractive institutions on outcomes of interest with the following regression discontinuity (RD) specification:

$$y_{i,v}^{k} = \alpha + \gamma RubberConcession_{i,v} + f(location_v) + \mathbf{X}_i\beta + \phi_{j(v)} + \varepsilon_{i,v} \tag{3}$$

where $y_{i,v}^{k}$ is our outcome of interest for individual i from origin village v for index of questions k; $RubberConcession_{i,v}$ is an indicator equal to 1 if v is inside a rubber concession area; $\mathbf{X}_i$ is a vector of covariates for individual i; $\phi_{j(v)}$ represent district fixed effects; $f(location_v)$ is the RD polynomial, which controls for smooth functions of geographic location for village v. For this section, we present results for our baseline RD polynomial (linear polynomial in latitude and longitude).[55] We present results for observations within 200 kms, 100 kms and 50 kms of the former concession border. All regressions cluster standard errors at the village of origin level. Our coefficient of interest is γ: the causal effect of being from just inside the concession area on our outcome of interest.

5.3. Economic Development in Origin Villages

To verify our own sample relative to the DHS sample, we first examine whether villages of origin within the former concessions are less developed than those just outside the former borders using our survey data from Gemena. We asked individuals about the public goods provided in their villages of origin and their perception of the relative wealth of their village of origin. Panel A of Table 8 presents the AES coefficients for equation (3) for two indices: an index of public goods available in the village of origin, and an index of a respondent's subjective measures of the development of their village of origin. All questions included in the index and their response options are reported in the notes of the table.[56]

[55] The results are similar for other RD polynomials but are omitted to conserve space.

[56] To conserve space, we suppress presenting summary statistics on the sample in the main paper, but Appendix C Table A2 presents summary statistics for the survey data broken down by whether or not an individual originates from inside the former concession. As well, a possible concern with data collected in Gemena mentioned previously is selective migration. However, Appendix Table A3 presents mean differences on key migration characteristics for individuals from inside and outside the former concessions; we find very little evidence of differences in migrant characteristics and/or selective migration between inside and outside the concession. This is consistent with evidence supplied in 4.3. Finally, there is no relationship between being from inside the former concessions and being knowledgeable about one's village of origin, which mitigates concerns about differential knowledge on villages of origin.

Consistent with the DHS results, villages within the former concession are described as having fewer public goods and are rated as less developed. Interestingly, for the subjective ratings, the coefficients of interest are large and negative but not statistically significant. This highlights a weakness of subjective village ratings: individuals might have been using different reference groups. When we combine the two indexes presented in Table 8 into one measure, the results are very similar in magnitude and significance to the public good index results alone. In general, the survey results are consistent with the results from the DHS results in Section 3.4 that show that places inside the former concessions are less developed today.

5.4. Differences in Local Institutions

Quality and Accountability of Local Chiefs

To examine whether there are differences in the quality of chiefs, we construct an index that combines all questions on whether chiefs are responsible for providing specific public goods (and their maintenance) in the villages of origin; a lower value on this index suggests chiefs are of lower quality in the sense that they are not considered responsible for providing key public goods at the village level. To examine whether there are differences in the accountability of local chiefs, we focus on whether chiefs are selected through local elections or if they are hereditary; we interpret hereditary chiefs as less accountable relative to those that are elected. Panel B of Table 8 presents the results examining the quality and accountability of chiefs. Chiefs in villages inside the former rubber concessions provide significantly fewer public goods and are 15 percentage points less likely to be chosen by election.

Respect for Chief Authority

While the results Panel B of Table 8 highlight differences in local institutions, the results could also be consistent with constituents inside the former concessions having less respect for local authority and therefore choosing to invest less in public good provision and maintenance. To examine respect for local chief authority, we first construct an index of subjective survey questions on confidence and trust in local chiefs. We scale all variables so that more positive values indicate greater respect for local chiefs.

Table 8: Local Institutions

	Panel A: Development Outcomes					
	Village Public Goods Index (AES Coefficients)			*Village Subjective Ratings Index (AES Coefficients)*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	-0.171***	-0.174***	-0.197***	-0.110	-0.122	-0.198
	(0.056)	(0.058)	(0.066)	(0.114)	(0.118)	(0.127)
Observations	317	290	231	211	195	160
Clusters	235	212	166	162	149	121
	Panel B: Chief Quality and Accountability					
	Chief Public Good Index (AES Coefficients)			*Chief Elected*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	-0.250***	-0.256***	-0.310***	-0.147*	-0.168**	-0.194**
	(0.095)	(0.097)	(0.107)	(0.078)	(0.079)	(0.085)
Mean Dep. Var.	–	–	–	0.51	0.51	0.52
Observations	274	250	204	277	255	209
Clusters	204	184	147	207	189	151
	Panel C: Respect for Authority					
	Survey Questions Index (AES Coefficients)			*Implicit Association w/ Chiefs Score*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	0.203**	0.201**	0.182*	0.020	0.016	0.043
	(0.091)	(0.094)	(0.100)	(0.059)	(0.060)	(0.063)
Mean Dep. Var.	–	–	–	-0.101	-0.088	-0.088
Observations	338	310	254	459	417	322
Clusters	244	222	178	315	285	219

Notes: Standard errors clustered at the origin village level. Regressions include district fixed effects. *Village Public Goods Index* presents Average Effect Size estimates for the following questions (with the number of components for each questions in brackets): (1) What material is the road in your village of origin made of? [2: 0=Sand, 1=Gravel or Pavement] (2) Is your village of origin on a main road? (3) Does your village of origin have a secondary school? [2] (4) Does your village of origin have a Health Dispensary? [2] (5) Does your village of origin have a Hospital? [2] (6) Does the water in your village of origin come from a well? [2: 0=Spring water, 1=Well]. *Village Subjective Ratings Index* presents Average Effect Size estimates for the following questions (with the number of components for each questions in brackets): (1) How would you rate the quality of the primary school in your village of origin? [5] (2) How would you rate the quality of the secondary school in your village of origin? [5] (3) How would you rate the quality of the road in your village of origin relative to other roads in the area? [5] (4) Relative to other villages in the area you have visited, how would your rate your village of origin overall? [5] *Chief Public Good Index* presents Average Effect Size estimates for the following questions: Is the chief in your village of origin responsible for providing (1) road maintenance, (2) new roads, (3) school maintenance, (4) land allocation, (5) protection of property rights, (6) tax collection, (7) jobs, (8) conflict arbitration, and (9) road brushing; all questions answered as a 0 to 2 categorical variable where 0 is Yes, 1 is Partially, and 2 is No. *Chief Elected* is an indicator variable equal to 1 if the village chief of a respondent's origin village is selected by elections. *Respect for Local Authority Index* presents Average Effect Size estimates for the following questions (with number of components for each question indicated in brackets): (1) How much do you trust your village of origin chief? [4], (2) How much do you trust your sub-tribe chief? [4], (3) How satisfied are you with your village of origin chief? [4], (4) Would you vote for your village of origin chief if there were an election held tomorrow? [2], (5) How much confidence do you have in local chiefs? [4]. *Implicit Association w/ Chiefs Score* is the D-Score for the Implicit Association Test that asked respondents to sort sounds of words related to local chief authority, where more positive values indicate a more positive implicit association with local chiefs. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Because respondents may be unwilling to answer potentially sensitive questions about local political figures truthfully, we also conducted a Single-Target Implicit Association Test (ST-IAT) to measure implicit attitudes towards local chiefs. The ST-IAT was developed by Bluemke and Friese (2008) and is a variant of the original IAT. The ST-IAT was created to measure the positivity or negativity of individuals' implicit association toward a single target. In our case, the target group is chiefs. ST-IATs have been used recently in similar settings in the DRC by Lowes et al. (2015a) and Lowes et al. (2015b).

During an IAT, respondents sort words related to happiness, words related to sadness, and words related to local chiefs to the left or right side of a touchscreen tablet. The intuition behind the IAT is that if a respondent has a positive view of chiefs, he will have an easier time sorting chief words to the same side as happy words than to the same side with sad words. By examining the difference in the speed at which the respondent sorts the words we can infer their implicit view of chiefs.[57] See Appendix C.4 for more information on IATs, screenshots of the IAT, the details of the words we selected, and the protocols for implementation.

With our two measures of respect for authority, we test whether individuals from inside the former concessions have lower respect for authority. Panel C of Table 8 reports the estimates from these two different measures of respect for authority. Interestingly, individuals from inside the former concessions report that they respect chiefs more in the subjective index, even though the results in Panel B suggest the chiefs are of lower quality. This counterintuitive result is consistent with recent work on respect for local chiefs in Africa by Acemoglu et al. (2014), who find a negative relationship between trust in chiefs and public good provision by chiefs in Sierra Leone. Interestingly, the IAT results presented in Panel C demonstrate that there is little difference in implicit views of chiefs: the coefficients are small in magnitude and statistically insignificant.[58] Overall, the measures of respect for authority in Panel C suggest that areas inside do not have lower levels of respect for chiefs and that the results of lower public goods provision by chiefs

[57]Formally, we follow Lowes et al. (2015b) and calculate the standard *D-Score* as our inferred measure of the implicit view of chiefs for a given respondent. The *D-Score* is defined as: *D-Score* $= [Mean(latency^{-ve}) - Mean(latency^{+ve})]/SD(latency^{+ve\,and\,-ve})$, where $Mean(latency^{-ve})$ is the average response time in milliseconds for the block in which the chief words are meant to go right, $Mean(latency^{-ve})$ is the average response time for the block in which the chief words are meant to go left, and $SD(latency^{+ve\,and\,-ve})$ is the standard deviation in response times across both blocks. In this *D-Score*. more positive values will indicate more positive implicit views.

[58]This difference between implicit and subjective measures could be a result of social desirability bias when answering subjective questions, which may influence how individuals respond to questions on local chiefs. This is consistent with the explanation for similar results in Acemoglu et al. (2014), where they argue that lower quality chiefs may be better able to "capture" social society, despite their worse performance.

inside the former concessions are not driven by lack of respect for authority.

5.5. Differences in Pro-Social Norms

Trust in Others

We now turn to an examination of pro-social norms within the former concessions. The rubber extraction may have decreased trust, and lower levels of trust could explain the worse development outcomes in former concession areas. We examine whether trust is different across the former concession borders in Panel A of Table 9 by constructing an index of questions on how much individuals trust various people. We chose these survey questions following work by Johnson and Mislin (2011) and Johnson and Mislin (2012) who demonstrate that trust survey questions have a positive, robust correlation with experimental measures of trust (i.e. amount sent in the trust game).[59] The coefficients on trust inside the former concessions are positive and marginally statistically significant, suggesting that individuals from the former concessions are in fact slightly *more* trusting than those outside the former concessions. It is therefore unlikely that lack of trust in the former concessions is driving the observed results. Following the literature on the effects of violence on pro-social norms (Bauer et al., 2016), we check whether there are differences between "in-group" and "out-group" trust. We do not find that individuals exhibit greater in-group trust or less trust in out-groups.[60] We also ask respondents how close they feel to people to various groups of people. We find that individuals from the former concessions report feeling closer to others.

Sharing Norms and Respect for Earned Income Property Rights

The rubber period may have induced an increased reliance on informal redistribution. We therefore test for differences in norms of sharing income and for a reduced respect for earned property rights – defined as willingness to take from other's earned income (Jakiela, 2011; Jakiela et al., 2014). To test whether there are differences in social norms of redistribution, we first construct an index of survey questions asking individuals whether they think it is appropriate to redistribute income in a variety of different situations. The index includes questions on whether

[59] Interestingly, they find that trust survey questions are unrelated to experimental measures of trustworthiness (i.e. amount returned as player 2 in the trust game).

[60] These results are not reported here, but they are available upon request.

Table 9: Survey and Experimental Measures of Pro-Social Norms

	Panel A: Trust and Closeness					
	Trust Index (AES Coefficients)			*Closeness to Others Index (AES Coefficients)*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	0.122*	0.135*	0.108	0.173**	0.168**	0.243***
	(0.074)	(0.072)	(0.076)	(0.076)	(0.078)	(0.086)
Observations	511	465	365	497	453	354
Clusters	346	313	245	338	306	239
	Panel B: Survey Measures of Sharing Norms					
	For Self (AES Coefficients)			*For Village of Origin (AES Coefficients)*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	0.293***	0.280***	0.297**	0.150*	0.148*	0.115
	(0.108)	(0.106)	(0.117)	(0.091)	(0.089)	(0.098)
Observations	498	453	355	348	320	259
Clusters	337	304	237	243	221	176
	Panel C: Experimental Measures of Sharing Norms					
	Dictator Game: Amount Sent			*Effort Task: Share Taken*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	13.78	15.50	11.88	0.037**	0.038**	0.031*
	(11.69)	(11.90)	(12.50)	(0.015)	(0.015)	(0.016)
Mean Dep. Var.	445	445	448	0.401	0.401	0.402
Observations	482	438	341	481	437	340
Clusters	332	300	232	332	300	232

Notes: Standard errors clustered at the origin village level. Regressions include district fixed effects. *Trust Index* presents Average Effect Size estimates for the following questions: How much do you trust (1) people from your village of origin, (2) people of another tribe, (3) people of your own tribe, (4) people you meet for the first time, (5) your family, (6) your neighbors, (7) people of another nationality, and (8) people of your sub-tribe; all questions answered on a 0 to 4 scale where 0 is Not at All and 4 is Completely. *Closeness to Others Index* presents Average Effect Size estimates for the following questions: (1) How close to you feel to people from your village of origin?, (2) How close to do you feel to people of Gemena?, (3) How close do you feel to people of your own tribe?, (4) How close do you feel to people of your age set from your origin village?, and (5) How close do you feel to people of your age set in Gemena?; all questions answered in a scale from 0 (Not Close at All) to 5 (Very Close). *Sharing Norms Index* presents Average Effect Size estimates for the following questions: (1) If you get money from luck you should share it, (2) If you earn money from hard work you should share it, (3) If someone else earns money from luck they should share it, (4) If someone else earns money from hard work they should share it; all questions answered in a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). *Sharing Norms Index Village of Origin* presents Average Effect Size estimates for the following questions, where all questions start with "How much would someone from your village of origin agree with the following statements", for the same statements listed above. *Dictator Game* measures the amount sent to an anonymous player 2 in the standard Dictator Game. *Effort Task: Share Taken* is the total share taken (weighted by the maximum budget amount possible to take) in the effort task from the anonymous player 1's earned income. It represents an experimental measure of respect for earned income property rights. Two individuals declined participating in the Dictator Game, and one additional individual declined participating in the Reverse Dictator Game. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

you should share your own income when it is earned by luck or work and whether others should share their income with you when it is earned by luck or work. We also ask the respondent how people in their village of origin would respond to the same series of questions.

Panel B of Table 9 present the estimates for each of these measures. Individuals from the former concessions are more likely to agree that income should be shared with others. They are also more likely to report that individuals in their villages of origin would also agree that income should be shared. Individuals support sharing income regardless of whether it is earned by work or luck and regardless of whether they are speaking about sharing their own income with others or others sharing with them.

We also collected experimental measures of sharing norms. Individuals in our sample participated in a dictator game (DG) to measure altruism and in a reverse dictator game, to measure respect for earned property rights. In the standard DG, a player 1 is given an endowment and is asked to allocate it between themselves and a player 2. The reverse dictator game differs in two key ways from the standard DG. First, the player 1 earns an endowment through an effort task. Second, the player 2 is told how much the player 1 earned and is asked what share of the player 1's earned income they would like to keep for themselves.[61] The amount player 2 decides to take from Player 1's earned income therefore represents a measure for the respect for earned property rights.

In our experiment, each respondent is matched to an anonymous, randomly selected individual from Gemena.[62] Additionally, every respondent plays the game twice: once as player 2 where they divide the earned endowment of the player 1 and then as a player 1 where they earn an endowment. Respondents first learned about the general structure of the experiment, the details of the earning task, and then decided whether to participate or not. Before performing the effort task (i.e. the task to earn an endowment as a player 1), subjects decide how they want to take from an anonymous player 1's income.[63] The share of earned income that player 2 decides to take

[61] Variation (i) of the DG has been used before by Hoffman et al. (1994) and Cherry et al. (2002); subjects tend to be much less generous when they earned their own income, which Farh and Irlenbusch (2000) refer to as *earned property rights.* Variation (ii) on its own changes the standard DG to what is known as a Reverse DG, which has been used many times before (List, 2007). Jakiela (2011) combines these two variations to get a measure of respect for earned property rights and finds that subjects in the US tend to others' respect earned income much more than subjects in Kenya.

[62] This individual was chosen from within our sample. Matches remained completely anonymous to everyone on the team except for the authors. This removed strategic considerations from the decisions of the participants on how much income to take from others.

[63] We used the strategy method to elicit these divisions: for each of the 20 possible amounts player 1 can earn in the effort task, respondents would enter the amount they wished to take for themselves.

from Player 1's earned income is our measure of respect for earned property rights.[64]

For the effort task, we selected a task that could be easily understood by all respondents and for which more effort was rewarded by more income. Subjects played a "clicking-game" on touch screen tablets. In this "clicking-game," a small blue dot appears in a random location on the screen every three seconds and the respondent has one second to push the dot before it disappears. Importantly, this effort task did not rely on physical strength or skill but instead relied on concentration and perseverance. It is purposefully a very boring game. The game lasted five minutes and respondents were paid based on the number of successful "clicks," earning 100 Congolese Francs (approximately $0.10) per 10 successful clicks.[65]

Panel C of Table 9 presents the estimates for the experimental measures of altruism and respect for earned property rights. We find no significant differences in amount sent in the dictator game, thought the coefficient on inside concession is positive. For the reverse dictator game, we find that individuals from the former concessions redistribute a larger share of the other players earned endowment. We interpret this as having less respect for earned property rights and greater support for redistribution, consistent with the survey measures on sharing norms that suggest individuals think income should be shared.

The results in Table 9 provide evidence that individuals from inside the former concessions have more pro-social norms. Specifically, individuals from inside the former concessions are more trusting, feel closer to others, believe it is important to share income, send more in a dictator game, and redistribute more in a reverse dictator game. Given that pro-social norms are generally associated with better development outcomes this is somewhat surprising. These results, however, are consistent with a literature on the effects of violence on social preferences. In a recent review paper, Bauer et al. (2016) present evidence from multiple studies that exposure to violence can increase norms of local cooperation, but that having more pro-social norms does not seem to be sufficient to improve development outcomes. Our results are similar in that we find evidence of more pro-social norms but worse development outcomes. However, we examine an historical episode of violence, while most papers in the study examine the effects of more recent violence.

[64]See Appendix C.2 for more details on the Reverse DG with Earned Income, the protocols used and the earnings task.

[65]Respondent were very engaged in the task and earned on average 700 CF in this task.

5.6. Discussion of Results

The results above indicate that individuals from former rubber concessions (i) originate from villages with lower quality and less accountable chiefs, (ii) are more trusting of others and (iii) potentially possess stronger sharing norms. The institutional results provide a plausible explanation for the present day underdevelopment of former concession areas and may help explain how an historical event of short duration continues to matter for development today. The results on pro-social norms, which suggest that individuals from within the former concessions are more pro-social, are puzzling in that we generally expect more pro-social norms to be associated with more development.

An important question is whether the differences we observe in institutions and culture are both directly due by the rubber regime, or whether a change in one led to a change in the other. With the existing data and archival resources, we are unable to answer this question definitively. However, guided by the historical accounts, we offer a speculative discussion in this section. While it is possible that both were independently affected by the rubber regime, historians have highlighted that these changes in institutions and norms could have reinforced each other:

> *"European conquest of the interior caused many Mongo big men to lose their positions of power and prestige and to be replaced by others deemed more loyal to the European state. Traditional forms of social stratification were altered as individuals were forced to cooperate in unprecedented ways to survive. ... These changes, despite their seemingly disparate natures, were intimately interrelated, for they were ultimately rooted in changes ... in work demands and activities [due to the rubber regime]."* (Nelson, 1994)

Our results are consistent with this idea from Nelson (1994) that changes to institutions and culture reinforced each other in this setting: as local chiefs were co-opted by the rubber concession agents or replaced with less accountable chiefs, villagers began to rely on each other for survival. This would imply that local institutions and norms of increased reliance on informal redistribution acted as substitutes. This result would be in line with theoretical work by Tabellini (2008) and Bisin and Verdier (2015).[66]

An important question then is why did these changes persist? One explanation may be that these changes possibly reinforce each other: chiefs are held less accountable and allowed to stay in power since individuals do not rely on their formal institutions as much and instead

[66] Additionally, it is related to work in anthropology by Scott (2010), who describes numerous cases of how villagers rely more on each other and withdraw from a state when they see the state as illegitimate.

rely on informal norms for support. Importantly, this is a setting with extremely low central state-capacity. This could help explain why this low development equilibrium has not been perturbed. Today, we see that both of these channels matter for economic development: worse institutions and stronger norms of redistribution would imply less engagement in risky activities such as trade, entrepreneurship, and cash crop farming. Appendix Table A22 presents survey evidence that suggests that this is in fact the case.

6. Conclusion

This paper exploits the well-defined boundaries of concessions given to private companies to extract rubber during the Congo Free State era to the examine the long-term effects of extractive institutions on development. Previous research has shown that historical events of long duration matter for long run development. We demonstrate that the 14 year exposure to extractive institutions during the CFS era has affected the development of this region of Congo.

The rubber concession period was characterized by its extreme brutality and violence, earning the period the nickname *"red rubber"*. Former rubber concession areas have lower levels of education, worse health outcomes and are poorer than areas outside of the concessions. We find no evidence that areas inside the former concessions are converging to the development levels of areas outside the former concessions. The differences in development inside and outside the former concessions cannot be explained by subsequent differential colonial treatment or missionary presence.

We then examine how deeper channels for development were affected by the rubber concessions. Using data collected along the boundary of one of the former concessions, we find evidence that there are important differences in local institutional quality inside the former concessions relative to outside. Inside the former concessions, chiefs provide fewer public goods and are less likely to be elected. We argue that the rubber concessions affected institutional quality, and that this helps explains why these areas are more poor today.

Additionally, we present evidence that individuals inside the former concessions are more pro-social. They are more trusting and are more likely to state it is important to share with others; however, we do not find significant differences in giving in a dictator game. In a reverse dictator game, individuals are less likely to respect earned property rights. These results are unlikely to explain the relative underdevelopment of former concession areas given a large literature that

relates trust and economic growth. They are however quite similar to recent work on how people in post-conflict areas exhibit more pro-social norms.

Studying the legacy of this historical event – the Congo Free State rubber concessions and their aftermath – highlights how even historical events of short duration can have lasting effects on development, local institutions and culture. The rubber concession period caused worse development outcomes inside the former concessions. We demonstrate that the rubber era affected local institutional quality, and that this plausibly explains the underdevelopment in these areas. We also find evidence that individuals from the former concessions exhibit more pro-social norms and more favorable views of informal redistribution. This paper demonstrates how Africa's colonial history and exposure to extractive institutions continue to matter for comparative economic development today.

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